

insurance matters

Focusing on personal lines pricing

**The Equality Bill
and pricing**

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and its impact
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**Houses built on sand –
are special offers
providing a solid
foundation for
profitable growth?**

**Motor market
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**When GLMs go
wrong – or how to
tell when your models
are not working**



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Welcome to insurance matters

Welcome to the fourth edition of 'insurance matters'. In this issue we are putting the spotlight on personal lines insurance. There are a number of current issues affecting the UK personal lines market which we felt would benefit from a more detailed investigation, and we are sure you will agree that there is much to think about.

Watson Wyatt works with a wide variety of UK personal lines companies, ranging from high profile direct writers to traditional broker based insurers. This gives us the opportunity to identify market trends and ensure that all our clients receive the highest quality advice. The authors of this edition have used this experience to create a series of insightful and topical articles which we hope you will find valuable.

There is much in the current market to give pause for thought. A common theme running through this edition is the difficulty of achieving profitable growth. Ryan Warren looks back at the UK motor market in recent years, and discusses the long run of poor performance. Against this background, Michael Garner discusses one possible explanation of this – the 'winner's curse'. Looking forwards, James Tanser reviews the recent consultation paper on the Equality Bill, and considers how this may impact the way insurance companies and intermediaries price insurance. Richard Bretton concentrates on the household insurance market, where a plethora of cut-price offers threaten to swamp the market. Finally, Richard Bland looks at the core analysis which underlies much of modern pricing – the generalised linear model – and examines the clues that tell you when it is perhaps not as reliable as it should be.

We hope you enjoy this edition, and we would welcome any feedback you have on future topics you would like to see addressed.

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A man with short brown hair and glasses, wearing a dark blue suit, white shirt, and blue patterned tie, is smiling and looking towards the left. He is in an office environment with a computer monitor on a stand visible in the background. The image is partially obscured by a green horizontal bar at the bottom.

The Equality Bill and pricing

The proposed Equality Bill may potentially impact how insurers price insurance. James Tanser reviews the current proposals and considers how insurance companies could adapt.

The UK government is proposing a new Equality Bill, which includes provisions to prevent discrimination on the basis of age. The feature box overleaf contains further information on the proposals.

Current legislation forbids age discrimination in the workplace, but there is no current legislation to prevent age discrimination in other areas. The Equality Bill is designed to address this issue, but there is a real risk that this will have unintended consequences, perhaps even result in a step backwards towards a universal tariff structure.

Background

This article considers what the proposals will mean for insurance companies, in particular what it may mean for insurance pricing.

A consultation paper on the age-related aspects of this bill was published by the Government Equalities Office on 29 June 2009 setting out their proposed approach and asking a number of specific questions. This phase of the consultation closes on 30 September 2009, but this is not the end of the process. The detail of the legislation will be updated following the consultation, and there may be a further opportunity to influence the final wording of the exemptions in 2010. The current plan is for the new rules finally to come into effect in 2012, although some aspects may be delayed further.

Planning for the changes

Given that it seems unlikely that the industry will be able to secure a total exemption (see feature box overleaf), we must accept that some form of restrictions will be applied to the use of age as a rating factor. Unlike the

gender legislation, where it appears unlikely that there will be a legal challenge to gender relativities, the pressure groups campaigning for equal rights for the elderly may well decide to challenge high premiums for the oldest policyholders. What steps can insurance companies take to deal with this issue?

A vital foundation for preparing for this legislation is ensuring that all the processes are clearly documented. Ensuring that you have a clear audit trail from data analysis to premium is in any case best practice, and a good way to manage operational risk. However, in the event of a legal challenge, good documentation will save time and effort and enable a robust defence to be constructed. Introducing this type of documentation can be unpopular, as it can seem to be adding an unnecessary layer of bureaucracy. To avoid this problem it is important that documentation is embedded within the IT systems used, so that (as far as possible) the documentation is produced automatically.

Companies should also be considering which of the options they wish to follow for the published relativities. In its present form, the proposal allows for use of either the company's own data, or pooled industry data; it even allows for one company to rely on a second company's data. There are clearly advantages and disadvantages to each option. Taking part in industry pooled data schemes protects a company's data privacy, and potentially may allow them to argue for a wider divergence between premium relativities and published data. On the other hand, if a company's experience for an age group differs widely from the industry, publishing their own data will allow them to price for this experience.

There are clearly implications for price optimisation, as price comparison websites can be used to calculate spot relativities to compare with the published risk data. However, as premiums do not necessarily have to be proportional to risk, this might be dealt with by applying a suitable constraint as part of the optimisation. For example, the optimised premium could be defined as risk cost plus expenses plus an optimised profit loading. The profit load could then be constrained to within a 'reasonable' range. This approach will reduce the benefits from optimisation, but still allow some scope for achieving company-specific targets.

One problem with this approach is that it does not limit relativities only for age – it ties premiums to cost across all the variables. In theory, you might want different profit margins for different levels of loyalty; for example, 0 to 1 per cent for new business and 3 to 5 per cent for renewing business. In this case, a two-stage process may be required: first doing an unconstrained optimisation, then fitting a model to determine the average age relativities. If these differed too much from the acceptable profile, a final model would be fitted, restricting age (and gender) to follow the allowable pattern. This would produce a new 'optimal' rating structure which could then be used going forward.

