Evolution of Loss Reserve Risk

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Concept

Property/ Casualty insurers face risks from many key areas such as operations, natural catastrophes and underwriting. Among the key underwriting risks are the potential financial impacts of adverse loss reserves development.

While multiple standard actuarial methods exist for evaluating the adequacy of reserves, little information exists on how deficiencies evolve over time. No risk models currently exist to make statements regarding the probability of a level of deficiency over a fixed time horizon. For example: What is the probability that current reserves will become 20% deficient over the next two years? Current models only make estimates over the "lifetime of liability" or run-off period.

The ability to analyze reserve risk over fixed time horizons is important from several angles. First, from a risk management perspective, the time horizon over which a risk will likely emerge is Property/ Casualty insurers face risks from many key areas such as operations, natural catastrophes and underwriting. Among the key underwriting risks are the potential financial impacts of adverse loss reserves development.

While multiple standard actuarial methods exist for evaluating the adequacy of reserves, little information exists on how deficiencies evolve over time. No current risk models exist to make statements regarding the probability of a level of deficiency over a fixed time horizon. For example: What is the probability that current reserves will become 20% deficient over the next two years? Current models only make estimates over the "lifetime of liability" or run-off period.

The ability to analyze reserve risk over fixed time horizons is important from several aspects. First, from a risk management perspective, the time horizon over which a risk will likely emerge is crucial. Understanding time horizon allows for the creation of appropriate mitigation strategies and an understanding of interrelations with other risks. Second, most other financial risks (credit, market) are measured over short fixed time horizons. A comparable measure of reserve/underwriting risk is important and required for many emerging capital measuring applications such as Solvency II.

This paper illustrates a model of loss reserve risk that will incorporate how risk evolves over time at annual time horizons. The paper will illustrate how to build and parameterize the model using multiple years of financial statement data. The model produces results for a sample line of business for time horizons from one to 10 years.

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Introduction

The appropriate measurement of required capital by modeling Economic Capital ("EC") levels has become an increasingly important issue for Property-Casualty ("P&C") insurers. Regulatory paradigms have emerged in the United Kingdom and Continental Europe which allow companies to build their own economic capital models to interface with regulators. In the U.S., lacking a regulatory initiative, rating agencies are increasingly viewing internal economic capital models as a necessity. Company use of EC models is considered a key element of effective risk and capital management which is considered in the rating process.

While insurance companies desire to manage using economic capital tools, no universal methodology exists. The insurance standard that has emerged in Europe, driven by Solvency II, is derived from banking risk management and capital analysis paradigms. Most P&C insurers in the U.S. have relied on factor-based methodologies borrowed from regulatory or rating agency formulas and Dynamic Financial Analysis ("DFA") models.

Under the Solvency II framework insurers will have to establish technical provisions to cover future claims expected from policyholders. The technical provisions will be equivalent to the amount another insurer would be expected to pay in order to assume and meet the original insurer's policyholders obligations. Insurers must also have available financial resources sufficient to cover both a Minimum Capital Requirement (MCR) and a Solvency Capital Requirement (SCR).

The SCR is based on a Value-at-Risk (VaR) measure calibrated to a 99.5% confidence level over a 1-year time horizon. The SCR is meant to cover all risks that an insurer faces including insurance, market, credit and operational risks. Loss reserve risk is usually considered a component of insurance risk along with underwriting and catastrophe risks. Reserve risk is the risk that the amounts held in reserve for current policyholder obligations are insufficient to cover the ultimate payout of claims.

The VaR measure is a commonly used in financial services to assess the risk associated with a portfolio of assets and liabilities. VaR attempts to answer the question of how much money could be lost, if events develop in an adverse and unexpected way. VaR measures the worst expected loss over a specific time interval at a given confidence level. For example, if VaR is measured over a one-year period at a confidence level of 99.5%, then this corresponds to the worst loss expected to occur in a single year over the next two hundred years.

Background on VaR Methods

The traditional U.S. actuarial approaches take a much different view of insurance risk than the VaR approach used in Solvency II. VaR methodologies have their roots in financial risk management tools that were originally used on a daily basis to monitor the potential fluctuations of trading portfolios. VaR originally viewed risk as the fluctuation in the market values of risky trading positions. Over time VaR methods have morphed into a broader set of applications, utilizing longer time horizons which to analyze potential fluctuations in the market value of a firm.

An excerpt describing the background, rationale and elements of the VAR view of economic capital used in a banking environment follows.

Market Value Definition of Risk[1]

Over the past decade, economic capital has steadily progressed toward market value models. Most commercial portfolio frameworks have by now discarded first-generation economic capital models based only on default risk, although these models persist in some cases for consumer portfolios. Given the goal of ensuring capital adequacy for a certain level of solvency, the volatility of market value is the best measure of a bank's risk and therefore its capital requirement.

Ultimately, shareholders are interested in the total return on their investment in the bank's stock and its risk in market value terms. They compare the return earned on their investment to a required return based on its risk. Bondholders also care about market values. The value of their fixed-income investment is a function of the credit spread of the bank, the level of interest rates, and the expected cash flows of the debt. Since both stockholders and bondholders evaluate their investments based on market values, management should evaluate its opportunities with the same market value discipline. Defining risk in market value terms reinforces this discipline by aligning the interests of business managers with those of shareholders and bondholders.

