Runoff Collateral Requirements

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Abstract
Motivation: To provide a simple method of estimating collateral for captive reinsurance contracts that are in runoff with respect to the issuing carrier.

Method: The paper demonstrates a simplified application of individual claim development.

Results: For small open claim counts, the parameter risk and distribution risk of the estimated collateral requirement is reduced by the presence of the loss limit.

Conclusions: Individual claim development addresses the two problems of reserving subject to a loss limit and dealing with a small claim count.

1. INTRODUCTION

The purpose of this paper is to present a method of estimating collateral for captive reinsurance contracts in runoff. Runoff situations are fairly common in captive management, where each ceding company and captive pair must be evaluated separately. The problem is to estimate the reserve distribution for a small open claim count subject to the presence of a loss limit. The study demonstrates a simple example of individual claim development. It was found that the collateral requirement for a primary layer is largely independent of the form of the model distribution of development factors and only modestly impacted by variations in its parameters.

1.1 Research Context

The paper will focus on a problem common to the reserving of workers compensation for captive insurance companies or large deductibles. It will be presented in the context of captive management because that area of practice is less well documented in the actuarial literature. In runoff situations we face the challenge of estimating the workers compensation tail for a small number of claims subject to a loss limitation. I have chosen to apply the method of individual claim development. This method is discussed in the actuarial literature in the calculation of excess loss factors and in excess of loss reinsurance pricing and reserving. The most recent discussion of the NCCI's excess loss factors was provided by Dan Corro and Greg Engl [1], which builds on the work of José Couret [2]. On the reinsurance side, William Gillam and Gary Venter [3] described the method in use in 1986. Stephen Philbrick and Keith Holler [4] considered a weakness of the method in 1996. More recently, John Mahon [5] described a version with a sophisticated development process.

1.2 Objective

This paper will adapt a method common in excess of loss reinsurance to a primary insurance problem. It will consider simplifying assumptions appropriate for the new setting.

2 BACKGROUND AND METHODS

This section will provide background for the problem and the proposed solution.

2.1 Background

Group captives insure the risk of their members, while agency captives insure risk that is written by the agency owner. Both types of captives are common, many of which were formed to provide stable markets for workers compensation. Captives are prohibited from writing workers compensation directly, out of solvency concerns. Therefore, they contract with admitted carriers to write the direct coverage and cede it to the captive. This type of arrangement is referred to as "fronting" and the admitted carrier as the "fronting carrier". In a fronting arrangement the fronting carrier cedes only the primary layer to the captive, while often retaining the excess layer for its own portfolio. The fronting carrier provides the captive excess coverage, infrastructure, and credit enhancement. Our focus here is on the credit aspect. The fronting carrier is responsible for the payment of claims regardless of the captive's ability to pay. As a consequence, fronting carriers require collateral for their losses ceded to captives, most of which is provided by the premiums written.

Fronting for captives is a competitive business. Companies compete on the basis of fees, excess insurance costs, direct premium rates, underwriting appetite, and other terms and conditions. Captives occasionally change fronting carriers to obtain better pricing and/or terms, while fronting carriers occasionally non-renew unprofitable or excessively risky programs. Both situations result in runoff situations that require periodic collateral adjustments.

Reinsurance contracts are often vague with respect to the method to be used to calculate collateral requirements. It is often left up to the fronting company to determine the appropriate collateral, which typically includes a safety margin. In runoff situations the fronting company has little incentive to release collateral to the former client. Meanwhile, the owners of agency and group captives are not professional risk takers. Wide gaps in expectations regarding collateral between fronting companies and captives frequently occur, which occasionally lead to disputes and arbitration. It is hoped that better methodology will help reduce these disputes.

2.2 Selection of Method

Consider the various reserving methods used along the timeline of a fixed block of claims. Initially we have no loss information, we rely on exposure rating and expected loss ratio methods. As we begin to receive loss data we blend actual loss data with an exposure based projection in the Bornhuetter-Ferguson method. When the loss data becomes sufficient we tend to prefer link ratio projections that rely on loss data only. As the number of open claims becomes small we reach a point where it no longer makes sense to estimate a reserve that is primarily IBNER (Incurred But Not Enough Reported) from the aggregate loss data.

For ongoing programs we typically ignore this problem or make ad hoc adjustments since the mature years contribute only a small fraction of the total reserve. In runoff situations these mature years assume significance in their own right. Most workers compensation captives would be considered small portfolios relative to more typical reserving situations. It is not unusual for a captive to have fewer than 20 open claims assumed from a former fronting company five years after the end of the last exposure period.