Special care will need to be taken where intermediaries are optimising their commission. There are two possibilities here:

- The intermediary offers premiums from a single insurance company only under a 'net rate' arrangement, where the intermediary pays a pre-agreed net premium to the insurance company, but is free to charge whatever they like to the customer.

Proposed legislation

The current proposals contain a number of exemptions where age differentiation is considered to be beneficial. For example, reduced cost travel for students and pensioners will be allowed to continue, as will cheap haircuts for over 65s. Similarly, age-specific clubs (such as retirement clubs) and holidays (including both '18–30' type package holidays and trips targeted at the retired) will also be allowed, so long as it is clear from promotional material what age restrictions are in place. For financial services, three alternative approaches are considered:

- No specific exemption is included, but age differentials are allowed where objectively justified. This would require product-by-product justification, with each insurance company separately having to justify its own relativities. The consultation paper suggests that this approach may have side effects, such as reducing the availability of insurance and increasing costs.
- A tailored exemption is added allowing age differentials proportionate to risk and cost. This may allow age bands and also premium relativities which are not strictly proportional to risk. Where cover is declined on the basis of age, insurers would be required to redirect customers to alternative providers.
- A wide exemption is added which would allow the current practices to continue. This is a business as usual approach, and has no requirements to redirect customers to alternate providers.

The government's preferred option is the second of these, with a tailored

exemption, and this is outlined in some detail in the consultation paper. The following paragraphs consider some of the detail of this preferred option.

The proposals are similar to the existing gender legislation, and would require evidence from the company or industry to justify premium relativities. It is likely that this evidence will need to be published, and age-related pressure groups are sure to scrutinise this data. (Interestingly, the discussion paper says that this may act to lower the barriers to entry, although it is not clear how this would work in practice.)

An element of good news is that strict proportionality is not currently expected. This seems reasonable as some elements of the premium are fixed (such as administrative expenses) and others vary with risk. As there is an element of judgement involved companies may find themselves having to justify their selections in court. The paper also considers allowing commercial considerations, with the example given of "pricing to retain customers". It remains to be seen, of course, how the authorities will differentiate between a commercial discount for 40 year olds and discriminatory loadings for 80 year olds. It may well turn out that these commercial discounts can only be given to groups with a vocal pressure group.

One area of potential concern was the suggestion that age bands would be forbidden, for example in travel insurance. The current proposals do allow age bands, although they may require bands to be narrower than at present. There is some discussion about the cross-subsidies implicit in age

bands, but the general conclusion is that older customers probably benefit from them. The government acknowledges that a combination of a lack of data and the cost of producing literature giving individual age-based premiums means that age bands are probably justified for some product types.

Another worry was that insurers would be obliged to offer cover to all ages, as this would threaten the business model of a number of specialist insurance companies. The current proposals will allow this type of specialisation, so long as customers falling outside the permitted age range are redirected to appropriate suppliers.

The Bill outlaws both direct and indirect discrimination but the discussion paper is silent on what insurance practices might be considered as indirect discrimination. However, indirect age differentiation is permitted where it can be justified, and so it is likely that the same requirements which apply to age will also be applied to other variables.

Comment

In general, the proposals seem to have addressed many of the key concerns of the industry and look to be a reasonable approach to the issues. For example, the consultation paper recognises that older age groups may actually benefit from some practices. While the industry may prefer the third option, the second option does not appear at first glance to place too many constraints on insurance business. While the detail may change, it is worth thinking about how this will affect pricing in the future so that appropriate plans are in place.

In this case, the intermediary may generate a discriminatory premium relativity which was not present in the net premium. This issue may reduce the scope for price optimisation by such intermediaries.

- The intermediary acts as a broker with a panel of insurance companies each offering a net rate. In this case, two quotes for an identical policy differing only in the policyholder age may well be allocated to different insurers. This could disguise premium relativities and continue to allow full optimisation. However, care would need to be taken that unusually large premium differences are not produced for the same insurer.

There are a number of techniques which will allow companies to produce reasonable relativities from quite sparse data, for example, the use of regression splines. In the event that age bands are banned or reduced to a smaller size (for example, five year bands for travel insurance), these techniques, together with industry data, should allow insurers to derive a set of relativities which would meet the requirements of the proposed legislation.

The need to recommend alternative insurers may actually provide a useful source of income to insurers. A number of companies already operate a panel so that customers who they do not wish to underwrite are passed on to another organisation in return for a commission payment. The Oxera report for the Government Equalities Office did not find a shortage of products at any age group, so this is one requirement which represents a win-win: customers find cover

more easily while insurers and intermediaries capture a profit stream they may currently be missing.

What next?

The published schedule for this Bill runs over the next general election and a new government may have different priorities. That said, few politicians would want to be seen opposing equality, and the post-retirement electorate is increasingly important in UK politics. It would seem sensible to start planning for the proposed changes, while continuing to lobby to ensure that the final options chosen will produce a viable framework.

It will be interesting to see if this legislation reduces the scope for price optimisation, or reverses the trend of customer value belonging to the intermediary rather than the underwriter. Many actions have unexpected consequences, and in this case, the proposed legislation may be a step back towards a tariff structure. Ultimately, more constraints on a market tend to lead to fewer competitors and higher prices. While the industry may welcome lower loss ratios, the customer may not benefit from these changes in the long-run. It could be argued that the UK motor market (for example) is already operating at very high levels of market efficiency, and competition means that pricing is already as fair as it can be.

