# An Enhanced Understanding of Using the RAA Excess Casualty Loss Development Study For Reserve Analysis

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**Abstract:**

This article explores the differences between the various studies published by the RAA over the years. In comparing the reporting patterns for the different lines of business in the RAA study, I attempt to determine what factors can have an effect on the reporting patterns. Based on the data I show that these factors include the underwriting cycle, data quality and data manipulation to minimize the impact of any one company. I also show how the actuary can incorporate this information in using the RAA data in his reserving analysis.

**Keywords:** RAA, Benchmarks, Underwriting Cycle, Reporting Patterns, Reserving, Reinsurance

## 1. INTRODUCTION

The RAA publishes a bi-annual study of incurred and paid loss triangles of the reinsurance companies that are members of the RAA. The triangles that are published are comprised of four casualty lines of business: Auto Liability, General Liability excluding Asbestos and Pollution, Medical Malpractice and Workers' Compensation. Besides triangles for the entire line of business, the data is also broken out by attachment point, divided into five attachment point ranges. As a disclaimer, in the introduction to its study, the RAA cautions that for various reasons the results of one study will not necessarily match up to the results of a prior or subsequent study.

The RAA triangles are often used to help the actuary in determining the ultimate loss for the non-proportional and facultative reinsurance triangles. In the casualty lines, especially for the long-tailed, high attachment point lines, there is often not enough credible company data to determine an appropriate ultimate loss. By incorporating the RAA studies, the actuary can come to a more reasonable conclusion in selecting an ultimate loss. However, if the RAA studies do change over time, and it is in fact true that one cannot assume a later study will match up with an earlier study, then what will be the impact to a company's results when a new RAA study is published? This paper will attempt to demonstrate if differences between the studies do exist, and if they exist, several suggestions will be offered to explain these differences. Several reserving procedures that utilize the RAA data will then be shown, with an attempt to show if any of the possible explanations could

have an impact on the procedures. This will help the actuary decide when to use the RAA benchmarks and what assumptions need to be made when using them.

## 1.1 Research Context

To the best of my knowledge, there has been no prior research done that compares the RAA studies. However, the RAA in its bi-annual study details the limitations that one should be aware of before using the study. These limitations can be helpful in understanding the potential differences between the studies. Furthermore, one area which is explored is the effect of the underwriting cycle on the different RAA studies. There has been some research published showing the impact that the underwriting cycle might have on the amount of reserves held by a company. In particular, the working party paper presented at the 2008 General Insurance Convention (Hilder), as well as the paper published by Line (et al) (Line), focus extensively on this issue.

## 1.2 Objectives

The primary goal of this paper is to understand what is driving the differences between the various studies published by the RAA. This is important for a couple of reasons. First of all, there might exist within a company some reserving groups where the company's historical data is sparse or volatile which will necessitate heavy reliance on benchmarks. Significant changes in these benchmarks may lead to significant changes in the reserve indications for reasons which are external to the reserve portfolio. This in turn may compromise the credibility of the actuaries in the eyes of end users of actuarial indications such as company management. Understanding why the RAA data has changed can go a long way in minimizing the concerns of management.

Secondly, from the actuarial side, an actuary might be tempted to continue using the benchmarks from a prior study even when a newer study is available. If in fact the newer study does give different results than the prior study, and the actuary does not update his projections, the reserves could wind up being either deficient or redundant. Furthermore, by understanding what differences exist, and why they exist, will help the actuary decide when it is appropriate to use the RAA benchmarks and what assumptions should be made in using them. Understanding these differences can help the reserving actuary make the necessary adjustments in the actuary's projections.

## 1.3 Outline

This paper will focus on the reporting patterns for the Auto Liability line of business. I will compare the reporting patterns by attachment point for the last four RAA studies. Where differences exist, I will propose some possible explanations and test the assumptions from the RAA

data. Finally, based on my findings, I will make some recommendations for the reserving actuary to keep in mind when using the RAA study as a benchmark.

# 2 METHODOLOGY

In this paper I will use the incurred loss triangles from the last four [1] RAA studies to produce a set of loss reporting patterns for the different attachment point triangles produced by the RAA. Although patterns are available for the General Liability, Medical Malpractice and Workers' Compensation lines of business, in this paper I will just present the results for Auto Liability. A cursory review on the GL and WC lines seems to produce similar results to the Auto Liability line so for the sake of simplicity I have focused solely on the Auto Liability line. A more in-depth study would be needed for the other lines and it would be interesting to compare the results of each of the lines.

In order to eliminate any bias due to the judgmental selection of factors between the various studies, I used the same procedure for each of the triangles. The all year weighted averages were selected for each triangle, without eliminating any high or low factors. By choosing the average for all years, the hope is that the outliers, both high and low, will balance each other out. Secondly, in selecting the tail factors, if based on the experience, the cumulative reported loss percentage was at 100% in a period with at least 5 years of experience, then no curve fitting was performed. Where the reporting percentage was more than 100%, then at the period where the reporting percentage reached 100%, a factor of 1.00 was chosen for the tail. In the event that it was necessary to select a tail factor other than 1.00, I used curve fitting to project the tail. Since my intention was not to figure out what the appropriate tail is, but rather to compare the studies, I chose the same curve fit for each study. The curve fit used was the one which gave the highest R^2 for the 2012 study. This curve fit was then used for that particular triangle in each of the studies.

## 2.1 Results

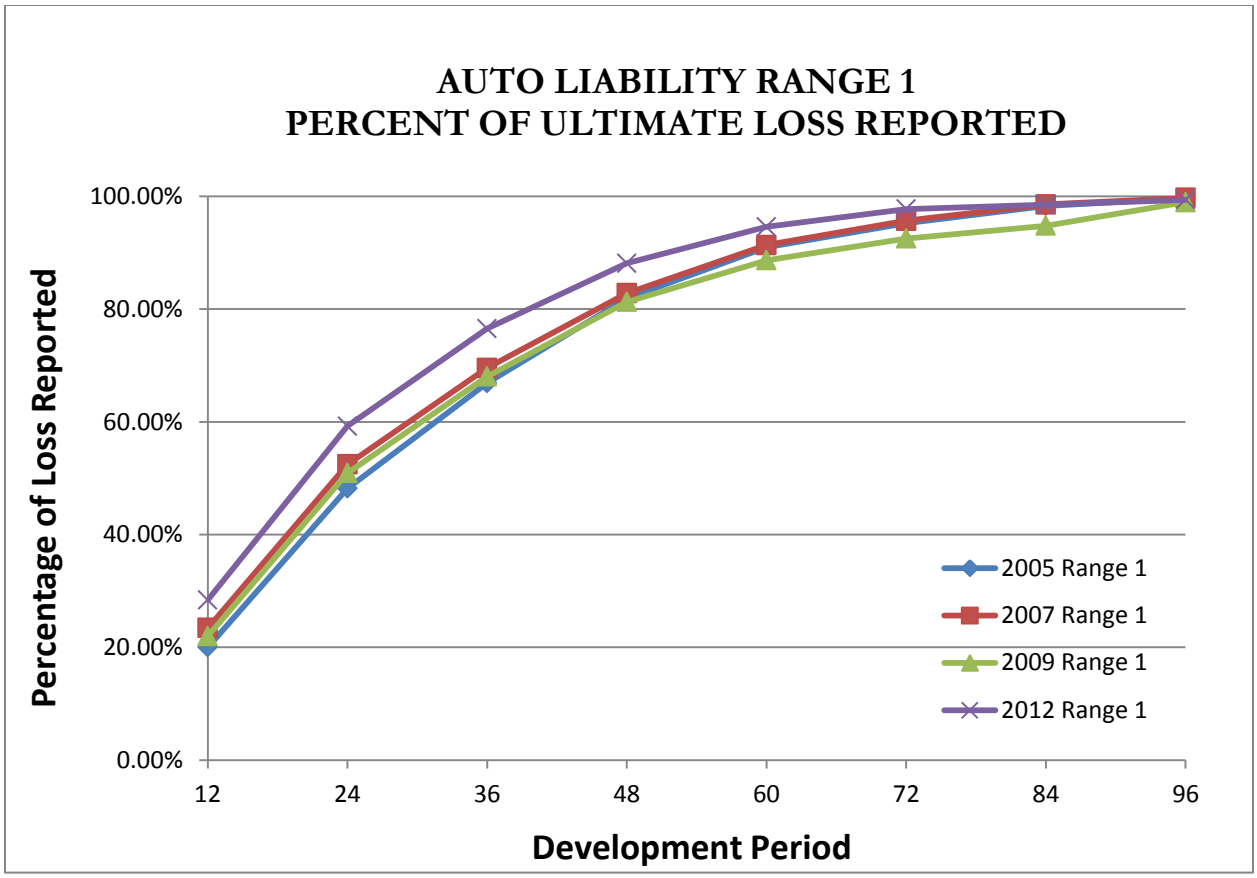
The RAA publishes triangles by various attachment points. In the exhibit below is a table detailing the five different attachment point ranges published by the RAA.