Capitalization and Confidence Levels

Two estimates describe a bank's risk profile: expected loss and unexpected loss. As illustrated in Figure 1, expected loss is the average rate of loss expected from a portfolio. If losses equaled their expected levels, there would be no need for capital. Unexpected loss is the volatility of losses around their expected levels. Unexpected loss determines the economic capital requirement.

Graph 1

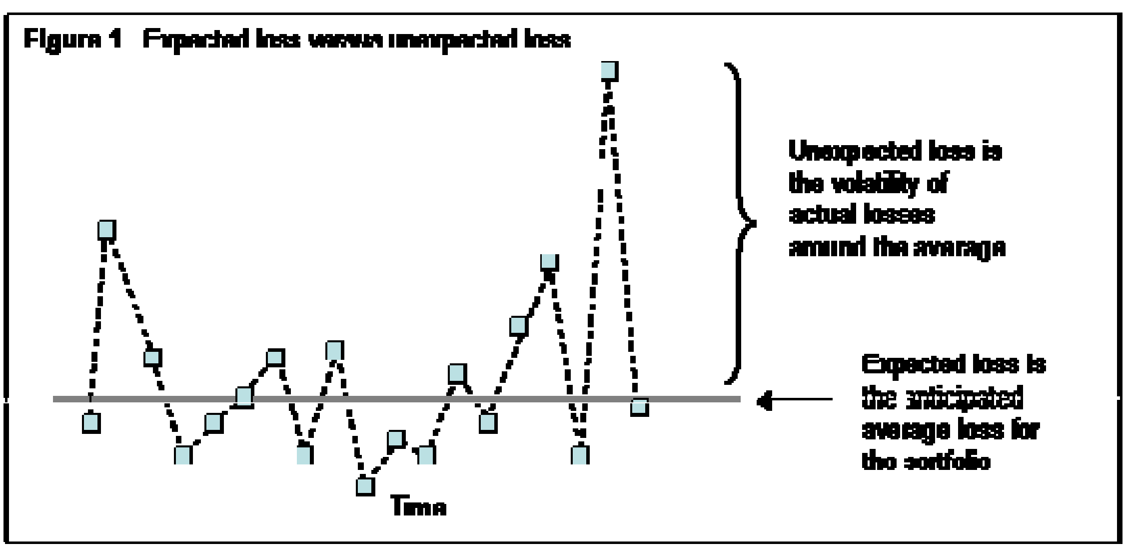
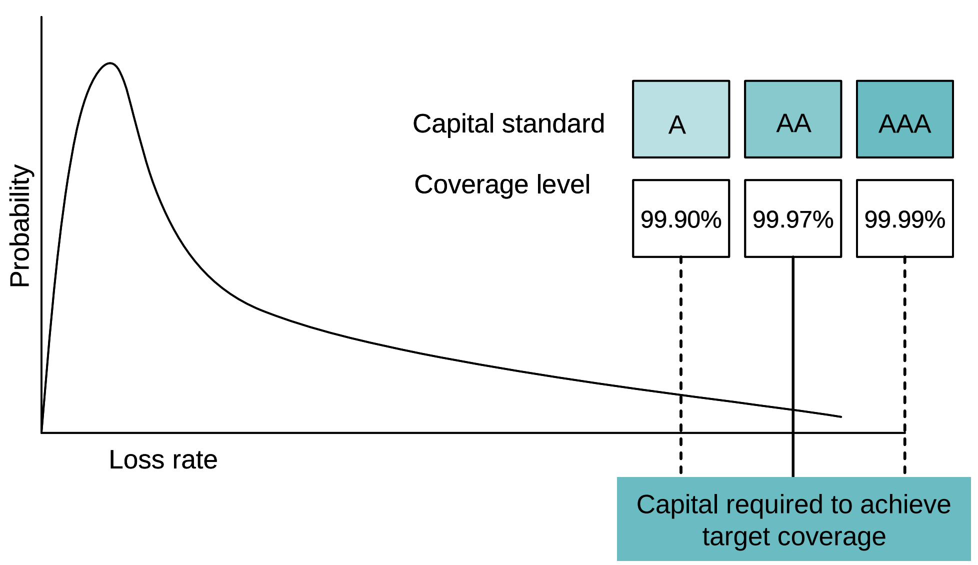


Figure 1 Expected loss versus unexpected loss

To prevent insolvency, economic capital must cover unexpected losses to a high degree of confidence. Banks often link their choice of confidence level to a standard of solvency implied by a credit rating of A or AA for their senior debt. The historical one-year default rates for A firms and AA firms are approximately 10 and 3 basis points, respectively. These target ratings therefore require that the institution have sufficient equity to buffer losses over a one-year period with confidence levels of 99.90% and 99.97% (see Figure 2).

Graph 2

Figure 2 Achieving the desired coverage



While VaR models are viewed of as risk models using a percentile or probability of ruin risk measure, the differentiating characteristic is at a more basic level. Differentiating requires answering the basic questions of what is considered an adverse event in the model and over what time horizon an adverse event can emerge. A VaR can be described as measuring an adverse change in market value over a one-year time horizon. Other risk models, such as DFA models view risk as an adverse change in accounting values over longer time horizons.