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“...the proposed legislation may be a step back towards a tariff structure.”

References

The Government Equalities Office website: <http://www.equalities.gov.uk>

Age consultation paper: <http://www.equalities.gov.uk/pdf/13511%20GEO%20Consultation%206th.pdf>

Oxera research paper: <http://www.equalities.gov.uk/pdf/The%20Use%20of%20age-based%20practices%20in%20financial%20services%20Final%20Report.pdf>

A man in a dark suit, light blue shirt, and blue patterned tie is smiling and looking towards the right. He is sitting at a desk with a laptop in front of him. The background is a plain, light-colored wall with a vertical shadow.

The 'winner's curse' and its impact on aggregators

Michael Garner examines how this phenomenon displays itself when insurers sell business via aggregator websites, and what can be done to avoid falling victim to the curse.



The winner of an auction based on imperfect information tends to pay too much – this concept is known as the ‘winner’s curse’. In this article, Michael Garner explores the pricing challenges facing insurers in this competitive market.

Emergence of a ‘winner’s curse’

After newer technologies allowed off-shore drilling by the Petroleum Industry in the late 1940s, the race for oil companies to secure drilling rights began. The US Department of Interior auctioned offshore oil leases in the Gulf of Mexico and this left oil companies with the problem of estimating how much to bid for each lease site. Companies each had different information on which to base their bids and the methods available to determine the volume of underwater oil were new and somewhat primitive.

By 1960, with many offshore wells in production, the business was clearly proving to be unprofitable. Had the winning bidders bid too high? Economists studying this in the 1970s thought so. They coined the term ‘winner’s curse’ to describe this outcome: when bidders have imperfect information, all make errors in estimating the ‘true’ value, and so the highest bidder will necessarily be offering too much.

More recently this winner’s curse has also been at play when governments have carried out auctions for radio

frequency spectrums, mobile telecommunication spectrums such as third generation (3G) mobiles, CO₂ permits, defence contracts and highway construction contracts. Possible overpayment due to the winner’s curse here has had a direct impact on insurers as some winning companies saw a steep fall in share price, leading to D&O claims.

The winner’s curse affecting aggregators

Selling insurance contracts via aggregators is a lot like the oil field auctions in which the winner’s curse phenomenon was first exhibited. Each company providing a quote through the aggregator is attempting to put a value on a series of future cashflows uncertain in both timing and amount. The main difference is that, in the case of insurance, the cashflows are negative so the bidding insurance company is paid for taking them on, and so it is generally the lowest bid that wins.

A personal lines insurer making a mistake in its pricing and exposed to the merciless operation of the aggregator can pick up large volumes of underpriced business in a very short period of time. Insurers selling via aggregators are therefore particularly vulnerable to the winner’s curse, as they also face:

- a high level of uncertainty surrounding the future cashflows and difficulty in modelling and measuring those cashflows

- the price-focused nature of aggregators – meaning the lowest bid generally wins, even when that bid is significantly out of line with the next lowest bid
- the ‘common-value’ issue – the ‘true’ value of the cashflows is similar for all insurers providing quotes through the aggregator (unlike, for example, an antiques auction where each item may genuinely have a substantially different value to different bidders).

Overcoming the winner’s curse

How can insurers selling business through aggregators, but seeking to offer competitive rates, try to counter the effect of the winner’s curse? Some possible approaches would be to:

Differentiate on areas other than price

- Price is clearly a key feature of purchasing decisions on aggregator sites, but the lowest quote does not always gain the policy. Insurance companies with a strong brand can convert policies even if they are not the cheapest. This effect is potentially magnified by the trend for aggregator sites to give more details on coverage and excess on the results page.

Reduce uncertainty

- Ensure that the actuarial control cycle is operating and that the actual results of past years' underwriting and pricing are compared to the expected results with suitable adjustments then made to the pricing.
- Improve the accuracy of pricing to reduce errors – the existence of the winner's curse makes it more important than ever for an insurer to have accurate pricing and expense models. A 'back to basics', thorough review of pricing methodology can help. Selling via an aggregator means any selection can happen very quickly and in large volumes. More focus on the underlying risks and costs involved, as well as constant monitoring of volumes and trends is critical. Attention should also be paid to getting the expenses correct, particularly since the volume of business from the aggregator channel may be very volatile.
- Concentrate on niche business where superior expertise can be built up.
- Use random pricing to judge elasticity and susceptibility to the winner's curse.

Opt out of aggregators altogether

- If insurers decide that aggregator commissions are too high for the business gained this may be a sensible option. Some insurers have even used the fact they do not need to pay aggregator commissions as a selling point. This may be doubtful given the costs of

obtaining business through other means, but an insurance group with a few strong brands could quite successfully have some participating, and others opting out of aggregators. They can hope to pick up the business to be gained through the aggregator channel, and still have a selling point of avoiding aggregator sales through another brand.