[1] This includes the 2005, 2007, 2009 and the 2012 RAA studies.

| Range Name | Attachment Point Range |
|---|---|
| Range 1 | 1 to 210,000 |
| Range 2 | 210,001 to 500,000 |
| Range 3 | 500,001 to 2,050,000 |
| Range 4 | 2,050,001 to 5,500,000 |
| Range 5 | 5,500,001 and greater |

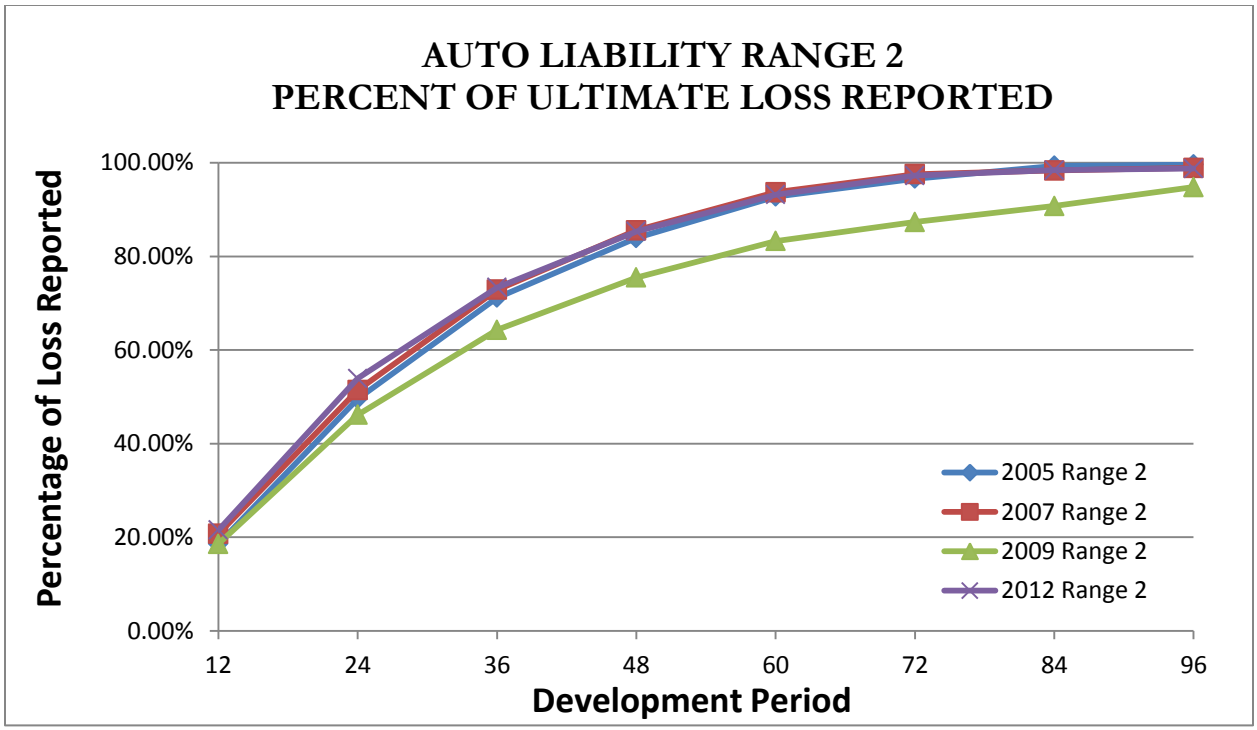
Looking at a comparison between the studies, at the various attachment points,[2] it is clear that the loss reporting pattern for the 2009 study is slower than the other studies. Even for Range 1 where the 2009 study seems to match up pretty well with the 2005 and 2007 study, it is still significantly slower than the 2012 study. There are several possible explanations for this and I will attempt to explore each of the possibilities.

[2] For Auto Liability, Range 4 data was only published in the 2005 and 2012 study. Therefore, this paper will only focus on Ranges 1, 2 and 3.



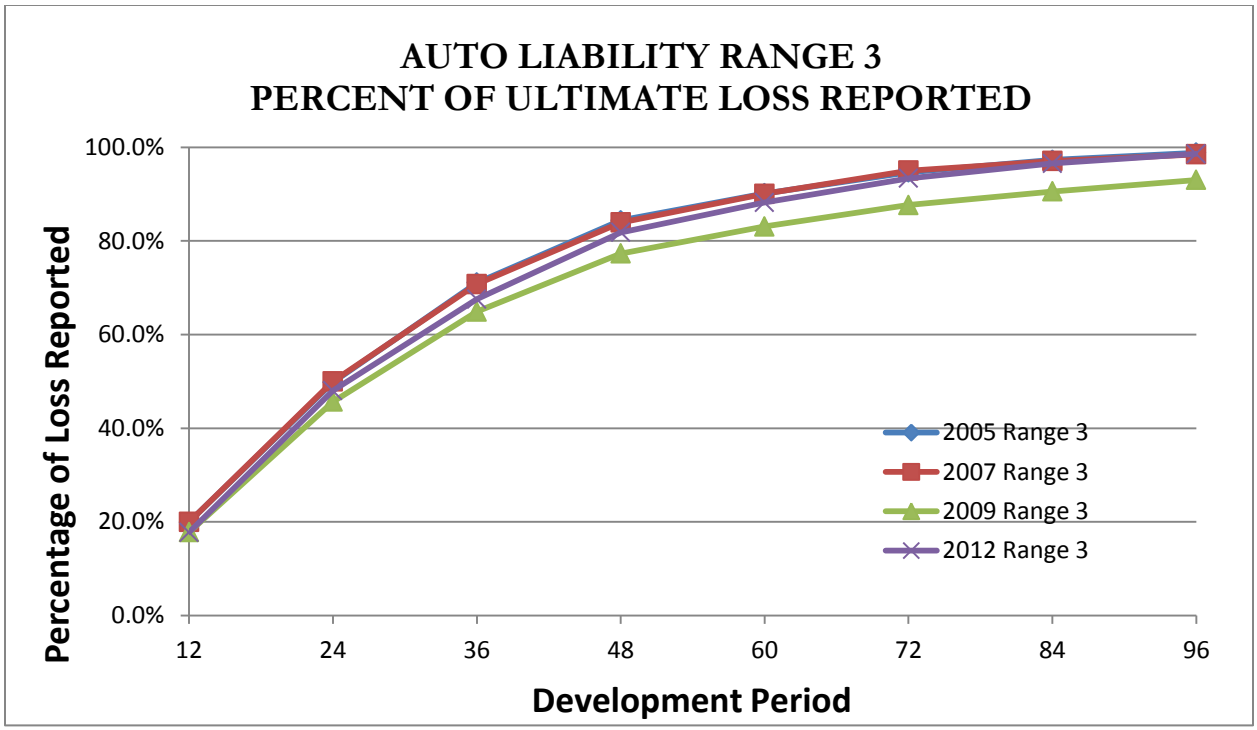

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 23.4% | 52.4% | 69.6% | 82.8% | 91.4% | 95.7% | 98.6% |
| 2009 | 22.0% | 50.9% | 68.0% | 81.3% | 88.7% | 92.5% | 94.8% |
| % difference | -6.2% | -2.9% | -2.2% | -1.8% | -3.0% | -3.3% | -3.8% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 22.0% | 50.9% | 68.0% | 81.3% | 88.7% | 92.5% | 94.8% |
| 2012 | 28.4% | 59.2% | 76.5% | 88.1% | 94.6% | 97.8% | 98.5% |
| % difference | 29.3% | 16.3% | 12.5% | 8.4% | 6.7% | 5.6% | 3.9% |




| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 20.7% | 51.4% | 72.9% | 85.6% | 93.7% | 97.6% | 98.3% |
| 2009 | 18.6% | 46.2% | 64.3% | 75.5% | 83.3% | 87.3% | 90.8% |
| % difference | -10.4% | -10.2% | -11.8% | -11.8% | -11.1% | -10.5% | -7.7% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 18.6% | 46.2% | 64.3% | 75.5% | 83.3% | 87.3% | 90.8% |
| 2012 | 21.5% | 53.9% | 73.4% | 85.3% | 93.2% | 97.3% | 98.4% |
| % difference | 16.1% | 16.8% | 14.1% | 13.0% | 11.9% | 11.4% | 8.4% |




| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 19.9% | 50.0% | 70.8% | 83.9% | 90.1% | 95.0% | 97.1% |
| 2009 | 17.8% | 45.7% | 64.9% | 77.3% | 83.1% | 87.7% | 90.6% |
| % difference | -10.9% | -8.6% | -8.3% | -7.9% | -7.7% | -7.7% | -6.7% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 17.8% | 45.7% | 64.9% | 77.3% | 83.1% | 87.7% | 90.6% |
| 2012 | 17.7% | 48.0% | 67.6% | 81.8% | 88.2% | 93.4% | 96.6% |
| % difference | -0.2% | 5.2% | 4.1% | 5.8% | 6.2% | 6.5% | 6.6% |