A P&C Insurer's Traditional View of Reserve Risk

While much of the methodology discussed relating to VaR and EC models could be applied to an insurance enterprise, construction of a similar model requires information on how the prices of assets or liabilities change. An active market is needed for the assets and liabilities in order to develop a historical profile of changes in value under multiple market conditions. Absent a market, a proxy for how the market value of the asset or liability would change under stress conditions could be also developed.

The concept of market valuation of both assets and liabilities is an emerging issue for insurers due to discussions around fair value and IFRS. Historically insurers in the US have operated through statutory accounting where the majority of investments, fixed income assets, were held at amortized value and loss reserves are held at an undiscounted nominal value. This accounting view is a significant deviation from the "mark to market" perspective that drove the development of VaR-based EC models for other financial services.

The source of differences between the traditional actuarial and the financial view of risk are also driven by the concept of time horizon. Standard actuarial models do not produce results over a discreet time horizon but rather results at "ultimate" or "life of liability basis". The actuarial methods are focused on the magnitude of the final value not how an estimate may move to its final value.

The reason for ignoring time step in actuarial methods is driven by the lack of relevance to their intended use. Current actuarial triangulation or chain ladder methods are used to produce best estimates of loss reserves for financial statement purposes. The focus is to set an adequate reserve value and reasonable range of potential incurred losses.

The point of the actuarial loss reserve estimation methods is to set a best estimate that will not change, while VAR focuses on how much the estimate could change over a time horizon. Hybrid methods, such as the Mack and bootstrapping method, have been developed to produce estimates of reserve variability using development triangle data. Unfortunately, the best estimate and distributions produced by these methods are not right for the VaR calculations since they ignore time horizon.

Most types of assets held by insurers can be analyzed in various historic market conditions due to the existence of long term, active markets. A wealth of standardized and consistent financial market data also exists to create a needed proxy for market values of most other asset types.

Insurance liabilities on the other end of the spectrum pose some unique challenges. No active market exists for insurance company liabilities. In a limited way, market prices can be observed through sales of companies, reinsurance transactions or securitizations. The numbers of transactions are small and information is not always public, so even this information is of limited value.

Given all of the issues mentioned above, attempts have been made to extend VaR and EC methodology into the P&C insurance world. Some notable examples are the paper published by Nakada, Shah, Koyluoglu and Collignon in *The Journal of Risk and Finance* in 1999. A more recent example can be found in the *White Paper of the Swiss Solvency Test* published by the Swiss Federal Office of Private Insurance in November 2004. While these papers lay out the principles of a methodology they fall short in actually defining a methodology that could encompass loss reserve risk in a constant manner.

P&C Reserve Risk Incorporating Time Horizon

To fully specify a VAR model for P&C insurance reserve applications we can rely on the banking concepts discussed above. Reserve Risk VaR ("RRVaR"), as in the banking applications, focuses on the unexpected loss in Net Loss Reserves ("NLR") at some percentile, 1-α, where NLR equals the recorded value of net loss reserves as of a financial statement date. The following equations and Graph 3 specify the model.

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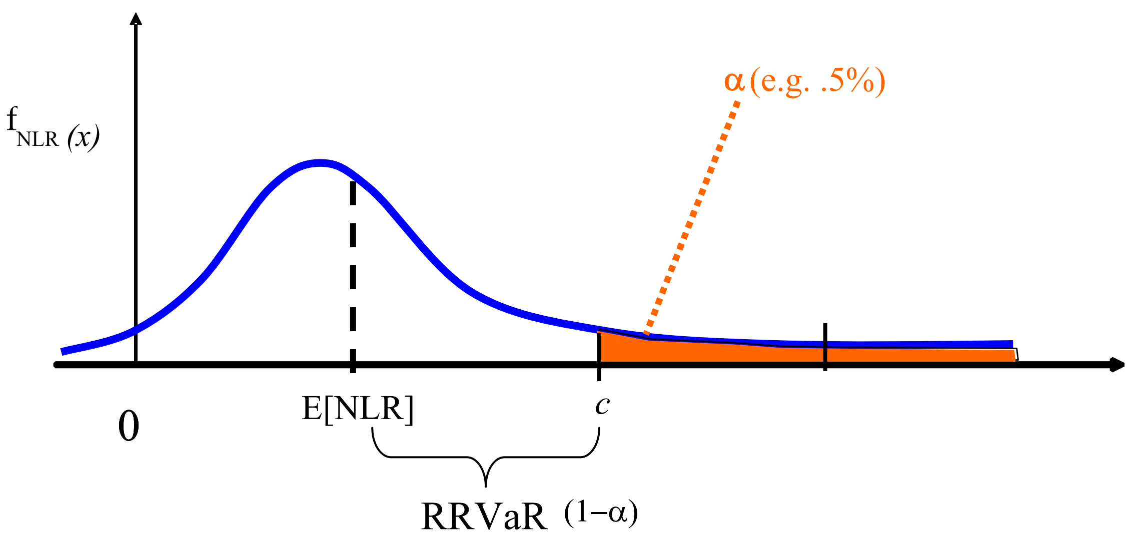
$$F_{NR}(x) = \Pr(NR \leq x)$$
$$F_{NR}(c) = \Pr(NR \leq c) = 1-\alpha$$
$$RRVaR_{(1-\alpha)} = \left|c - E[NR]\right|$$
$$RRVaR_{(1-\alpha)} = EC_{(1-\alpha)}$$

Over a fixed annual interval, greater than or equal to one - year

Graph 3



The appropriate model to satisfy the required VaR structure will have several key criteria which are:

1. Produce a distribution of potential changes in loss reserve estimates.
2. Provide a proxy for market value reserve estimates
3. Produce results over appropriate time horizons or time steps.