Address the common value issue

- Introduce superior claims handling techniques to mean that the actual expected costs of claims are genuinely lower than for competitors.
- Aim for a competitive advantage on internal costs, acquisition costs or cost of capital (including reinsurance costs), all of which mean a lower premium can be charged for the same expected claims ratio.

Conclusion

For personal lines insurers, already struggling with how to make money when on the panels of brokers with 10 or more insurers, the rise of the aggregators has dispelled any real doubt that much of personal lines business is an ultra-competitive auction where the insurer offering the lowest price tends to prevail. This is more prone than ever to the effects of the winner's curse.

The winner's curse has shown itself to be a fundamental part of many auction processes, and aggregators are no exception to this. Can insurers selling through aggregators ever

escape the effects of the curse? Individual insurers might take some of the steps suggested above to try and avoid falling victim, but if the rest of the market follows, this is only likely to offer a temporary respite. Improved pricing can only go so far in overcoming the curse – even the best pricing structure may contain some error and so could fall victim to the curse.


In an aggregator market where the curse is prevalent, we might hope that the market as a whole will adjust to mitigate the effect of the curse by raising profit margins to add a risk margin. It has to be said that it is doubtful that such an approach could stay in place for very long in the highly-competitive, cyclical markets currently being experienced. It therefore remains to be seen whether markets using aggregators can ever truly overcome the curse, or whether it is likely to forever remain an inherent feature of any such auction-based channel.

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“ Improved pricing can only go so far in overcoming the curse – even the best pricing structure may contain some error and so could fall victim to the curse. ”



Houses built on sand – are special offers providing a solid foundation for profitable growth?

Richard Bretton considers some of the wider implications of the current offers.

“...there is a real danger that an immediate increase in volume is considered a measure of success.”

Discounts, freebies, guarantees!
At present there are a fantastic range of offers being made to customers seeking to buy new home insurance.

Insurance companies are obviously keen to win new business and hope that generous headline promotions will achieve their aims. However, with almost every major provider in the market currently selling new policies at some level of discount, are the benefits really so clear or do the new volumes come at a heavy cost?

Promotions

The specifics of deals on offer vary between companies, but common features are that they are simple, easy to communicate and are only available to new customers. Many approaches are targeted at customers taking both buildings and contents cover, where there is an initially larger pot of money from which to discount. Simple percentage discounts, free or discounted contents cover and online discounts are commonly available for these customers. These discounts have some justification, of course, as customers with both buildings and contents are often lower risk, and there may be genuine online savings. However, the advertising around these discounts may change the profile of customers, potentially reducing the actual benefit.

Other insurers have opted for a pure financial incentive approach, unrelated to the premium amount.

Cashback offers, interest-free monthly payment options and even entries into competitions are being used. A more subtle solution, appealing to forward thinking customers, is the guaranteeing of fixed premiums or discounts at future renewals. Another common approach is to offer free or enhanced cover. Offering free home emergency or legal cover, or unusually high standard sums insured can be very attractive to some consumers. Indeed, this can be a way of indirectly targeting specific segments of the market.

In addition, some insurers have recently launched discount versions of their products in response to the current economic climate. These lower level cover policies are heavily discounted from standard rates.

Though many solutions result in reduced average profits from policies in year one, some solutions do incorporate amendments to policy terms that aim to make offers cost neutral.


Conversion and retention

The hunger to forego income to achieve sales seems to be predicated on the assumption that home insurance customers are loyal and there is therefore a good opportunity to recoup income in future years.

The promotions undoubtedly are attractive and help win new business, but there is a real danger that an immediate increase in volume is considered a measure of success. There is little reason to believe

that customers attracted by special promotions at reduced costs will behave like customers attracted in the past on standard risk-based premium rates. It is not unreasonable to expect that people attracted to a company by discounted rates will be more likely to go looking for another discounted deal with a competitor one year later.





“ The increasing use of aggregators makes it easier than ever before for customers to find companies who are willing to offer a lower premium than a market average. ”

Most offers are available only for first year premiums and so at first renewal customers taking these deals will see large premium increases. Past observations of renewal behaviour rarely reflect periods where such significant premium increases were imposed at first renewal. Therefore, even allowing for a potential difference in the type of customer attracted via an offer, it is very dangerous to assume that future renewal rates will follow historically observed behaviour.

An interesting issue is one of customer expectations. If the customer is told of an increase in the renewal when they take out the policy they may be more tolerant of a given change than customers who are not told to expect an increase. Indeed, the change could be managed by offering customers coming off a promotion a smaller discount, balancing the financial reality of higher premiums with the marketing message of giving a further discount. Measurements of success of a promotion, and therefore the appetite to repeat the offer in future should therefore be strongly linked to timely and complete analysis of retention rates for customers obtained through a particular deal.

Profitability of customers

It is a common observation that loyal customers have low loss ratios even allowing for lower premiums often

offered to them. It is again dangerous to assume that the quality of new business won during discounted periods will be the same as the quality of an existing portfolio.

The increasing use of aggregators makes it easier than ever before for customers to find companies who are willing to offer a lower premium than a market average. In some situations, the cheapest quoting company may indeed have identified an otherwise overpriced customer, but it is reasonable to assume that in most cases being out of line with the rest of the market may indicate over-optimism (see the article: 'The 'winner's curse' and its impact on aggregators' on page 8 for more on this problem).