## 2.2 UW Year Cycle

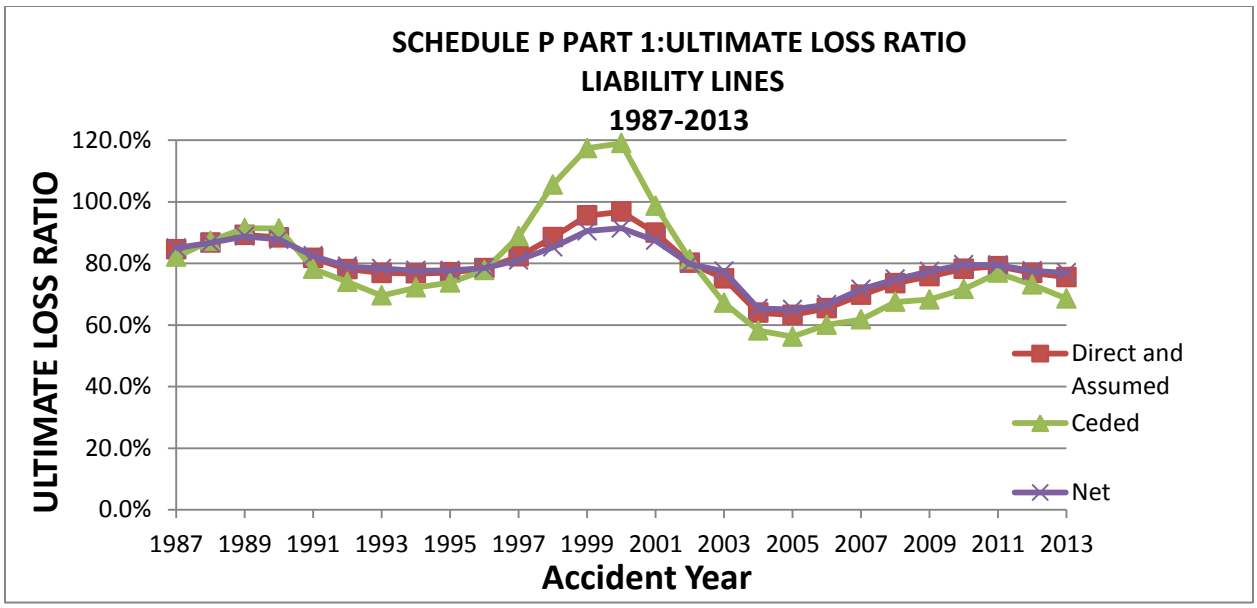
One possible explanation for the slower reporting pattern in the 2009 study can be due to the position within the underwriting cycle. An underwriting cycle is the cyclical manner in which profits within the sector tend to rise and fall over a period of time. Over the last decade, studies have been done to show that there is a relationship between the underwriting cycle and reserving cycle. A reference was made by Bob Conger (Conger), a past president of the CAS, during his keynote address to the 2002 GIRO convention. Subsequently, several papers have been published showing that there is indeed a relationship between the underwriting cycle and the reserving cycle, and that the underwriting cycle can distort development patterns. Line (et al) (Line) attempted to offer several hypotheses why this might be the case. Although the authors were not able to confirm or refute their hypotheses beyond doubt, they did point out that the soft market years appeared to develop more slowly than the hard market years.

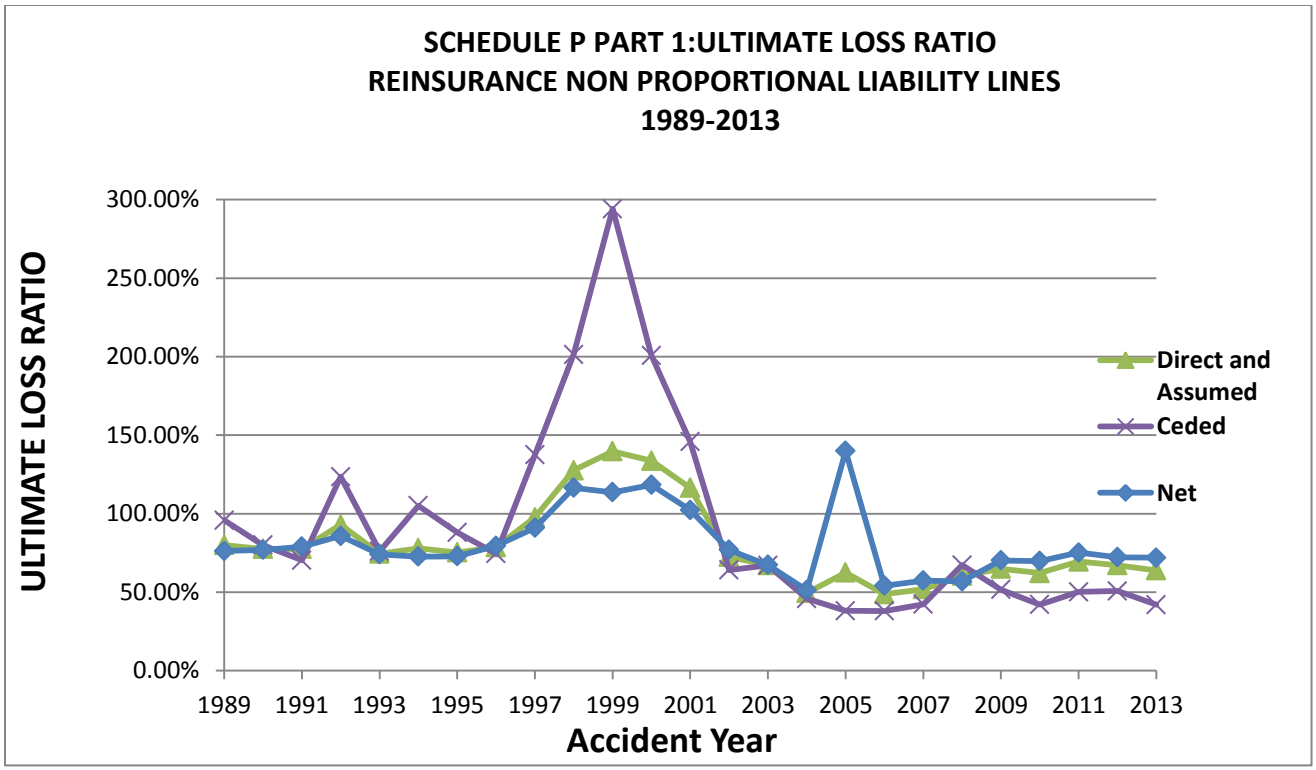
If this is indeed the case, then it is quite possible that the underwriting cycle is driving the difference in the benchmarks. The patterns selected for each study are based on the all year weighted averages for each period. It should be pointed out that the later studies will contain more accident years in the weighted averages for a particular development period compared to the earlier studies. For example, the weighted averages for the 2012 study will contain two more accident years (accident years 2009 and 2010) in the average than the 2009 study (where the latest accident year is 2008). However, even taking this into account, to the extent that a soft market year is given more weight in the average, it would stand to reason that the overall weighted average will be slower. Conversely, if the hard market years are given more weight, then the overall average for a particular period will be faster.