The first criterion requires that the model produce a distribution of results along with an expected value. Since a VaR model requires distribution percentiles, multiple model forms could satisfy this criterion. Those that have been used in practice include closed form distribution models, simulations and bootstrap sampling models but they won't really work since they don't incorporate time horizon.

The second criterion requires that a market value proxy, could be calculated for each of the outcomes that comprise the distribution of adverse reserve outcomes. Much research has been done around stating fair value of insurance liabilities for the purposes of implementing International Accounting Standards. The basic techniques involve discounting cashflows at an appropriate interest rate and then increasing the discounted value with a Market Value Margin ("MVM"). The MVM is an adjustment that is meant to approximate a purchaser's risk premium or cost of committed capital required in a transfer situation.

The concept behind a MVM creates many intriguing issues that are beyond the scope of this paper. One such issue is how the MVM would react in a stress situation where a large adjustment to reserves is made. Most methods currently contemplated assume the MVM is a fixed proportion of the expected value of the reserve liability. This is obviously a simplification that may be acceptable in a typical situation but is not in the extreme tail situations that drive the need for EC.

For purposes of this paper an adequate calculation of the fair value of reserve estimates will be the discounted value of the expected reserve payout cash flows at a risk-free rate. While this approach ignores some theoretical issues, the simplicity will aid in the discussion and development of a VaR model for loss reserves.

Specifying a VaR model for Loss Reserve Risk

In order to satisfy the three discussed criteria in the last section a new type of loss reserve variability model will have to be specified. Prior to developing the model it is useful to discuss and clarify some basic concepts regarding the composition and estimation of loss reserves and they impact reserve risk.

P&C loss reserves can be viewed as a portfolio of reserves which are composed of separate sub-portfolios from each Accident Year ("AY"). An AY is the underlying subgrouping of reserves used for statistical and financial statement purposes in insurance. AY contributions to a company's current reserve position can be viewed as different cohorts of Reported and Open ("RO") and Incurred But Not Reported ("IBNR") claims which when aggregated drive the company's required reserve position as of an accounting date.

As of any accounting date, the total reserve contribution is derived from AY's with different levels of maturity or seasoning. Typically the current AY (corresponding with the accounting year) is seasoned by twelve months at a year-end accounting date. The first and second prior AY's are seasoned by twenty-four months and thirty-six months respectively. This pattern increments by an additional twelve months for each older AY and continues for as many years as an insurance company has been in business and claims are still open. In general the variability of an AY's ultimate value should decrease as it matures since more claims are closed and more information is known about the RO claims the longer they have been reported to the insurer.

The actuarial reserve estimation process involves analyzing AY development patterns from older, more mature AYs and imputing the same level of growth to less mature years. Development patterns are typically represented by the percentage growth observed in paid or case-incurred amounts by AY as they mature. Multiple actuarial methods utilizing different development patterns are typically used to produce loss reserve estimates.

Deciding on a reserve level to establish in company financial statements necessarily involves a set of judgments about the appropriate value for each AY in the face of uncertainty. Companies strive to reduce uncertainty by using multiple actuarial estimation methods, tracking price levels changes, understanding operational or data issues and using expert judgment. The financial statement reserves set at any point in time, therefore, is not the direct result of a mathematical calculation or single actuarial method; rather it is the combination of judgments which weigh many factors. Along with the results of the actuarial calculations, factors such as future economic conditions, jury attitudes and the state of the insurance market are considered. The reserving process has some similarities to how prices are set in an active market for financial instruments; the process is not always completely rational.

A true model of the volatility of reserve estimates cannot be reproduced by a simple mathematical method since it combines so many judgments and sources of risk. Most models, like the Mack method assume that variability in reserves can be estimated by using the historic variability in loss reserve triangles. While the variability in the data may capture some sources of risk, it ignores many others. Risk such as process and parameter risk may be captured, but model risk and operational risk are ignored. All of these risks can manifest themselves as adverse loss development and should be captured in a reserve risk model. An appropriate solution requires observation of actual changes in estimates over time, similar to the way a study of the market price volatility of a financial instrument requires observing actual price changes over time.

As previously mentioned no open active market exists for loss reserve liabilities so other sources of information will have to be used. In the case of US P&C insurers the available data takes the form of the detailed information included in Schedule P of the Annual Statement. This schedule tracks AY reserve run off for the prior ten years and is available electronically from several sources.

A. Data Exploration and Analysis

The data used to develop the model was drawn from Annual Statement data from 1995-2006 filings, as provided by Highline Media's P&C Insurance Data product. We limited our analysis to the Private Passenger Auto Liability Ultimate Loss and ALAE and Cumulative Paid Loss and ALAE from Schedule P Parts 2B and 3B, respectively. This line of business over the available period of filings provided over 17,000 data points to calculate ratios and metrics for changes between 12 and 24 months of development; for between 108 and 120 months of development, there were over 10,000 data points available for analysis.