The common practice of making offers available only to customers of a 'minimum quality' (for example, claim-free for a defined period) does give some comfort that business won is not particularly poor, but some risk remains. It is therefore very important to analyse the claims experience of business won via a particular offer as soon as there is enough data to do so, to give a full measure of the success of a campaign.

Allocating costs

Analysing the data relating to promotions brings its own challenges. It is of course important to accurately record and easily access information about the specific deal under which

a customer was acquired. Allocation of discounts to different elements of cover needs to be treated carefully, and it is not always appropriate to record the data in the same way as it is presented in the promotion itself. Failing to approach this in a reasoned way can make it very difficult indeed to assess the relative profitability of buildings, contents, standard, accidental damage or other additional cover types.

Most customers do not actually care for example, whether they are being offered 50 per cent off their contents insurance. They simply want a cheap overall quote for the type of cover they seek, and it is the headline aggregate premium that dictates whether the sale is achieved. It may therefore be appropriate to allocate any discounts proportionally across the covers irrespective of how the promotion is being messaged.

There is a further complication however, as the existence of a promotion may itself result in different combinations of covers being sold. Some customers do not have a strong desire to hold particular covers, and whether they buy them or not simply depends on their assessment of whether the price offers value for money. Customers receiving discounts on standard covers may actually be willing to use the money saved to buy add-ons to their policy.

Of course, actually arriving at the promotion's cost is non-trivial as in heavily marketed promotions it may also be appropriate to allocate an element of the campaign-specific marketing costs to policies, in addition to specific premium discounts.

It is clear that a reasoned approach to allocating the costs of promotions is therefore vital for proper assessment of the value of offers, and should be based on detailed analysis of new customer purchasing behaviour.

Do special offers provide a firm foundation for profitable growth?

As the points above illustrate, this question is not simple to answer. Clearly, promotions attract customers and increase new business volumes, but the cost of offers in the first year due to reduced premiums can be high. Whether a promotion represents overall good value to a company depends on the quality of the new business acquired and whether it can be retained in the future. Each company's volume versus profitability appetite needs to be factored in to the assessment.

The dramatic differences to business that can arise following attractive promotions means it is very important to fully capitalise on successful campaigns and to quickly remove detrimental ones. Holistic assessment of the costs and benefits needs to be undertaken quickly and can be

complex because there is often a lack of relevant historic data. It is difficult to project the results from promotions with much certainty ahead of launch, and simple performance indicators can give a misleading impression of the success of campaigns.

Attracting new business is important, but in a market where most providers are offering some sort of discounts, might current efforts be better rewarded by focusing on retaining good quality business already on the books?

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Motor market profitability

Ryan Warren discusses a recent investigation by Watson Wyatt into the UK motor market, and reveals a bleak future for shareholders.

Car insurance companies are struggling to make a profit. A study into the UK private motor insurance industry by Watson Wyatt reveals insurers have made a £1 billion underwriting loss during 2008, which is likely to surprise shareholders with another below expectation return on their capital of -11 per cent per annum.

Insurers have tried to bolster their results by releasing surplus contained in reserves for prior years, and some have dramatically reduced reinsurance costs through large increases in their risk retention. However, the continuing rising cost of claims means that premiums desperately need to increase.

According to returns to the FSA, the private motor insurance market (excluding Lloyd's and foreign-domiciled firms) reported an underwriting loss (premiums less claims and expenses) of £493 million in the 2008 fiscal year. During the same period, however, insurers released a large amount from the reserves held in respect of previous years' liabilities, therefore disguising the actual underlying performance of the business. Watson Wyatt has undertaken a study which included removing the reserve releases in each fiscal year so that the accident year result is not affected by prior accident years and allocating each

fiscal year's reserve release to the accident year from which it came, to understand better the true underlying profitability of the market. It has been assumed that all accident years as at 31 December 2008 are correctly reserved. This study has shown that the market achieved a net underwriting loss of £1,030 million during 2008, which is significantly worse than the headline fiscal result. This corresponds to a combined ratio of 115 per cent for the 2008 accident year compared to the 108 per cent fiscal year combined ratio. As the net earned premium figure is £6.8 billion, this implies a disappointing result of -15.1 per cent of the net earned premium.

The adjusted 2008 result is a very slight reduction from the underwriting loss of £1,123 million achieved during 2007. This small improvement follows a period of continuously deteriorating results since 2004, which was the only profitable year in the past 10, and when the market had made an underwriting profit of £77 million after allowing for subsequent reserve movements.



The key reason for the slightly improved result was a small reduction in the net claims ratio, the main constituent of the underwriting result, from 88.4 per cent in 2007 to 85.4 per cent in 2008. The smaller loss ratio is mainly driven by a 7 per cent increase in the overall net earned premiums. This material increase in overall net earned income appears surprising, however, when considered alongside the small change in gross earned premiums. This anomaly arose because a couple of the largest insurance groups restructured their reinsurance programme for 2008, leading to significant savings in their reinsurance spend. These insurers appear to be