In order to test this theory, it is first necessary to determine which years are the hard market years and which years are the soft market years. It is widely assumed that AY 1997-2001 were the soft market years for reinsurance. In fact if one looks at Schedule P data[3] from the 2013 year-end annual statements for the years 1987-2013, one can clearly see that the reinsurance results for AY 1997-2001 were worse than other years. It appears that we can say that these years were in fact the soft market years.[4]

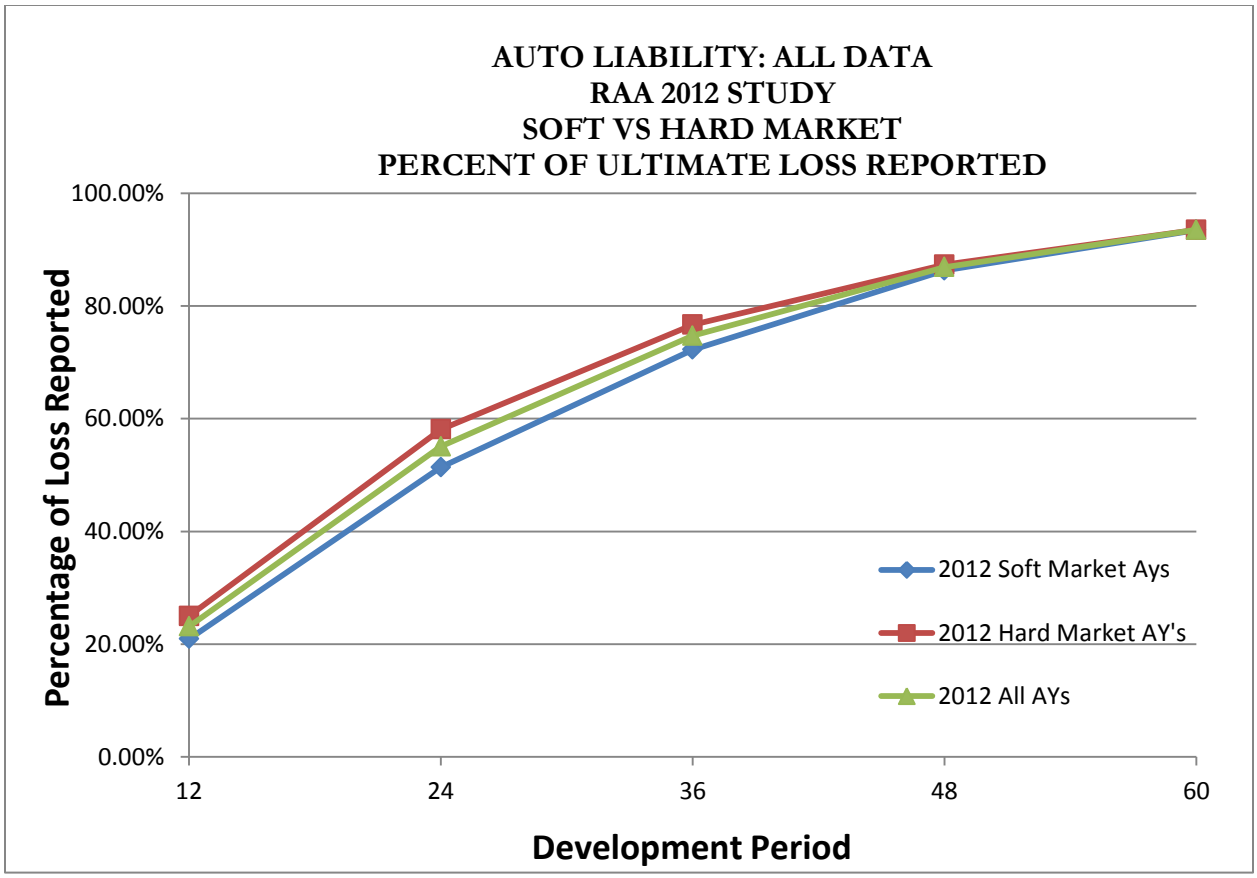
[3] Schedule P Part 1 data was taken from the 1996, 2003 and 2013 Annual Statements using data collected by SNL Financial

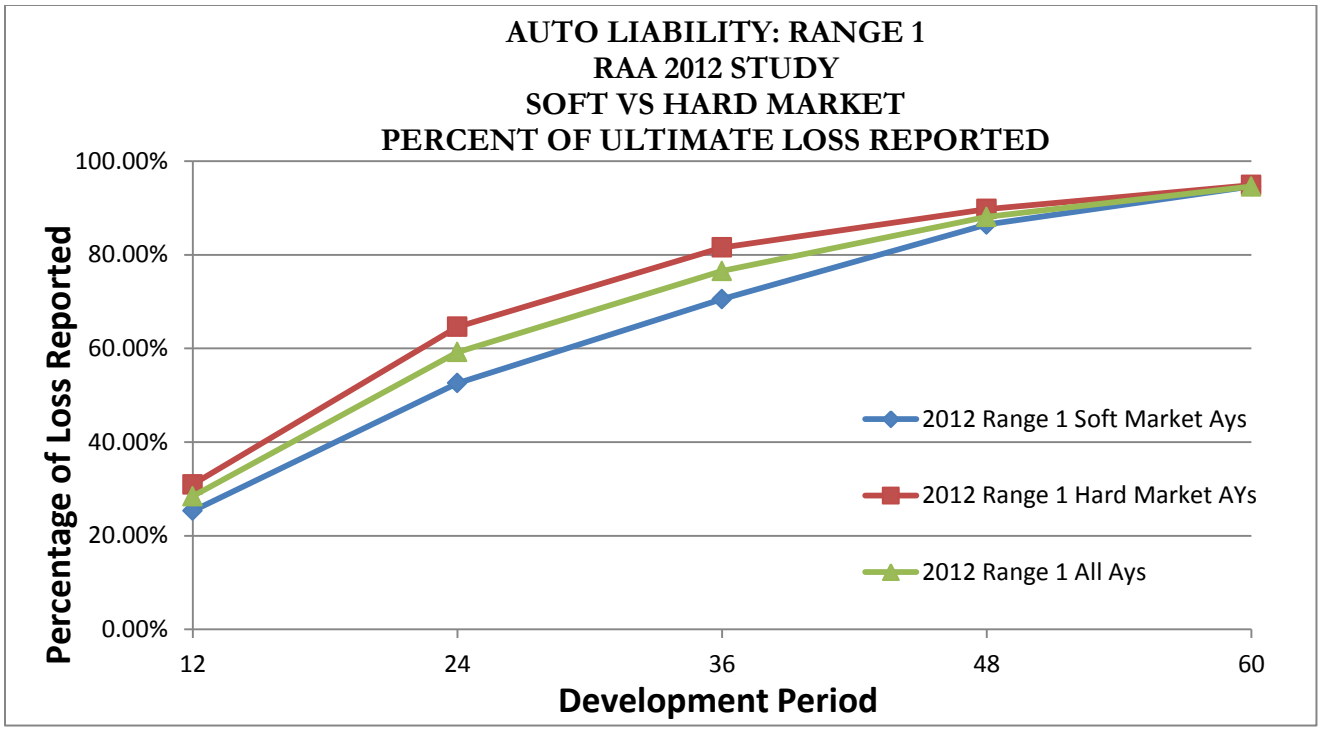
[4] The following exhibits have been adapted from a presentation given by Christopher Bozman of Towers Watson.