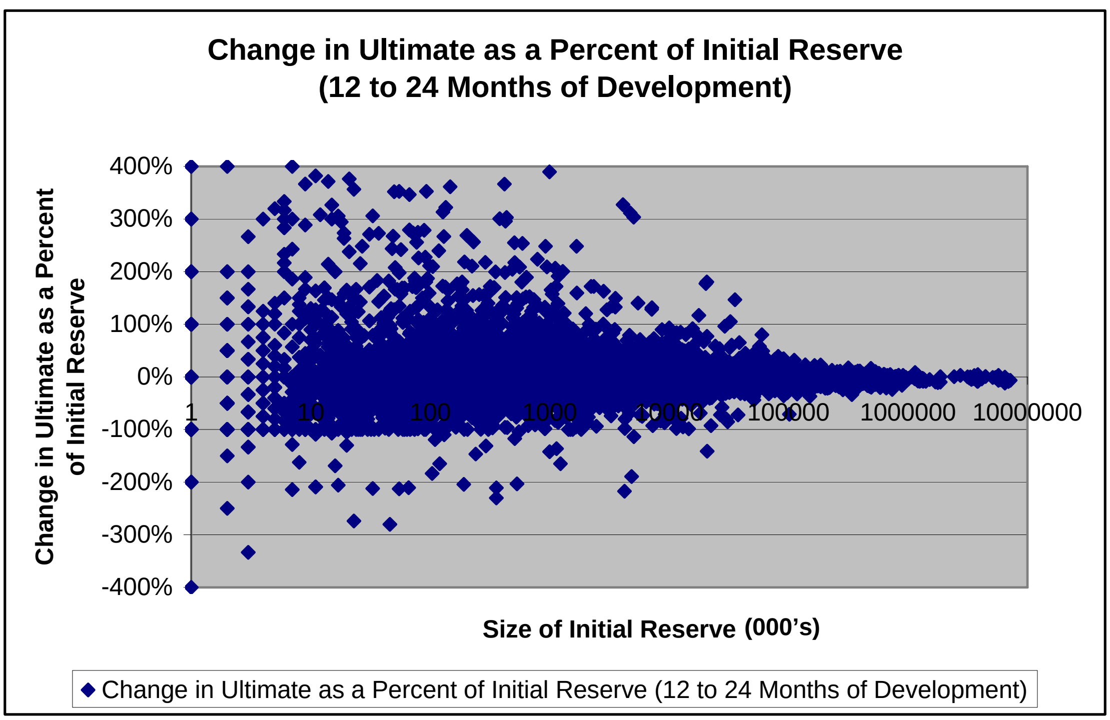
This data was sufficient to calculate various metrics used in our data exploration, notably:

- Incremental and Cumulative Change in Ultimates,
- Initial Reserve, Current Reserve and Reserve at interim points in time, and
- Ratios of changes in ultimate relative to a selected reserve base, e.g. the cumulative change in ultimate relative to the initial reserve at the end of 12 months of development.

Univariate and bivariate analyses were performed on the selected metrics to identify suspected outlier data points and relationships between the metrics. The following two relationships were noted:

1. The spread of the metrics related to changes in ultimate decreased with the size of the initial reserve, i.e. as your initial reserve increases in size, the amount of change you experience relative to your reserve balance drops proportionally.
2. The metrics for cumulative changes in ultimate were strongly correlated, and the correlation between two consecutive periods increased the more developed the periods are, i.e. the incremental changes are inversely related to time.

We applied these two observations in developing a model to estimate the future one-year change in ultimate. The first observation poses quite a problem, as any model using this data would have to account for this size-related variability, or the model would exhibit heteroskedasticity, or non-constant variance. This is illustrated in the following graph:



Heteroskedasticity violates an assumption underlying linear regression that errors have a constant variance. We accounted for this by segmenting the data into two size categories and utilizing a reserve size variable in model development. The size categories were segmented by whether or not the accident year's initial reserve was greater than or equal to $10 million.

For data in the "greater than $10 million" category, the size of initial reserve variable was not significant and was dropped from the model. For data in the smaller reserve category, the size of initial reserve variable was significant for nearly every model and successfully mitigated the heteroskedasticity issues.

The second observation is what helped formulate the model. If the cumulative changes in ultimates are strongly correlated, you can use the cumulative change at one point in time to estimate the subsequent cumulative change, and thereby estimate the total change. This thought process is developed further in the next section.

B. *Derivation of Model*

Our assumption is that, for an accident year at given point of development, the subsequent change in ultimate for the accident year depends on information known at the end of the development period, notably the initial reserve and the cumulative change in ultimate. From our analysis, we assume that a linear relationship exists between the cumulative change in ultimate through a period (k-1) relative to the initial reserve and the cumulative change in ultimate through a period k relative to the initial reserve. Through a little algebra, we arrive at a simple formula for the model:

$$
\begin{aligned}
(ChgUlt_k) &= \left(\frac{CChgUlt_k}{\mathrm{Re}s_0} - \frac{CChgUlt_{k-1}}{\mathrm{Re}s_0}\right) \cdot \mathrm{Re}s_0 \\
&= \left(\left[\beta_{k0} + \beta_{k1} \cdot \left(\frac{CChgUlt_{k-1}}{\mathrm{Re}s_0}\right) + \varepsilon_k\right] - \left(\frac{CChgUlt_{k-1}}{\mathrm{Re}s_0}\right)\right) \cdot \mathrm{Re}s_0 \\
&= \left(\left[\beta_{k0} + (\beta_{k1} - 1) \cdot \left(\frac{CChgUlt_{k-1}}{\mathrm{Re}s_0}\right) + \varepsilon_k\right]\right) \cdot \mathrm{Re}s_0 \\
&= (\beta_{k0} + \varepsilon_k) \cdot \mathrm{Re}s_0 + (\beta_{k1} - 1) \cdot (CChgUlt_{k-1})
\end{aligned}
$$