Figure 1 | UK private motor insurance market

	2008	2007	2006	2005	2004	2003
Net earned premium	£6,812m	£6,365m	£7,102m	£6,455m	£6,368m	£6,043m
Net incurred claims	£5,820m	£5,629m	£5,779m	£4,863m	£4,555m	£4,259m
Underwriting balance	-£1,030m	-£1,123m	-£579m	-£220m	£77m	-£276m
Loss ratio	85.4%	88.4%	81.4%	75.3%	71.5%	70.5%
Underwriting ratio	-15.1%	-17.6%	-8.2%	-3.4%	1.2%	-4.6%
Estimated return on capital	-11.0%	-14.0%	0.0%	9.0%	16.0%	6.0%

Note: figures have been adjusted for movements in prior years

“...drivers will look to cut costs in a recessionary environment too and the high number of price comparison websites already mentioned makes it particularly easy for consumers to shop around.”



willing to accept higher volatility in return for (initially) lower net loss ratios. Only time will tell if this saving will produce genuinely higher profitability. A further anomaly is the marginal 1.3 per cent increase in the average premium per policy charged by insurers during the year compared to the large rate increases suggested by a number of different market premium indices. First, while our experience indicated that many insurers were setting higher premium rates, they often did not achieve a fully commensurate uplift in actual premiums. This may be because customers are embracing price comparison websites. These websites increase the transparency of the pricing process, allowing errors or weaknesses in rating structures to be exposed, and also make it easier for customers to change their details to reduce the price. While some

misrepresentation of details may well have taken place, we have also observed a general move towards higher excess policies which would reduce average premiums too. Secondly, a few insurers elected to reduce rates to increase their market share.

The increase in net premiums was partly offset by higher overall claims costs. Claims frequencies have continued to reduce during 2008, being 6 per cent lower than 2007, but were countered by higher average claims inflation. This resulted in overall net claims incurred rising by around 3 per cent.

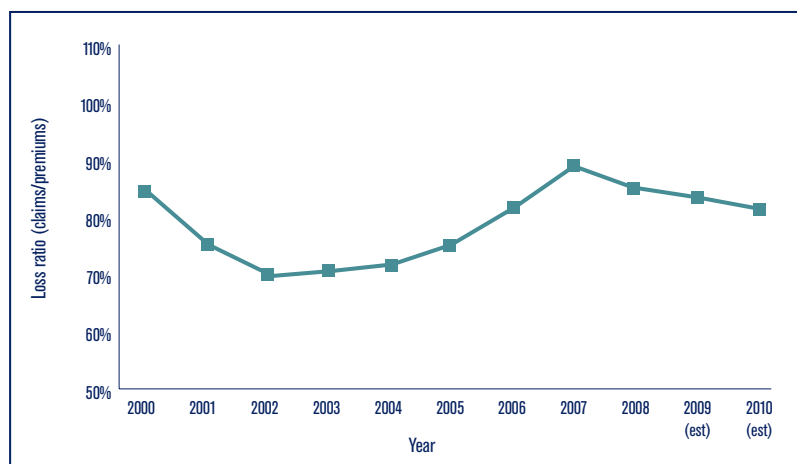
After allowing for investment income on technical reserves, we estimate that the overall insurance profit for 2008 was around -7.9 per cent of net premium. Assuming a capital allocation of 40 per cent of premium,

this implies a net of tax return on capital employed of -11 per cent per annum, compared to a return of -14 per cent per annum for 2007.

Shareholders will be expecting to see much improved future results, but insurers are facing a number of challenges. First, the generally lower claims frequencies that were seen over the 2008 accident year are unlikely to continue into the future. In particular, there has been a significant increase in the number of third-party bodily injury claims, with the number of notifications rising at an increasing rate in each month from last autumn. This has been exacerbated by a larger number of claimants on average for each reported event. As a result, a number of insurers have seen the average cost per policy for these types of claims as much as double over the past three years. Reasons for the increasing proportion of third-party claims with a bodily injury element may include a greater focus from credit hire firms and accident management companies on identifying other persons who may have been involved in an incident and referring them to personal injury lawyers.

The recessionary environment will create additional difficulties too. A risk for insurers is an increase in fraudulent claims. Recessions tend to increase the number of people looking to make money where they can, as well as criminals who cause crashes with innocent drivers to make bogus claims. A further risk is the potential acceleration towards more periodic payments being awarded

Figure 2 | UK motor loss ratios



Note: figures have been adjusted for movements in prior years



in personal injury cases with substantial cost implications for insurers. This is because (logically at least) claimants should find structured settlements more attractive than lump sum settlements in a low interest rate environment.

We may therefore expect insurers to increase premium rates, as well as look to further cut their costs and the cost of claims. Many insurers have already increased their vigilance over potentially fraudulent claims, for example, and we have seen evidence of some healthy increases in rates since the beginning of this year. However, drivers will look to cut costs in a recessionary environment too and the high number of price comparison websites already mentioned makes it particularly easy for consumers to shop around. An insurer raising premiums at a greater rate than its competitors may therefore face the prospect of losing market share. Insurers may also attempt to sell different types of insurance or add-on services to customers in search of other sources of profit. Some insurers have been relying on other profitable products, such as legal expenses cover, breakdown cover and premium financing to mitigate their motor losses.