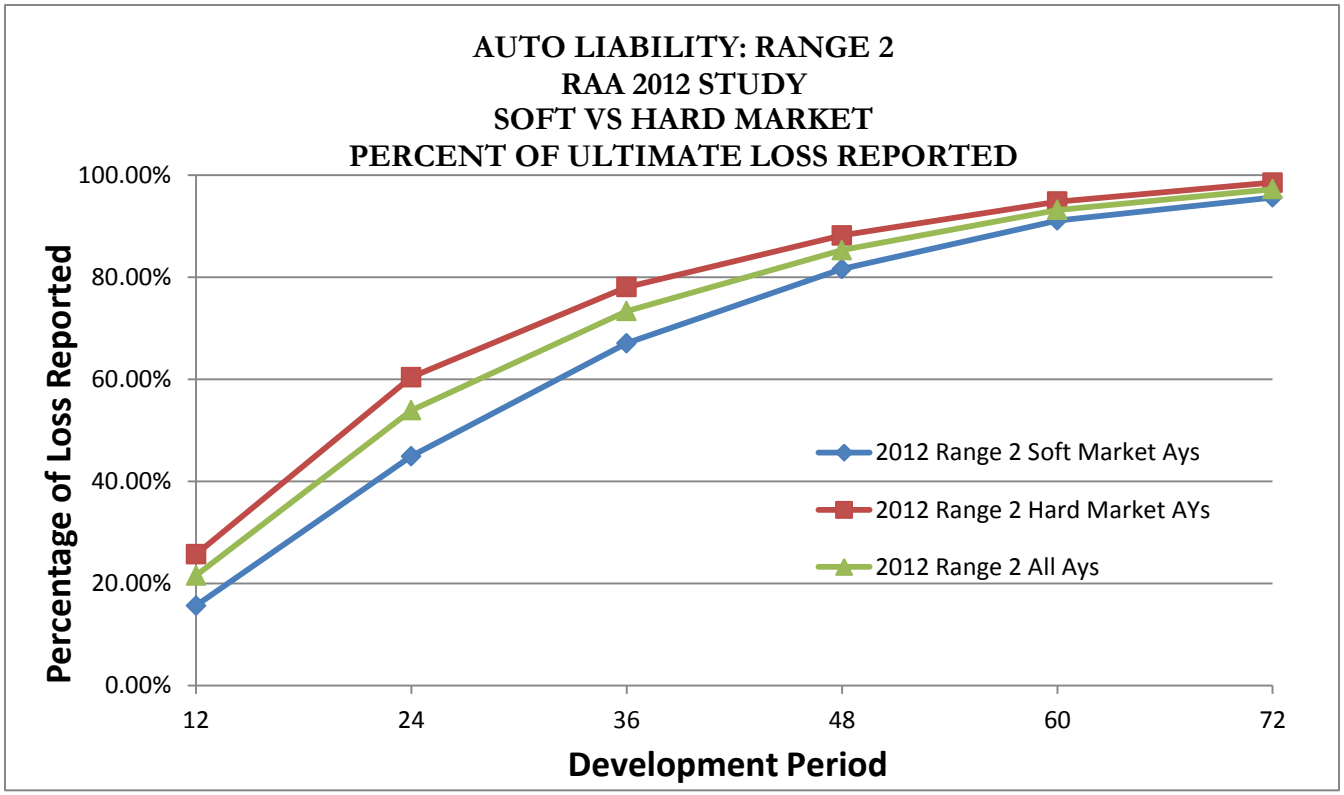

SCHEDULE P PART 1:ULTIMATE LOSS RATIO
LIABILITY LINES
1987-2013
ULTIMATE LOSS RATIO
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013
Accident Year
Direct and Assumed
Ceded
Net

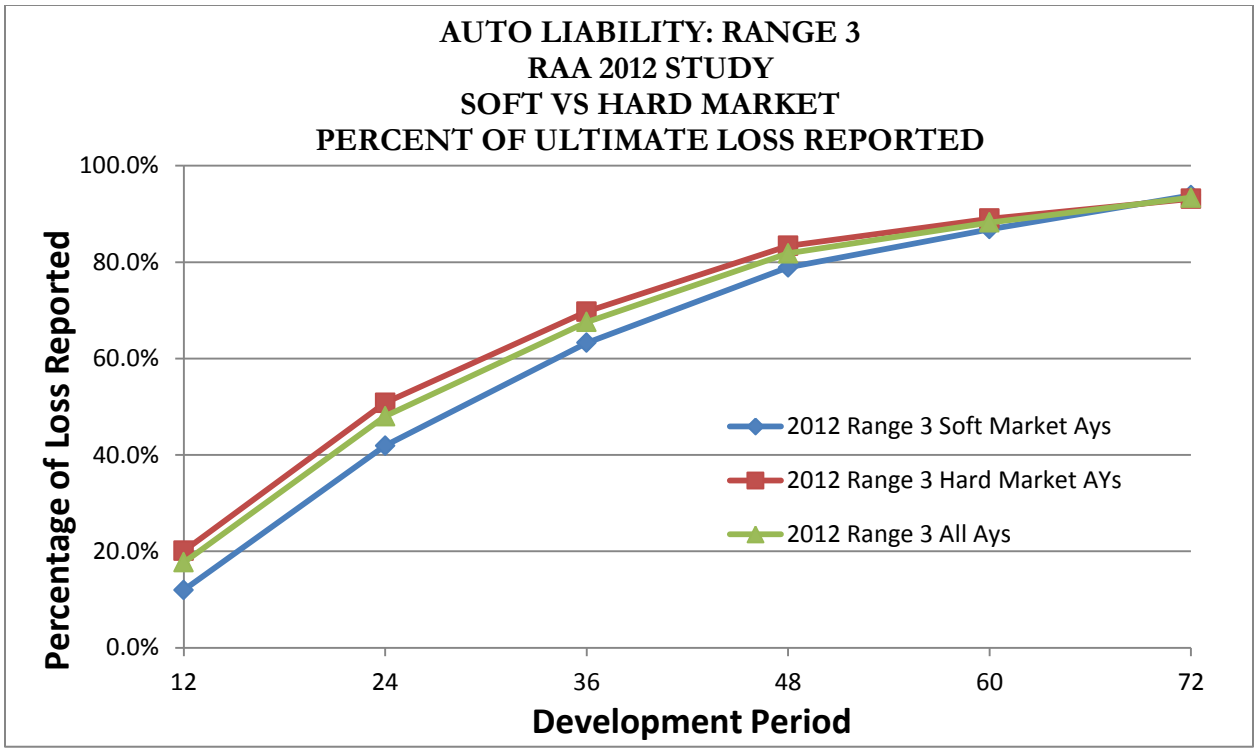

SCHEDULE P PART 1:ULTIMATE LOSS RATIO
REINSURANCE NON PROPORTIONAL LIABILITY LINES
1989-2013
ULTIMATE LOSS RATIO
300.00%
250.00%
200.00%
150.00%
100.00%
50.00%
0.00%
1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013
Accident Year
Direct and Assumed
Ceded
Net

Furthermore, the following exhibits show a comparison between the soft market years and the hard market years from the most recent RAA study. It seems clear from the RAA data, that the soft market years do in fact produce slower reporting patterns than the other years.




AUTO LIABILITY: RANGE 1
RAA 2012 STUDY
SOFT VS HARD MARKET
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
Development Period
2012 Range 1 Soft Market Ays
2012 Range 1 Hard Market AYs
2012 Range 1 All Ays

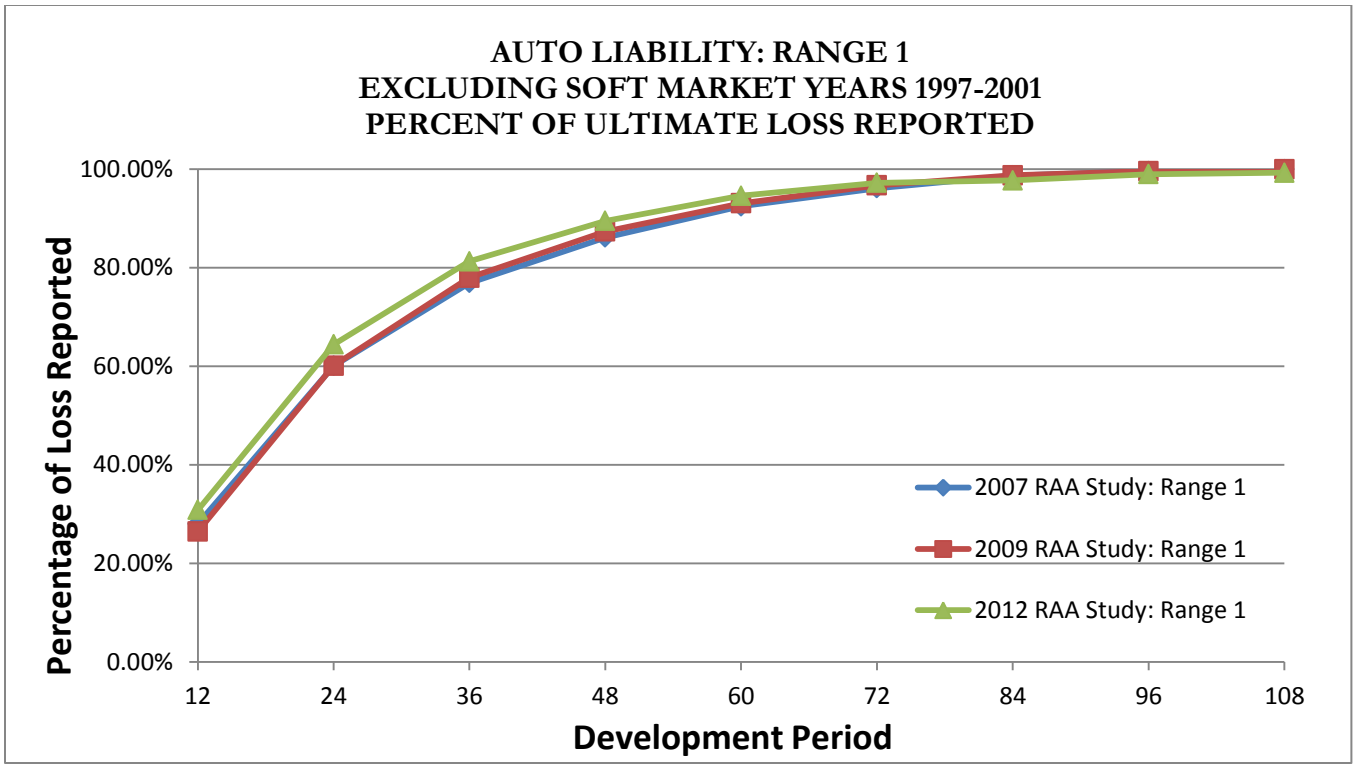

AUTO LIABILITY: RANGE 2
RAA 2012 STUDY
SOFT VS HARD MARKET
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
Development Period
2012 Range 2 Soft Market Ays
2012 Range 2 Hard Market AYs
2012 Range 2 All Ays