<u>Explanation of Terms:</u>

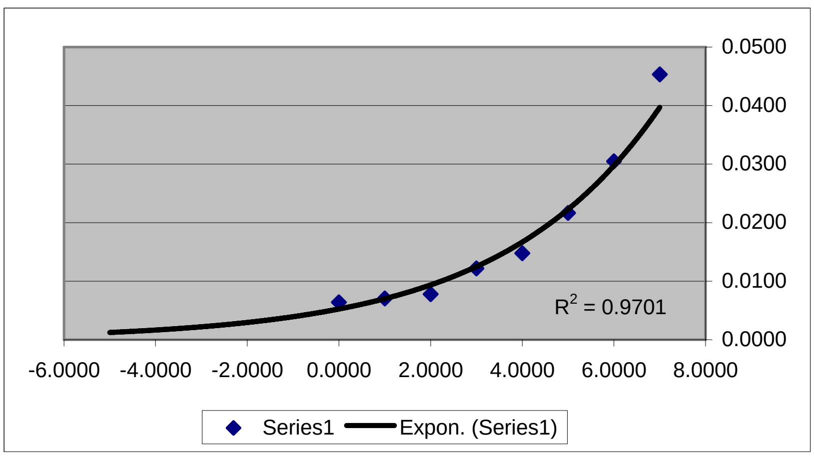
$\mathrm{Re}s_0$	Initial Reserve, i.e. reserve at the end of the first period of development
$ChgUlt_k$	Change in ultimates from period k-1 to period k
$CChgUlt_k$	Cumulative change in ultimates to period k
$\beta_{k0}, \beta_{k1}, \varepsilon_k$	Regression parameters to go from period (k-1) to period k, noting the constant coefficient, the independent variable coefficient, and the random term, respectively

The random error term is scaled by the size of the initial reserve and is independent of the cumulative change in ultimate to period k-1. This allows the formula to be applied successively to estimate a series of future changes in ultimate.

A significant item to address is points in development for which there is no data to model. For instance, given annual statement data, there is no means to estimate change in ultimate beyond 120 months of development. In order to estimate change from 120 to 132 months of development, we need to consider all parameter sets and use these to make assumptions for these periods. Consider the following set of parameter estimates:

	b0	b1	SE
108-120	-0.0008	1.0000	0.0064
96-108	-0.0010	1.0000	0.0071
84-96	-0.0017	1.0000	0.0078
72-84	-0.0035	0.9865	0.0122
60-72	-0.0032	1.0164	0.0148
48-60	-0.0038	1.0558	0.0216
36-48	-0.0043	1.0986	0.0305
24-36	-0.0100	1.1803	0.0453

To simulate results, an estimate of the error is necessary. The table above shows the model standard error ("SE") decreases as the development period increases. This does not appear to be a linear relationship, in fact, the relationship appears exponential when plotted (from oldest to newest), as shown below:



Given the R-squared value, a fitted exponential curve to the SE estimates could provide a reasonable estimate for periods that we cannot model. We may also assume a constant value of 1 for the linear parameter ("b1"), as it appears to asymptotically approach this value; doing so implies that, beyond 120 months of development, the expectation for changes in ultimate should approach zero. Finally, the value for the constant term ("b0") appears to approach zero, a linear or exponential trend could be applied to estimate this parameter as well.

C. *Estimating the initial change in ultimate between 12 to 24 months of development*

We cannot model the first change using a linear regression model, since there is not an independent variable. However, we can fit a distribution to the data which would provide percentiles for use in the model. For the accident years with initial reserves greater than or equal to $10 million, we found the change in ultimate from 12 to 24 months of development as a percent of initial reserve is approximately T-distributed, with an allowance for shift and a scaling parameters.

For the accident years with initial reserves less than \$10 million, we used a mixture of two distributions: a T-Distribution, with shift and scaling parameters, and a Fisher-Tippett distribution, also with shift and scaling parameters. The addition of the Fisher-Tippett distribution allows for the data to be skewed.