Postulating that future claims inflation will be slightly higher than historic inflation, we might assume that claims during 2009 and 2010 could increase by 7.5 per cent, largely driven by bodily injury claims. If we further assume that premium rates during 2009 and 2010 will increase by 10 per cent, the

market might make underwriting results of -11 per cent and -6 per cent of net earned premium for 2009 and 2010 respectively; allowing for investment income, this implies a corresponding net of tax return on capital of -4 per cent and 2 per cent. Rates would need to increase by 12.5 per cent in each of the next two years under this scenario to return 10 per cent per annum on capital employed in 2010. It is unlikely that shareholders will find the prospect of such low returns acceptable, particularly given the uncertainty surrounding the level of future claims inflation. Even if there is still surplus in the reserves, it is only a matter of time before this runs out, forcing insurers to finally confront the issue of underwriting profitability.

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“ Even if there is still surplus in the reserves, it is only a matter of time before this runs out, forcing insurers to finally confront the issue of underwriting profitability. ”

A photograph of Richard Bland, a man with short, graying hair and glasses, wearing a dark pinstriped suit jacket, a white shirt, and a dark blue tie with small white dots. He is sitting in an office, looking slightly to the left of the camera. In the background, there is a framed picture on the wall and a glass partition.

When GLMs go wrong – or how to tell when your models are not working

Generalised Linear Models are at the heart of successful personal lines pricing. Richard Bland considers the risk that these powerful tools might misbehave.

Generalised Linear Models (GLMs) often fail during a typical rating exercise and it is important that, as a modeller, you are able to identify when this happens. Failure to do so will result in inaccurate models, and hence wrong premiums being charged. Fortunately, many (but not all) rating software tools provide automatic messages to warn the user.

Some basic theory about GLMs

Before examining how GLMs fail, it is first necessary to run quickly through the theory of how GLMs work and the numerical techniques which are used to derive the solution.

The general concept of a linear model is that a statistic (the Y-variate) can be represented as a linear combination of some explanatory variables, where each variable is multiplied by a parameter and then added together. Some error term is then added to this formula to allow for variation in all the observed values of the Y-variate.

In the case of generalised linear models, the linear combination is transformed by the inverse of a link function (often $\log()$) before the error term is added. This enables us to model a wider range of relationships, in particular the multiplicative combination often used in insurance models. A further generalisation allows us to use categorical variables in the formula – rather than using a

parameter multiplying the variable itself, we use multiple parameters, selecting the appropriate parameter for a data point based on the category into which the variable falls. This produces the GLM formula with which many will be familiar:

$$y_i = g^{-1}(\sum x_{ij} \cdot \beta_j) + \varepsilon_i$$

How are the appropriate parameters selected? The error term is deemed to come from a particular distribution, for example, Poisson or gamma, and so for a given set of parameters and a given set of data points, we can calculate a likelihood (more usually expressed as a log likelihood for scaling reasons) that the observed data would occur, given the parameters used. A maximum likelihood solution occurs when we alter the parameters to maximise the likelihood of the observed data, given the parameters.

A convenient way to maximise a differentiable function $f(y_i)$ is to use a Newton-Raphson iteration. If we take the probability density function, substitute in the formula above and differentiate with respect to β_j , we then get:

$$\beta_j' = \beta_j - \frac{f'(\beta_j)}{f''(\beta_j)}$$



and because the error functions have been defined, they can be analytically differentiated with respect to the parameters. The good news is that exponential error functions have well-behaved differentials which lead to a single maximum for the log-likelihood function; the bad news is that the β_j in the formula above is not a single variable, but a vector of parameters. So $f'(\beta_j)$ is a vector, and $f''(\beta_j)$ is a symmetrical square matrix, this means that we need to invert $f''(\beta_j)$ and then multiply $f'(\beta_j)$ by it to perform the iteration.



Figure 1 | Example showing correct aliasing (aliasing – groups 15–20 are aliased)

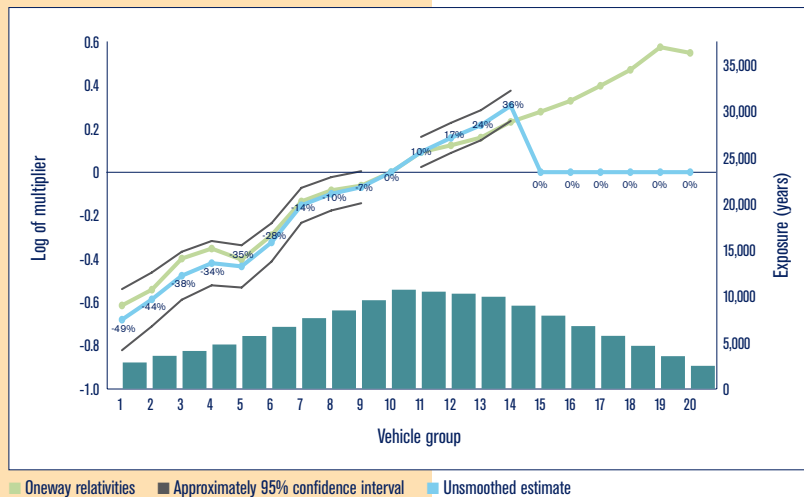
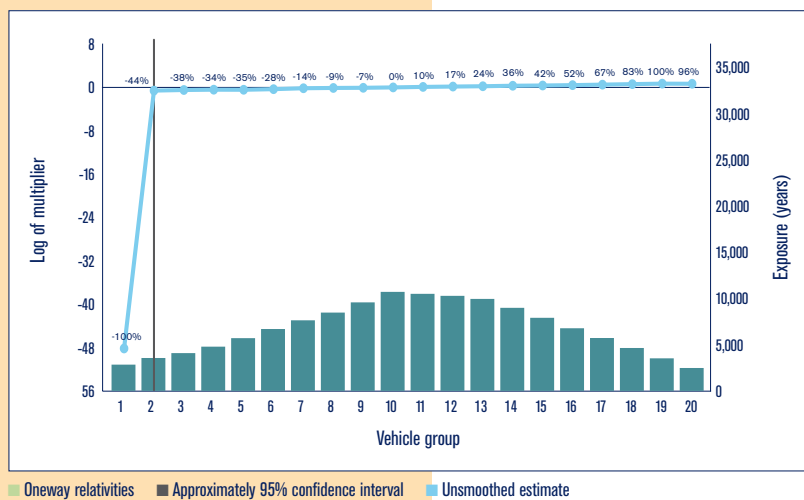