While the number of open claims is getting small, they are also revealing their severity potential. The more serious claims will have reached or begun to approach the retention. Our projection of future development should take into account the proximity of individual claims to the retention.

Individual claim development provides a method that allows us to estimate IBNER from the open claims. It is responsive to the open claim count and it allows us to explicitly consider the presence of the specific limit. The method fits the form of the data for runoff calculations.

Individual claim development treats loss development as a stochastic process, which adds a level of complexity compared with deterministic methods. But collateral calculations require a distributional estimate of unpaid losses, so there is no net cost in effort or complexity using individual claim development in this setting.

2.3 Description of Method

The basic features of individual claim development are:

- Development factors are applied to open reserves.
- The development factors are considered as distributions.
- Unlimited development is computed claim by claim, with the loss limit applied to the resulting unlimited developed claim.

With this approach the limited expected value of each claim can be calculated explicitly, or the distribution of all open claims can be simulated. The limited expected value is useful for reserving questions, but the later findings regarding distribution risk and parameter risk would not apply. Collateral estimation requires simulation of the full distribution to protect the ceding carrier against credit losses in the event of adverse losses development.

2.4 Reserve Development Factors

We would like to develop the total reserve from the open claim data. We can do this by relating total reserves to case reserves. This makes sense because workers compensation development is dominated by reserve development after the first couple of years. IBNER is a function of the open claims.

The first step is to derive development factors for loss reserves that would produce a result consistent with the paid and incurred loss development methods. The reserve development factors can be calculated using algebra from incurred and paid loss development factors.
An example of the calculation of reserve development factors is shown below using the five-year average Arizona factors published in the NCCI 2012 Annual Statistical Bulletin[1].

Arizona

Accident Year	Development Factors Paid	Development Factors Incurred
2008	1.527	1.298
2007	1.480	1.257
2006	1.441	1.229
2005	1.409	1.210

We take the reciprocal of each factor to obtain the proportion of losses expected to be paid or incurred:

Accident Year	Development Factors Paid	Development Factors Incurred	Proportion Emerged Paid	Proportion Emerged Incurred
2008	1.527	1.298	0.655	0.770
2007	1.480	1.257	0.676	0.796
2006	1.441	1.229	0.694	0.814
2005	1.409	1.21	0.710	0.826

We can then obtain the expected proportion of losses in reserve status by taking the complement of the proportion emerged. The complement of the proportion paid is the total reserve expressed as a proportion of ultimate loss. The complement of the proportion incurred is the IBNR. The proportion of ultimate losses in case reserve status is obtained by subtracting IBNR from the total reserve.

[1] Used with the permission of the NCCI.

Accident Year	Proportion Emerged Paid	Proportion Emerged Incurred	Reserve Total	Reserve IBNR	Reserve Case
2008	0.655	0.770	0.345	0.230	0.116
2007	0.676	0.796	0.324	0.204	0.120
2006	0.694	0.814	0.306	0.186	0.120
2005	0.710	0.826	0.290	0.174	0.117

Finally, the reserve development factor is the ratio of total reserves to case reserves:

Accident Year	Expected Case Reserve	Expected Total Reserve	Reserve Development Factor
2008	0.116	0.345	2.987
2007	0.120	0.324	2.706
2006	0.120	0.306	2.557
2005	0.117	0.290	2.487

Appendix A displays the reserve development factors for each NCCI state, based on the calculation described above. The reserve development factors vary greatly between states, but within each state they tend to remain fairly stable from year to year.

Individual state factors range from about 1.5 to 5. At the top of the range we find two states with escalating benefits (CT, NH) and two states that have very low tail factors (NM, SC). We should expect jurisdictional differences such as benefit laws to be reflected in reserve development factors. On the other hand, the presence of two states with small tail factors highlights the potential instability in a method that relies on a ratio of two small numbers. South Carolina presents a particularly interesting example in that the calculated reserve development factors are wildly unstable from year to year.

Excess reinsurance applications of individual claim development utilize more detailed development schemes than statewide average factors. They may include additional factors such as injury type and claim size. The excess reinsurance problem is far more complex because reinsurers are attempting to estimate potential excess losses at early development periods. In contrast, our problem demands simplicity considering the small reserves involved. Fortunately, we will see that runoff collateral calculations tend to be quite forgiving of simplification.