D. *Applying model to subsequent periods*

By using the model output along with the original inputs, one can estimate the accident year's change in ultimate in the subsequent period or a series of subsequent periods. This is illustrated with the following model formula, extending the process another step:

$$\begin{aligned}(ChgUlt_{(k+1)}) &= (\beta_{(k+1)0} + \varepsilon_{(k+1)}) \cdot \operatorname{Re} s_0 + (\beta_{(k+1)1} - 1) \cdot (CChgUlt_k) \\ &= (\beta_{(k+1)0} + \varepsilon_{(k+1)}) \cdot \operatorname{Re} s_0 + (\beta_{(k+1)1} - 1) \cdot (CChgUlt_{(k-1)} + ChgUlt_k)\end{aligned}$$

So, to estimate the subsequent step, the result from the prior step is incorporated and the k+1st set of parameters are applied. Carrying these formula forward j periods would result in the following:

$$\begin{aligned}(ChgUlt_{(k+j)}) &= (\beta_{(k+j)0} + \varepsilon_{(k+j)}) \cdot \operatorname{Re} s_0 + (\beta_{(k+j)1} - 1) \cdot (CChgUlt_{(k+j)-1}) \\ &= (\beta_{(k+j)0} + \varepsilon_{(k+j)}) \cdot \operatorname{Re} s_0 + (\beta_{(k+j)1} - 1) \cdot \left(CChgUlt_{(k-1)} + \sum_{i=0}^{j-1} ChgUlt_{(k+i)} \right)\end{aligned}$$

One item of significant importance is that of correlation. A model must provide some means of correlating development of accident years. If the model is applied successively, the results from successive iterations must be correlated as well. Correlation structures for both accident year development and calendar year development were implemented in the model as illustrated in the next section.

D. *Illustration of Model Results:*

Part B - Private Passenger Auto Liability
Industry Aggregate

Schedule P Part 2

Calendar Year

Accident Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	(1) Current Reserve	(2) Initial Reserve	(3) Cumulative Chg in Ult
Prior	34,752,578	31,346,443	30,167,738	29,907,574	29,927,309	30,067,107	30,069,405	30,470,625	31,038,755	31,244,832	3,272,851	34,752,578	-3,507,746
1997	50,200,041	48,290,567	47,535,635	47,271,589	47,127,111	47,077,980	47,039,351	47,034,045	47,039,455	47,029,752	189,520	31,688,173	-3,170,289
1998		49,434,552	48,460,577	48,284,985	48,131,836	48,135,650	48,069,855	48,082,718	48,050,243	48,059,599	274,561	30,755,018	-1,374,953
1999			51,723,573	51,624,048	51,564,759	51,666,795	51,566,364	51,566,370	51,611,145	51,624,968	457,175	31,190,704	-98,605
2000				54,595,508	54,925,540	55,082,187	55,161,479	55,166,228	55,216,804	55,226,484	727,614	32,372,910	630,976
2001					57,013,900	56,780,128	56,680,946	56,719,452	56,860,754	56,819,386	1,211,797	33,946,336	-194,514
2002						60,401,184	59,704,434	59,392,363	59,454,492	59,388,076	2,408,578	36,244,781	-1,013,108
2003							61,641,577	59,671,262	58,945,904	58,712,992	5,005,421	37,495,349	-2,928,585
2004								62,261,624	59,968,158	59,065,620	9,787,887	37,851,774	-3,196,004
2005									63,194,894	61,049,536	18,288,344	38,047,147	-2,145,358
2006										62,784,420	37,101,198	37,101,198	0
											78,724,946		

Schedule P Part 3
Calendar Year

Accident Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Prior	0	12,254,730	19,167,111	23,138,007	25,317,110	26,355,590	26,948,074	27,412,486	27,726,891	27,971,981
1997	18,511,868	32,741,805	39,395,546	43,154,607	45,166,895	46,091,431	46,417,086	46,654,814	46,784,768	46,840,232
1998		18,679,534	33,396,138	40,252,877	44,102,374	46,117,821	46,990,271	47,445,784	47,674,543	47,785,038
1999			20,532,869	36,312,876	43,511,959	47,436,687	49,497,795	50,453,888	50,921,028	51,167,793
2000				22,222,598	39,156,911	46,605,247	50,800,756	52,976,433	53,987,662	54,498,870
2001					23,067,564	40,240,041	47,946,837	52,270,348	54,565,025	55,607,589
2002						24,156,403	41,941,707	50,033,846	54,541,463	56,979,498
2003							24,146,228	41,478,517	49,192,971	53,707,571
2004								24,409,850	41,554,907	49,277,733
2005									25,147,747	42,761,192
2006										25,683,222

This data is drawn from the 2006 Industry Aggregate for Private Passenger Auto Liability, as provided by Highline Media. The initial and current reserve and the cumulative change in ultimate are shown.