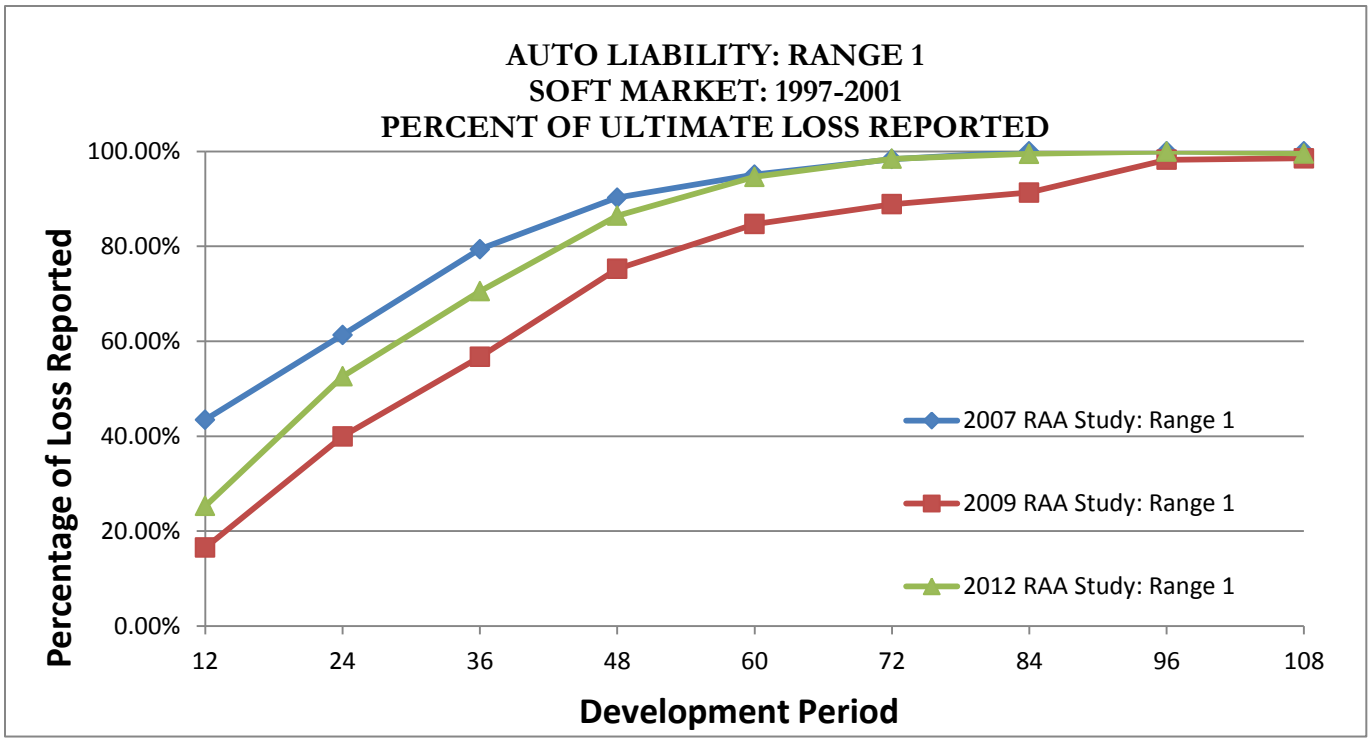


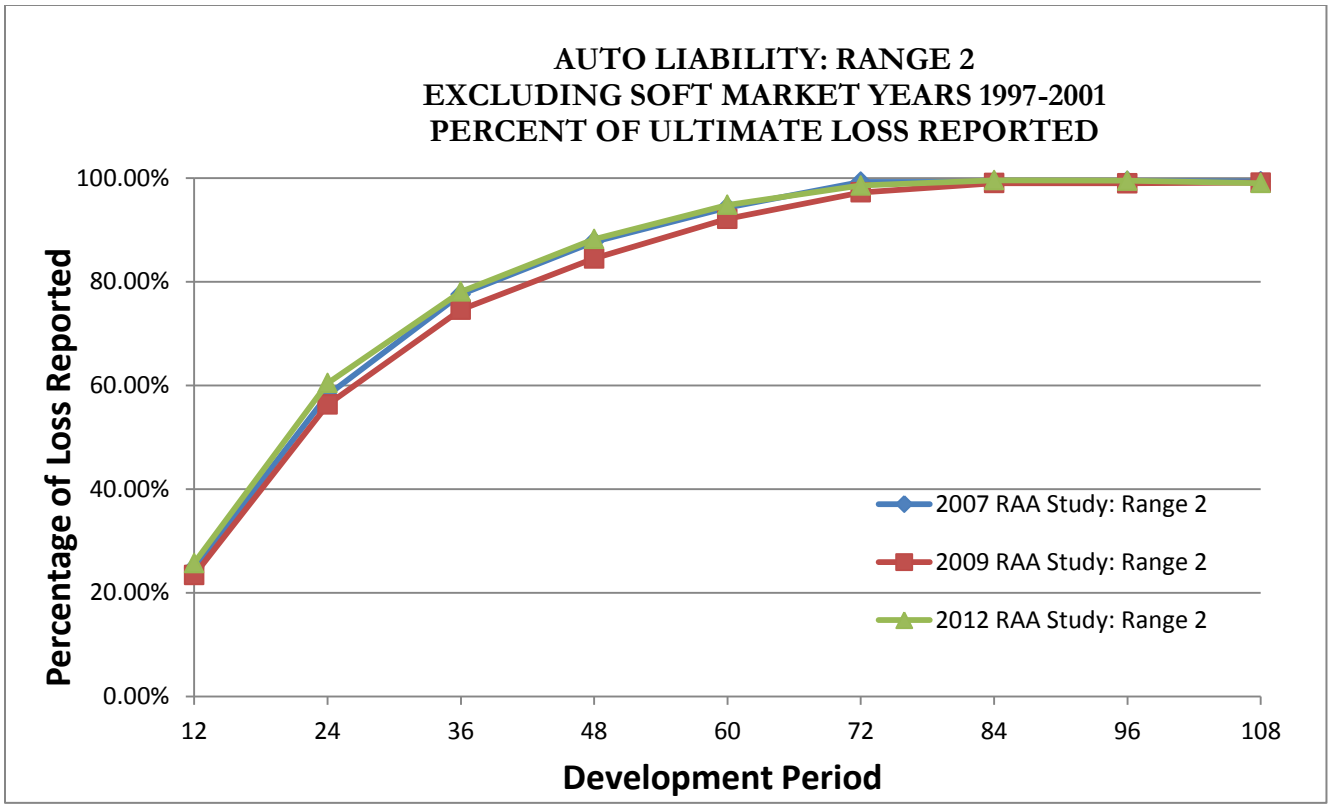

We are now left with determining if in fact the soft market years of the 2009 study are the reason why its reporting pattern is slower than the other studies. If we compare the reporting patterns of each of the studies excluding the soft market years as well as the patterns for just the soft market years,[5] we get the following results.[6]