2.5 Development Factors Considered as a Distribution

When we consider the development of individual claims, we can be certain that they will not all develop in an identical fashion. Therefore, it makes sense to consider individual claim development as a random process. We make this random process conform with observed data by requiring that its mean is given by the reserve development factor.

I have chosen to model the reserve development factors with a lognormal distribution. The lognormal distribution model is easy to work with; it is convenient that its moment distributions are also lognormal and it is available as a built-in function in Excel. Other possible distributional forms will be considered.

2.6 Model Parameters

The parameters of the lognormal distribution of reserve development factors are completely determined by the mean and coefficient of variation. We have seen that the mean of the reserve development factor distribution can be estimated from the loss development factors, so to parameterize the model we need only fix the coefficient of variation.

I set the coefficient of variation at 0.5, as reported by Corro and Engl. On an intuitive level this seems low, but the authors discuss this point in detail, as it is one of the points of departure from the previous work on the topic.

The shape parameter σ^2 can be derived from the formula:

$$CV^2 = \exp(\sigma^2) - 1 \quad (2.1)$$

For a CV of 0.5 this yields $\sigma^2 = .223$.

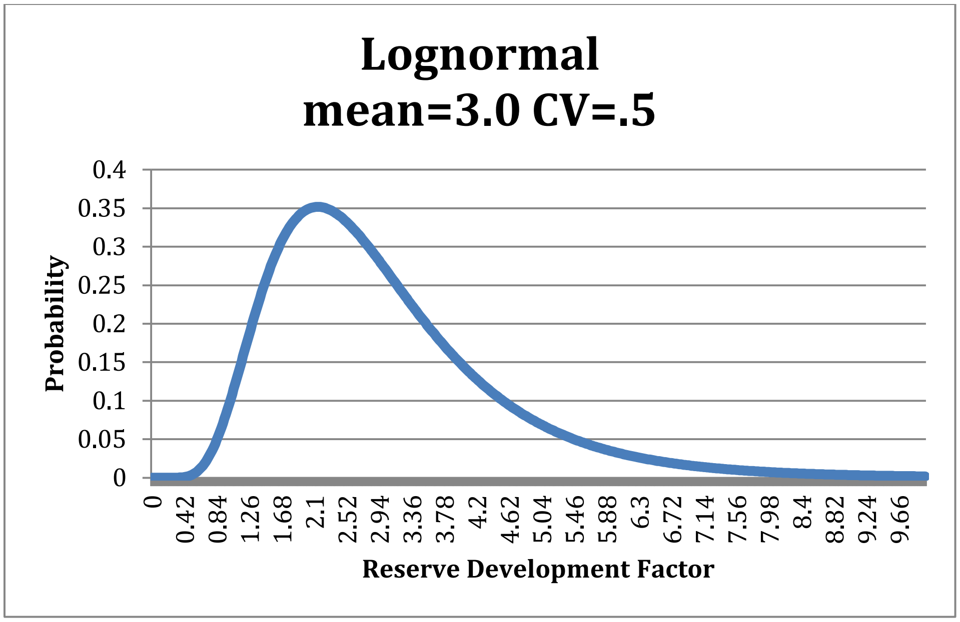
I selected a mean reserve development factor of 3.0 for the model. It is slightly higher than the indicated NCCI Countrywide factors and well within the range of factors shown in Appendix A. We can now find the location parameter μ from the well-known formula:

$$\text{mean} = \exp(\mu + \sigma^2/2) \quad (2.2)$$

$$\mu = \ln(\text{mean}) - \sigma^2/2 \quad (2.3)$$

Solving for a mean of 3.0 and CV of 0.5 yields $\mu = .987$.

A graph of the model distribution of reserve development factors is shown at the top of the next page.



In the model, there is a 98% likelihood that case reserves will develop upwards. The most likely result is that any individual reserve will double, but a few reserves will develop by a large amount.