Figure 2 | Example showing an infinite parameter (non-convergent – group 1 has no claims)



Singularities in the Hessian

It is now clear what can go wrong with this method. Suppose we cannot invert the matrix of 2nd partial differentials (often known as the Hessian) because it is singular? (If a matrix is singular, attempting to invert it would involve dividing by zero.)

Aliasing

The most common cause of singularity is linear dependence between parameters – the value of parameter **a** always tells us the value of parameter **b**. This will immediately result in a singular Hessian and prevent us from iterating the Newton-Raphson formula. An alternative way of looking at this is that it would not be possible to find a unique solution for the parameters if two or more were completely correlated. Fortunately, there is an easy way of detecting linear dependence in the data. By multiplying the data matrix of the explanatory variables by its transpose, we create a symmetrical square matrix of the order of the parameters, and we can apply a decomposition to this which will identify any columns in the data which are linearly dependent. (A decomposition is a transform which breaks a matrix down into useful component parts – in this case, one of the parts will have zeros where columns in the original matrix are linearly dependent.) The parameters corresponding to these columns are known as 'aliased' and are removed from the model in order to ensure a unique solution (see Figure 1).



“ It is unlikely to be acceptable for you to charge near-zero premiums for some of your risks. ”

Most good GLM programs do this for you automatically and have a (sometimes hidden) option which allows the cut-off point at which the aliasing algorithm is triggered to be tuned – since the data may consist of many millions of records, the linear dependence does not have to be exact to cause a problem; the aliasing algorithm defines a threshold beyond which two variables are close enough to being linearly dependent to be aliased.

Estimating infinity

A more serious failure which cannot be handled automatically by the software is what happens when the maximum likelihood solution occurs at infinity for one or more parameters. This commonly happens for models with a log link solution when the correct estimated value for the Y-variate is zero, and it will occur, for example, in models of claim frequency if a categorical factor contains a category for which there are no claims. It may be that the GLM algorithm will fail immediately because of an inability to invert the Hessian, or it may be that it will be able to iterate – but it will never converge, because the convergence point is at infinity for one of the parameters (see [Figure 2](#)).

A similar failure can occur in a situation known as near-aliasing, where two or more variables are not quite linearly dependent. The variables are perfectly correlated for most data points, but there are a small number of points – typically data errors – where one of the variables has a different value. This is problematic if the data

points for which this occurs also form a category in which the Y-variate is zero (or infinite, after applying the link function). Again, if it is possible to iterate the model, it will never converge because the optimal solution requires the parameters to be at positive and negative infinity.

What happens if you fail to identify these failures?

Some different GLM systems react to this situation in different ways. If you define convergence as obtaining a set of unique, stable parameter estimates, then your model will never converge in these error situations and this will be reported as model failure by the software. If you define convergence as having obtained a stable value of the deviance (a definition of the difference between the data and the model fit), then you may accept this as a solution since the wayward parameters are unlikely to make much difference to (most of) the modelled values – but the resulting model does not have a uniquely defined set of parameter estimates and you might very well produce a different result with the same data if you were to vary the starting point of the iteration. There is also one very dangerous consequence in terms of insurance rating – some of the modelled values will be close to zero. It is unlikely to be acceptable for you to charge near-zero premiums for some of your risks.

Differences in the behaviour of GLM systems also arise because, although this article has described the classical mathematics of fitting GLMs, there are also some mathematical

shortcuts which can produce reasonably good approximate solutions for well-behaved GLMs using much less computational time, but since they do not involve constructing the matrices described above, the error detection methods described here are not applicable and there may not be any easy way of determining when a model has failed.

Some actuaries are happy to accept non-convergent models as solutions to their rating processes. One modeller was heard to comment that they were much happier with their new modelling software because models which previously did not converge were now being defined as convergent. However, they could equally well have commented that models which were faulty were now not being correctly identified, and which attitude is correct depends on the purpose for which the models are being used. If the purpose of the model is to produce modelled values for internal purposes which are then used as part of a further analysis, then it may not matter that the underlying parameter estimates are not a unique solution. However, if the parameters are then used as part of a rating formula which is engineered into a front-end rating system or published as premium tables, then it is vitally important that the model used produces stable parameters and does not produce outlying values when fitted to data.

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