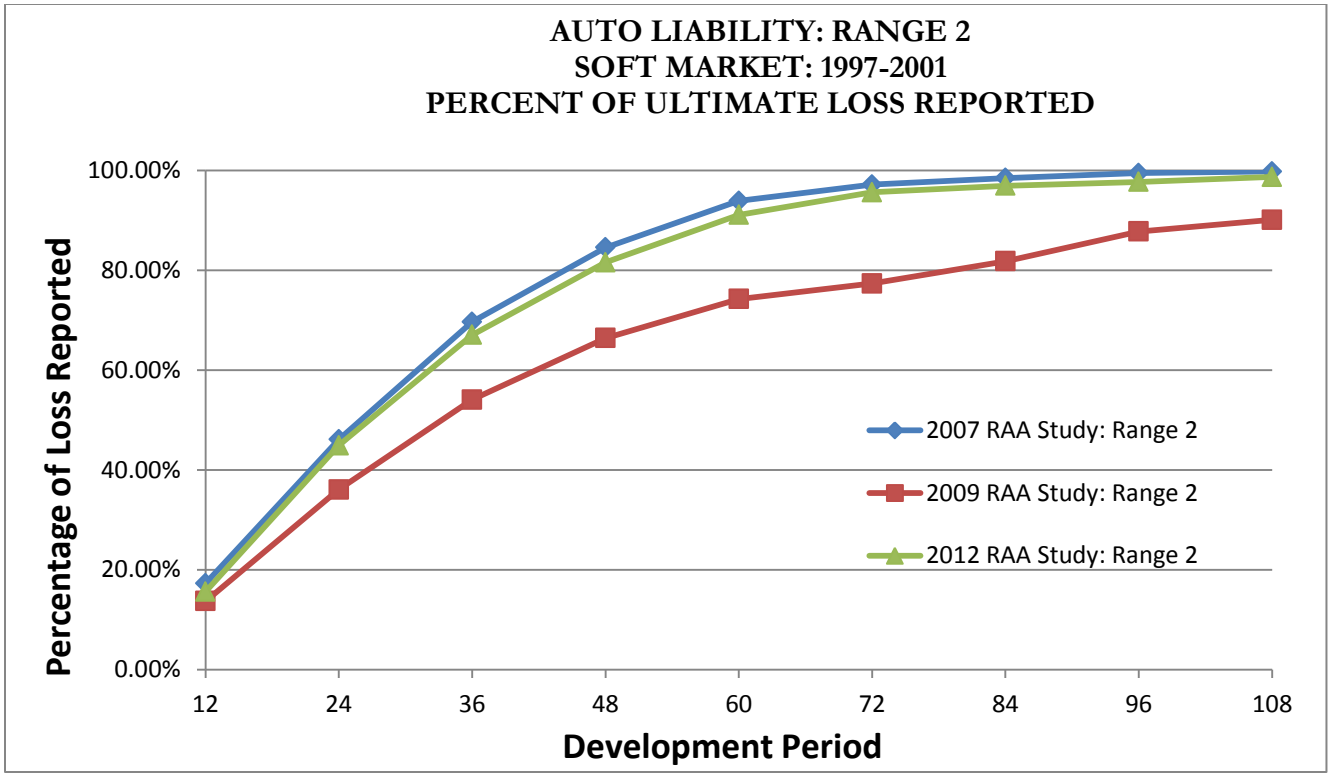
[5] As shown above, we have determined that the soft market years are the underwriting years 1997-2001

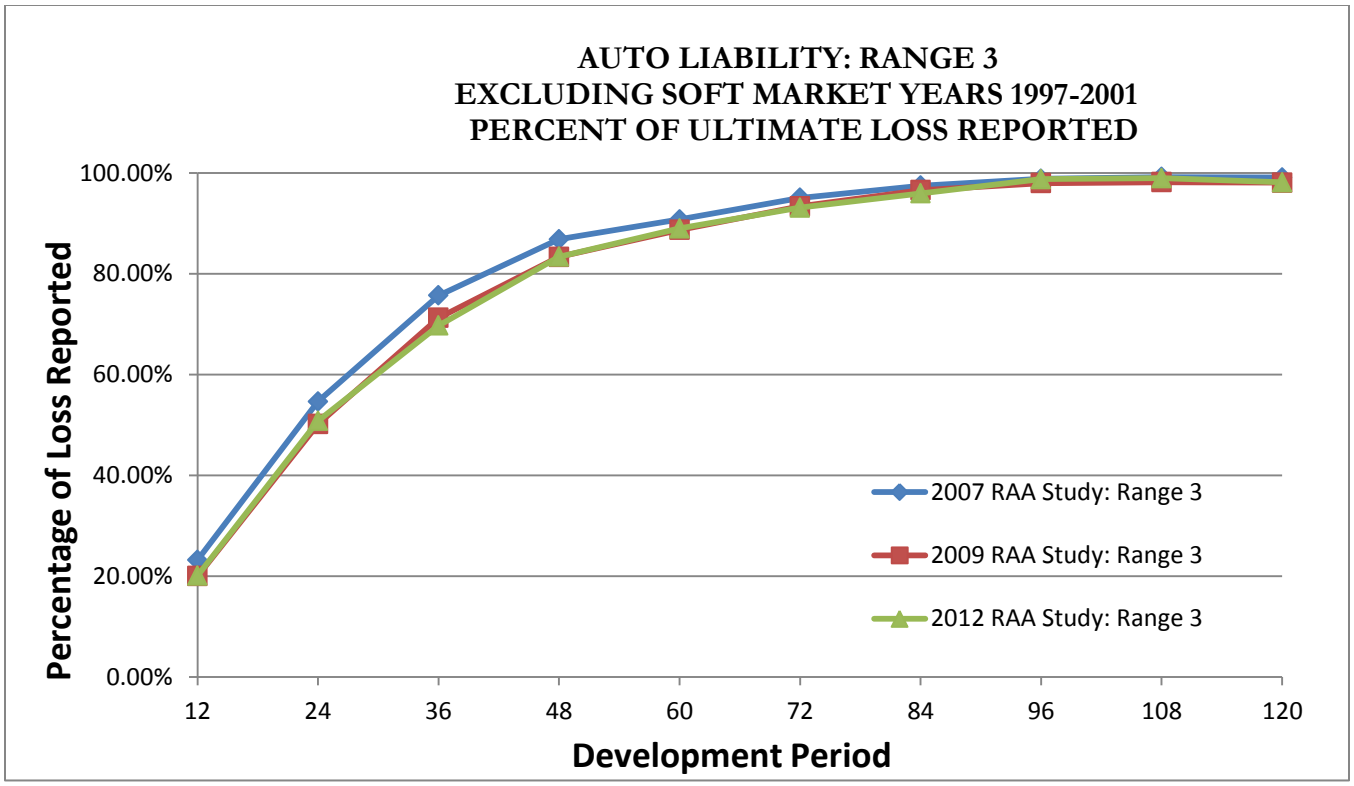
[6] For simplicity and to make the exhibits easier to read, I have left out the patterns from the 2005 study. The patterns from the 2005 study are similar to the 2007 and 2012 studies.

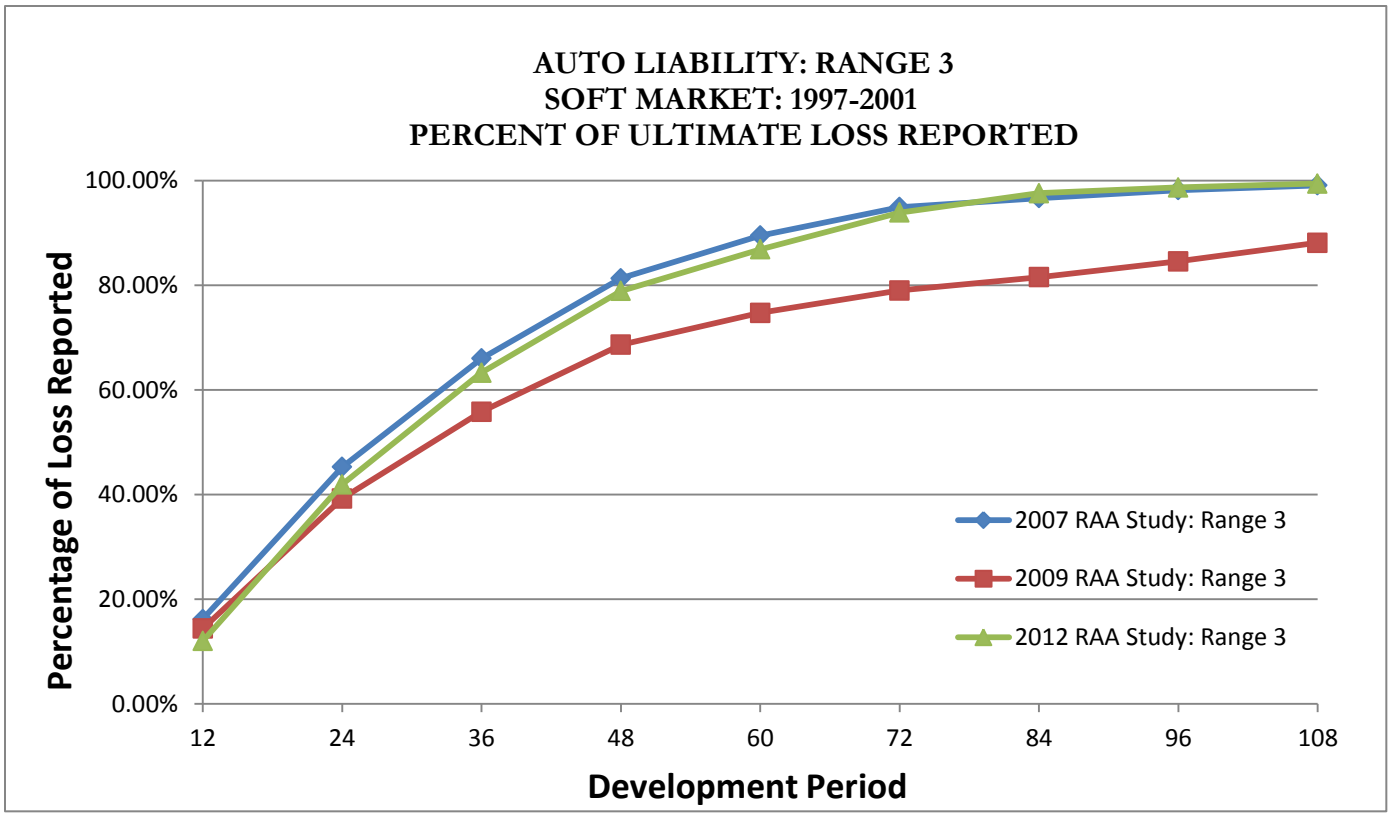

AUTO LIABILITY: RANGE 1
EXCLUDING SOFT MARKET YEARS 1997-2001
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
84
96
108
Development Period
2007 RAA Study: Range 1
2009 RAA Study: Range 1
2012 RAA Study: Range 1