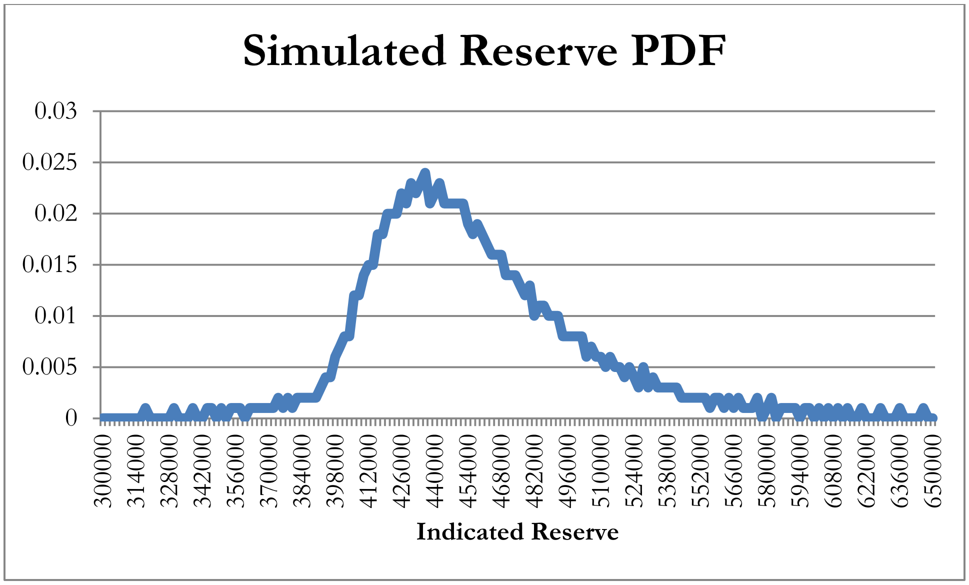
2.7 Collateral Requirement

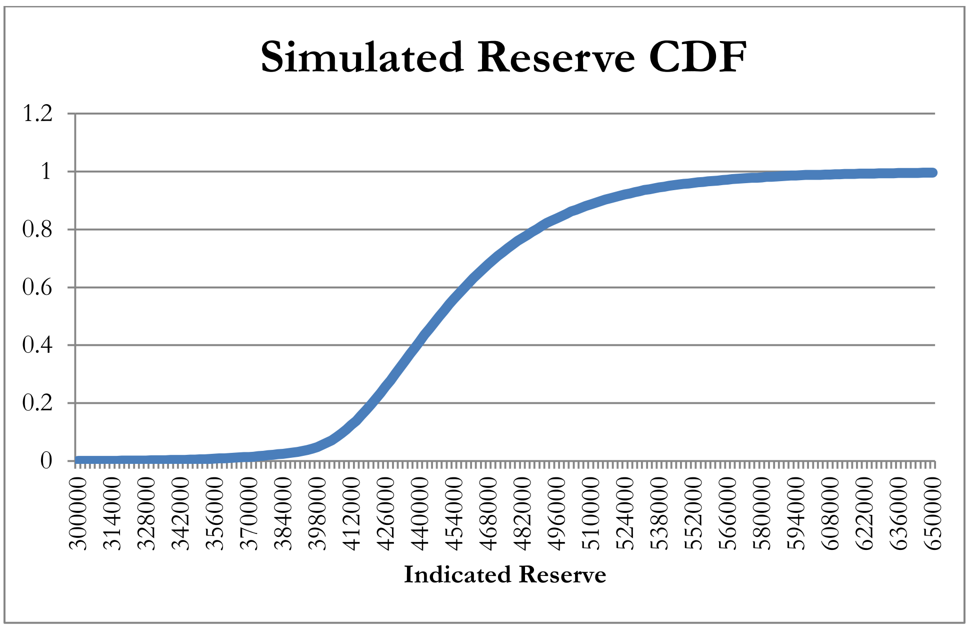
The collateral requirement for the program should consider potential for adverse development beyond the expected ultimate loss. To this end, I will estimate the distribution of limited reserve outcomes by simulation.

I will demonstrate the simulation outcomes for an actual example. The captive and fronting company relationship ran from 2004 to 2008. The captive remains in operation, but utilizes a different fronting company. The limited losses paid totaled $5.1 million through 12/31/2012, at which time there were 4 open claims with total limited reserves of $333,247. One of the claims has reached the retention of $400,000. The current values of the four open claims are as follows:

Claim	Limited Paid	Limited Case Reserve	Limited Incurred
1	217,909	182,091	400,000
2	221,190	117,844	339,034
3	-	29,500	29,500
4	16,922	3,812	20,734

For each trial in the simulation, I randomly generated 4 lognormal reserve development factors. The product of these factors and the case reserves generated the unlimited reserves, to which I added the payments and applied the retention limit.
The following graphs display the results of a simulation with 50,000 trials:





Key elements of the simulated distribution of the limited reserve are shown in the following table:

Percentile	Limited Reserve
50%	448,000
75%	478,000
90%	514,000
95%	540,000
98%	578,000
99%	604,000