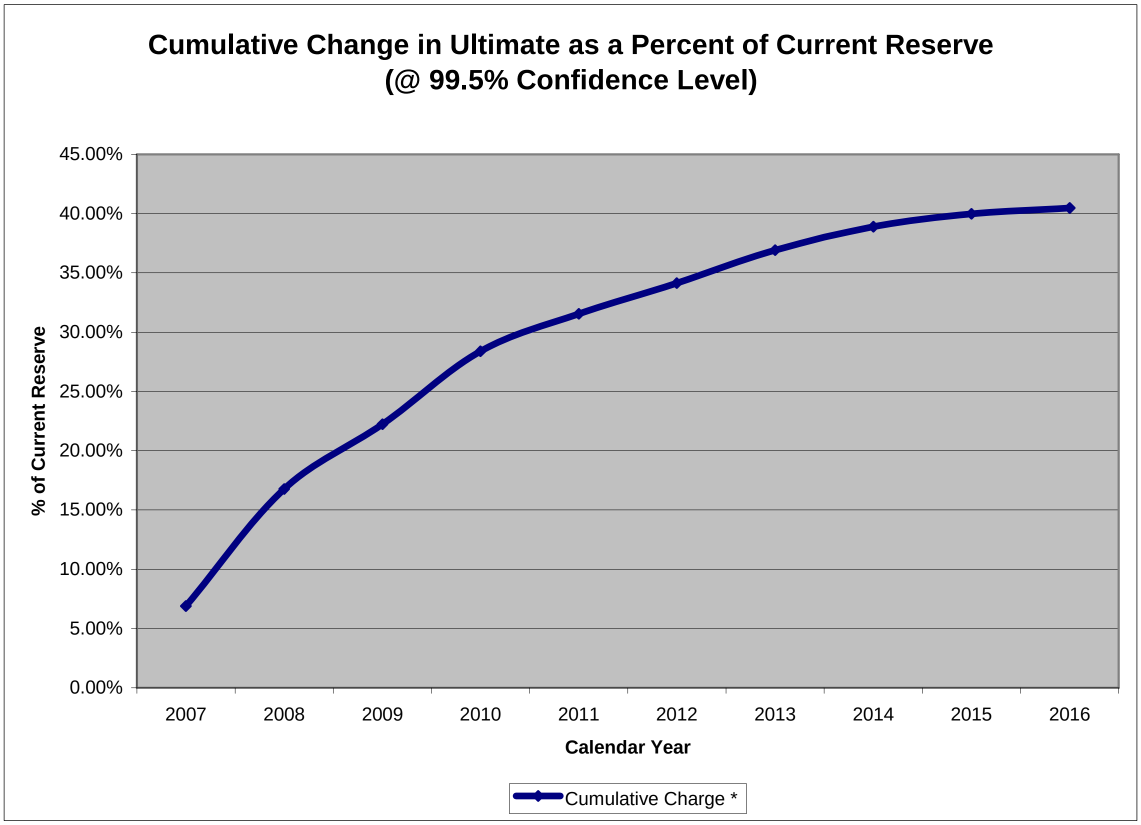
Part B - Private Passenger Auto Liability
Industry Aggregate

P-Value
0.995

	2007 Chg in Ultimate	2008 Chg in Ultimate	2009 Chg in Ultimate	2010 Chg in Ultimate	2011 Chg in Ultimate	2012 Chg in Ultimate	2013 Chg in Ultimate	2014 Chg in Ultimate	2015 Chg in Ultimate	2016 Chg in Ultimate
	20,133	32,266	-4,771	-4,241	-23,152	-28,033	-29,109	-36,668	-42,938	-45,282
	56,068	73,754	20,346	21,450	-5,575	-12,632	-14,139	-24,617	-33,422	-36,890
	103,914	128,831	51,509	55,206	14,575	4,987	2,116	-12,533	-24,613	-29,898
	242,596	297,114	89,703	95,144	38,351	25,004	20,758	456	-16,165	-23,634
	254,838	335,518	227,552	155,617	74,034	54,962	48,853	19,748	-4,105	-14,842
	221,223	346,780	258,650	366,527	127,512	99,633	90,521	48,418	14,095	-1,555
	408,547	531,367	261,099	428,167	319,148	169,321	154,319	92,029	42,092	19,027
	436,504	725,971	395,309	457,810	366,686	403,268	251,504	160,975	87,595	53,381
	670,332	1,083,030	521,875	679,537	363,981	446,348	549,209	249,305	147,353	97,599
	894,505	1,670,981	878,572	935,801	466,482	446,255	583,377	527,417	230,223	156,969
	2,126,365	2,541,037	1,611,895	1,650,604	737,143	440,988	522,540	529,076	461,336	218,800
Incremental	5,435,025	7,766,648	4,311,739	4,841,622	2,479,185	2,050,101	2,179,948	1,553,604	861,452	393,674
Cumulative	5,435,025	13,201,673	17,513,412	22,355,034	24,834,219	26,884,320	29,064,267	30,617,872	31,479,323	31,872,997
Charge *	6.90%	16.77%	22.25%	28.40%	31.55%	34.15%	36.92%	38.89%	39.99%	40.49%

** Charge is applied to reserve as of 12/31/2006*

The estimates for 2007 through 2016 are determined by applying the model for initial reserves with values greater than $10 million successively as noted above. The cumulative charge, as a percentage of current reserves, increases steeply, then levels off around 40%. The development of this metric is shown on the following page.


Cumulative Change in Ultimate as a Percent of Current Reserve
(@ 99.5% Confidence Level)
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
% of Current Reserve
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Calendar Year
Cumulative Charge *

Conclusion

We have developed a model for P&C insurer loss reserve risk that conforms to the structure of a VaR model by incorporation time horizon. This important step is necessary for insurers to be able to understand how reserve risk evolves over time and integrate risk models into existing EC modeling paradigms. Full integration requires that all risk sources, whether from assets or liabilities, are expressed in common time horizons. The common horizon, typically selected as one year, allows the risk distribution to be aggregated.

In addition, VaR models are usually calibrated at very high percentiles which has proved difficult to reasonably match in insurance applications. With less available data the tails of distributions are hard to parameterize with confidence at the extremes. The RRVaR method utilizes the data available in a way to maximize the sample size and also seems to produce plausible results at the extreme percentiles.

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