3 RESULTS AND DISCUSSION

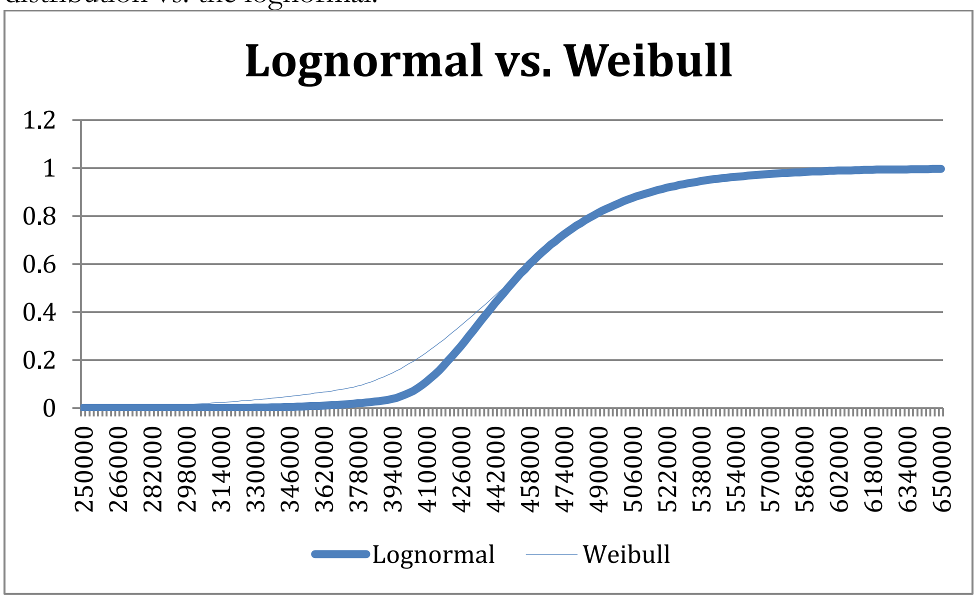
In this section we will explore the impact of varying the form of the development factor distribution and its parameters. This will be followed by a discussion of other factors not previously considered.

3.1 Alternative Distributional Forms

The Weibull distribution and the inverse translated gamma distribution will be considered as alternatives to the lognormal for the distribution of reserve development factors. We will compare the simulation results for each alternative distribution to the lognormal simulation results while holding the mean and coefficient of variation fixed.

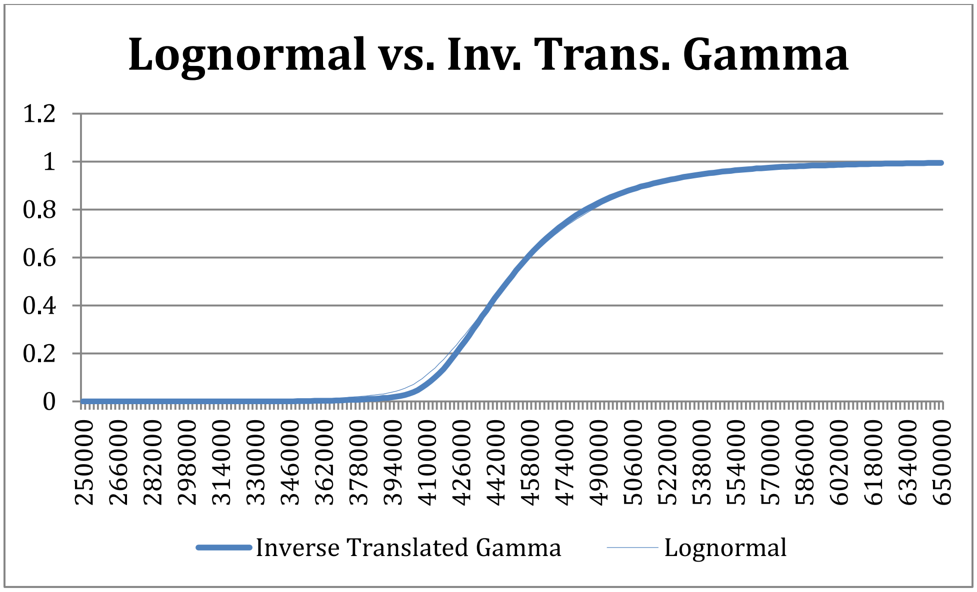
The Weibull distribution is appealing for use in simulation because it has closed form inverse. The inverse translated gamma is less simple, but was used by Corro and Engl in their update of the excess loss factors. The inverse translated gamma has three parameters, but the authors gave two of these as $\alpha = 8.7775$ and $\tau = 0.8$. This gives a coefficient of variation of 0.5 and allows a free parameter to scale the mean of the distribution.

The following graph shows a comparison of the CDF of the simulation results for the Weibull distribution vs. the lognormal:

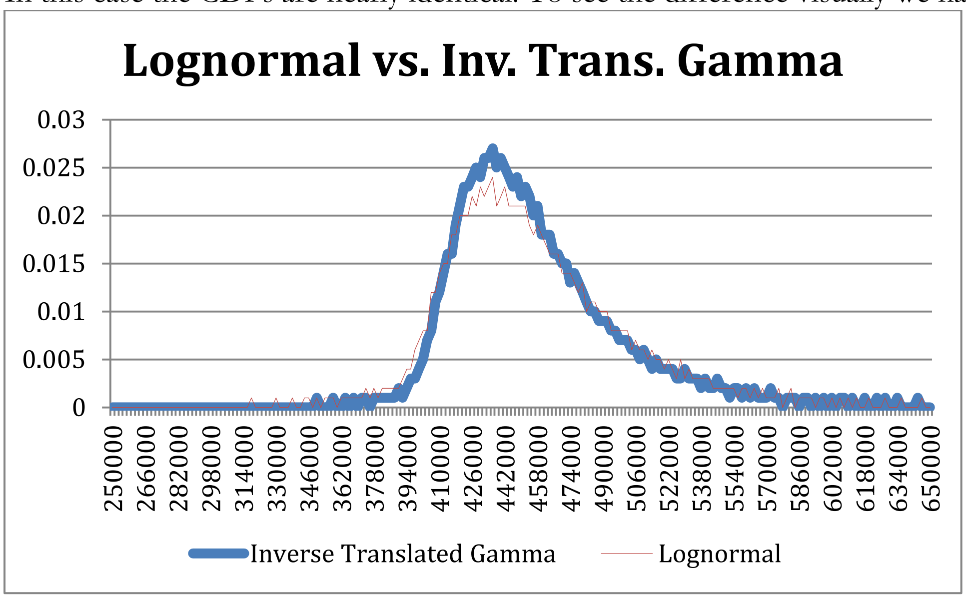


Weibull distributed development factors are more likely to produce a low simulated limited ultimate than the lognormal, but the two distributions are extremely close for higher loss amounts. We are only interested in the higher percentiles of the loss distribution when setting collateral, so it makes little difference which distribution we use.

We now consider a similar comparison of the CDF of simulation results for inverse translated gamma development factors vs. the lognormal:



In this case the CDFs are nearly identical. To see the difference visually we have to go the PDF:

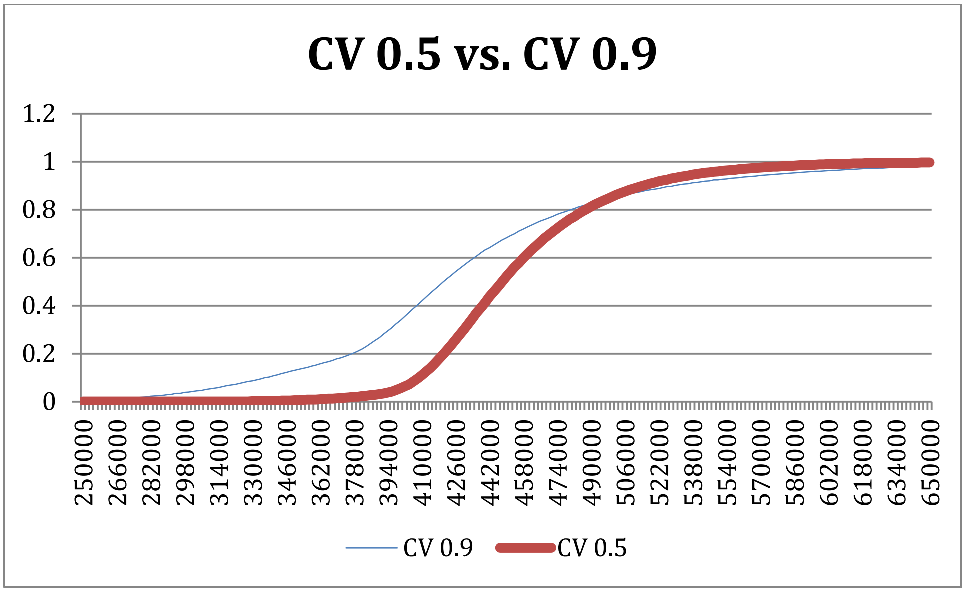


The lognormal rises a little sooner, but the inverse translated gamma has a higher peak. As we get to the higher loss amounts the two distributions are quite close.

Based on these comparisons, the form of the distribution of development factors seems to have little effect on the collateral estimate for a runoff book of business subject to a specific loss limit.

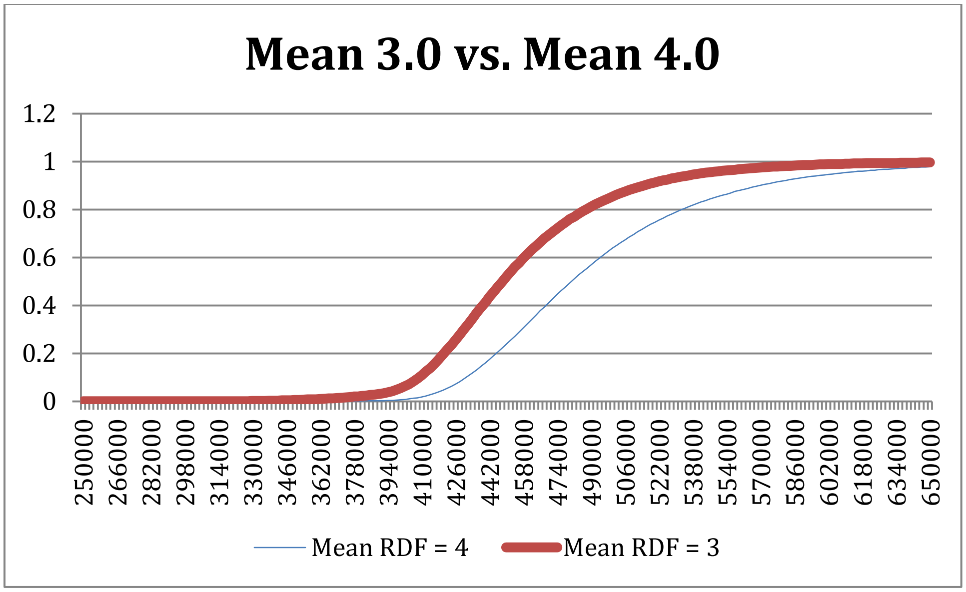
3.2 Alternative Parameters

In the first case, we will increase the coefficient of variation of the development factor and compare the resulting distribution to our original model. In the second case, we will increase the mean of the development factor distribution, while holding the CV constant. For the first case, I set the alternative CV at 0.9, which corresponds with the assumptions underlying the 1997 Excess Loss Factors by Gillam and Couret.



When we alter the coefficient of variation there is a wide gap between the simulation results for lower loss amounts, but the two curves come closer together as we go to higher loss amounts. In the absence of a single loss limit, the increase in the CV of the development factors would spread out the high end of the distribution as it has spread out the low end. However, the presence of the single loss limit causes much of the adverse development on the first two claims to fall into the excess layer.

We will next test the impact of moving the mean of the development factor distribution. Increasing the mean of the development factor distribution moves the entire limited loss distribution, but the increase at the 99th percentile of the limited ultimate loss distribution is only a small fraction of the increase in gross losses. Once again, adverse results tend to be pushed into the excess layer. This is shown in the graph at the top of the next page.



The following table provides a comparison of the upper percentile values of the simulated loss distribution under the scenarios graphed above. Increasing the mean of the loss ratio distribution from 3.0 to 4.0 increases expected gross losses by $333,000 in total, or $180,000 if the claim at the retention is excluded. Meanwhile, the 99th percentile of the simulated loss distribution increases by only $46,000.

Form	Lognormal	Lognormal	Lognormal
Mean	3	3	4
CV	0.5	0.9	0.5
90%	514,000	528,000	568,000
95%	540,000	580,000	604,000
99%	604,000	650,000	650,000

It is the nature of collateral estimates that our interest is focused on the adverse tail of the loss distribution. Given a fixed number of claims, in the presence of the single loss limit, adverse results tend to fall into the excess layer. The relative insensitivity of collateral estimates to model assumptions occurs because the higher percentiles of the reserve distribution are reached only when all of the large claims reach the retention.

3.3 Reopened Claims

It is well known that the weakness of open claim development is its treatment of IBNR and/or reopened claims. Stephen Philbrick and Keith Holler correctly stated that "To increase open reserves for anticipated development of open claims is plausible, but to increase individual claim amounts to account for newly reported counts seems unreasonable." Incurred but not yet reported (IBNYR) is not a big issue in runoff situations due to the elapsed time since the last exposure, but reopened claims present the same problem.

The direct solution is to add a reopened reserve estimated from the aggregate losses. I don't have data to estimate the reopened reserve, but I can offer an ad hoc approach. One could simply assign some fraction of the remaining aggregate tail (e.g. ¼) or some a fixed percentage of ultimate (e.g. 2%) as a provision for the reopened claims. Algebraically one could offset the reopened provision in the reserve development factor. One could ask if an offset is necessary, because as we have seen, the overstatement of the IBNER reserve will largely fall into the excess layer.

As for the distribution of the reopened reserve, the simplest approximation would seem to be to give it the same distribution as the IBNER. This approach, while not precise, has the effect of bringing the implicit provision for reopened back into the retained layer.

3.4 Other Considerations

It is reasonable to ask whether one should be making projections from open case reserves at all. Case reserves for an individual company or TPA can vary greatly from industry averages. Also, the application of large factors to a small base magnifies the variability of the outcome.

The simplified method presented here seems reasonable when it is used to cap the development of large claims. The uncertainty in the projection of the reserves for the large claims will tend to fall in the excess layer. Other methods should be considered for cases in which all of the remaining open claims are small. A lack of large claims may be an indication that case reserves are inadequate.

Open claim development is the only method of individual claim development that is available to a consultant without access to a large database. I would like to be able to experiment with incurred or paid development on open claims, but the aggregate loss data for open claims is not publicly available.

4 CONCLUSIONS

Individual claim development offers a method for estimating collateral requirements for captive fronting arrangements or workers compensation large deductible that are in runoff with respect to the issuing carrier.

The collateral question demands estimates of high percentiles of the loss distribution. This tends to reduce the parameter risk and distribution risk in the construction of the model, as those risks tend to fall into the excess layer. This effect is greatest when the model is used to limit large claims, but less so when large claims are not present.

Users of the individual claim development method should consider including a separate provision for reopened claims based on aggregate losses.

Acknowledgement

I would like to thank the committee members Susan Forray and John Alltop, whose comments helped guide me to the most interesting conclusions.

APPENDIX A

Reserve Development Factors by State

	60-ult	72-ult	84-ult	96-ult
NCCI States	2.023	2.037	2.075	2.076
AL	2.646	2.461	2.345	2.294
AK	3.139	3.393	3.015	2.885
AZ	2.987	2.706	2.557	2.487
AR	1.910	2.005	2.002	2.017
CO	1.370	1.337	1.296	1.313
CT	3.144	3.205	3.352	3.298
DC	2.265	2.269	2.251	2.209
FL	2.080	2.060	2.071	2.030
GA	2.201	2.034	2.026	2.264
HI	2.891	3.481	3.412	3.373
ID	2.662	2.333	2.510	2.519
IL	1.301	1.314	1.374	1.467
IA	2.136	2.170	2.370	2.515
KS	2.883	3.245	3.462	2.769
KY	1.854	1.826	1.780	1.710
LA	1.575	1.597	1.570	1.520
ME	1.866	1.774	1.835	1.897
MD	3.136	3.029	2.966	2.880
MS	1.897	1.912	1.910	1.798
MO	1.384	1.410	1.455	1.502
MT	3.942	3.576	3.215	3.155
NE	1.690	1.638	1.635	1.637
NH	4.599	4.984	5.001	4.183
NM	3.516	4.237	5.049	4.744
OK	2.660	2.967	2.742	2.413
OR	3.024	2.957	2.814	2.731
RI	1.117	1.289	1.346	1.366
SC	1.968	2.473	3.458	5.607
SD	1.864	1.783	1.826	1.882
TN	3.580	3.414	3.425	3.376
UT	3.441	3.296	3.302	3.223
VT	2.567	2.237	2.275	2.188
VA	2.198	2.357	2.362	2.354

Source: Derived from NCCI Annual Statistical Bulletin 2012 edition. Used with permission of the NCCI.

5 REFERENCES

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[4] Philbrick, Stephen and Keith Holler, "A Survey of Methods Used to Reflect Development in Excess Ratemaking" *Casualty Actuarial Society Forum*, 1996 Winter.
[5] Mahon, John, "Transition Matrix Theory and Individual Claim Loss Development" *Casualty Actuarial Society Forum*, Spring 2005.
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