AUTO LIABILITY: RANGE 1
SOFT MARKET: 1997-2001
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
84
96
108
Development Period
2007 RAA Study: Range 1
2009 RAA Study: Range 1
2012 RAA Study: Range 1


AUTO LIABILITY: RANGE 2
EXCLUDING SOFT MARKET YEARS 1997-2001
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
84
96
108
Development Period
2007 RAA Study: Range 2
2009 RAA Study: Range 2
2012 RAA Study: Range 2


AUTO LIABILITY: RANGE 2
SOFT MARKET: 1997-2001
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
84
96
108
Development Period
2007 RAA Study: Range 2
2009 RAA Study: Range 2
2012 RAA Study: Range 2


AUTO LIABILITY: RANGE 3
EXCLUDING SOFT MARKET YEARS 1997-2001
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
84
96
108
120
Development Period
2007 RAA Study: Range 3
2009 RAA Study: Range 3
2012 RAA Study: Range 3


AUTO LIABILITY: RANGE 3
SOFT MARKET: 1997-2001
PERCENT OF ULTIMATE LOSS REPORTED
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Percentage of Loss Reported
12
24
36
48
60
72
84
96
108
Development Period
2007 RAA Study: Range 3
2009 RAA Study: Range 3
2012 RAA Study: Range 3

If we look at the reporting patterns for the non-soft market years, we see that the Range 1 and Range 2 triangles show the same reporting pattern for each of the RAA Studies. The Range 3 triangle actually shows a faster reporting pattern for the 2007 study, but this could be due to other factors as well. In comparison, the triangles for underwriting years 1997-2001, the soft market years, show a completely different result. The 2009 RAA study has a much slower reporting pattern than both the 2007 and 2012 studies. This would suggest that the soft market years have a significant impact to the overall all year weighted average reporting pattern for the 2009 study as opposed to the other studies.

We can understand that the reason the soft market years affect the 2009 study moreso than the 2005 or 2007 is because by 2009 we are further along in the development and the adverse development has more of an impact on the 2009 tail. For example, if we look at the actual triangle we can see that the additional two years of development increase the average for the development periods significantly.

**RAA 2009 Study: Auto Range 2**

| Origin Period | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 2.660 | 1.571 | 1.313 | 1.118 | 1.072 | 1.012 | 1.017 | 1.001 | 0.998 | 1.013 | 1.007 |
| 1998 | 3.093 | 1.474 | 1.276 | 1.107 | 1.028 | 1.045 | 0.999 | 1.002 | 0.999 | 1.020 | |
| 1999 | 2.964 | 1.473 | 1.263 | 1.100 | 1.013 | 1.000 | 1.014 | 1.016 | 1.068 | | |
| 2000 | 2.690 | 1.481 | 1.219 | 1.160 | 1.076 | 1.004 | 1.167 | 1.074 | | | |
| 2001 | 2.039 | 1.533 | 1.114 | 1.108 | 1.038 | 1.217 | 1.143 | | | | |

**RAA 2007 Study: Auto Range 2**

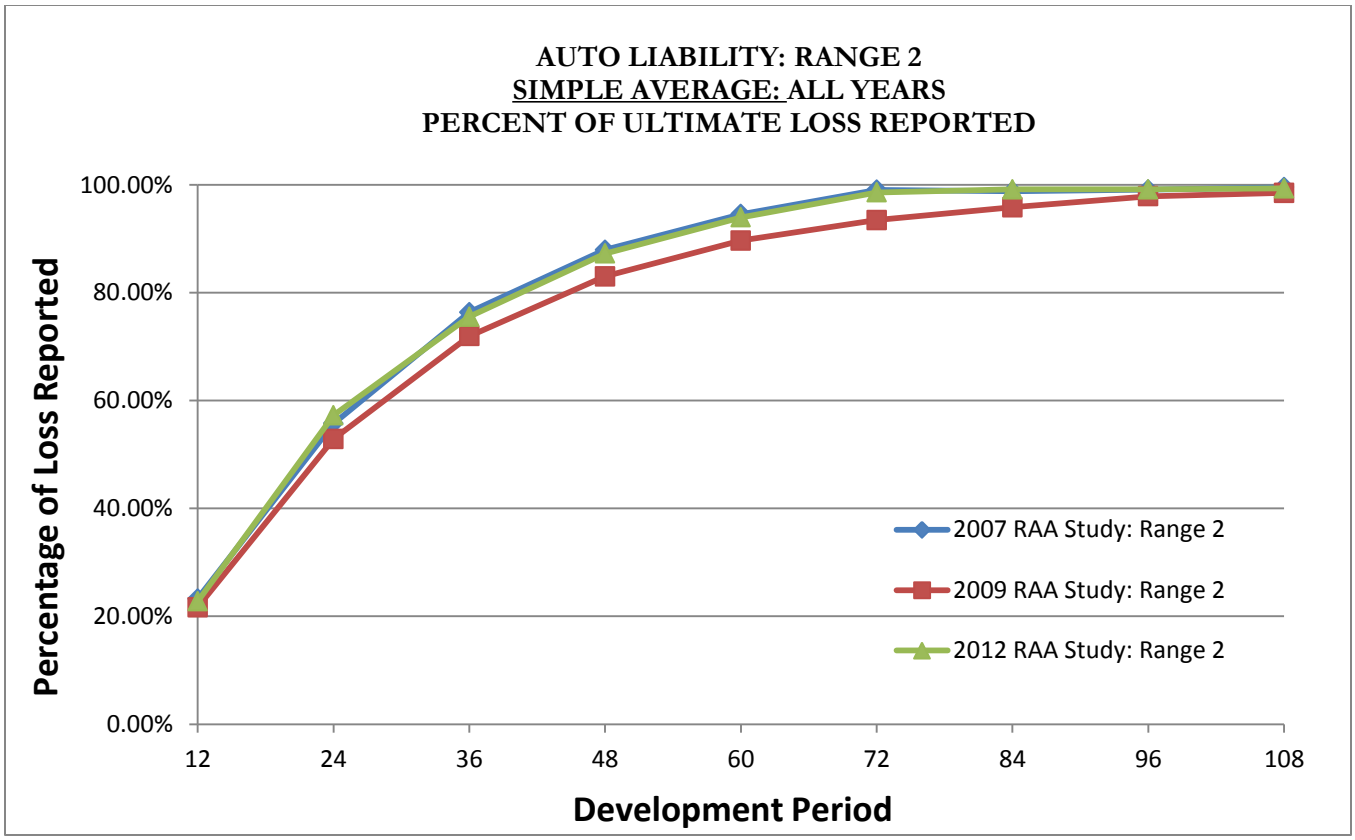
| Origin Period | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 2.691 | 1.550 | 1.278 | 1.109 | 1.063 | 1.019 | 1.011 | 0.990 | 0.999 | | |
| 1998 | 3.157 | 1.495 | 1.267 | 1.098 | 1.027 | 1.037 | 1.004 | 0.999 | | | |
| 1999 | 3.019 | 1.537 | 1.234 | 1.100 | 1.012 | 0.998 | 1.015 | | | | |
| 2000 | 2.548 | 1.462 | 1.200 | 1.149 | 1.059 | 1.004 | | | | | |
| 2001 | 2.077 | 1.530 | 1.103 | 1.099 | 1.030 | | | | | | |

However, why do we not see a similar impact on the 2012 study?

### 2.2.1 Effect of Using Volume Weighted Averages

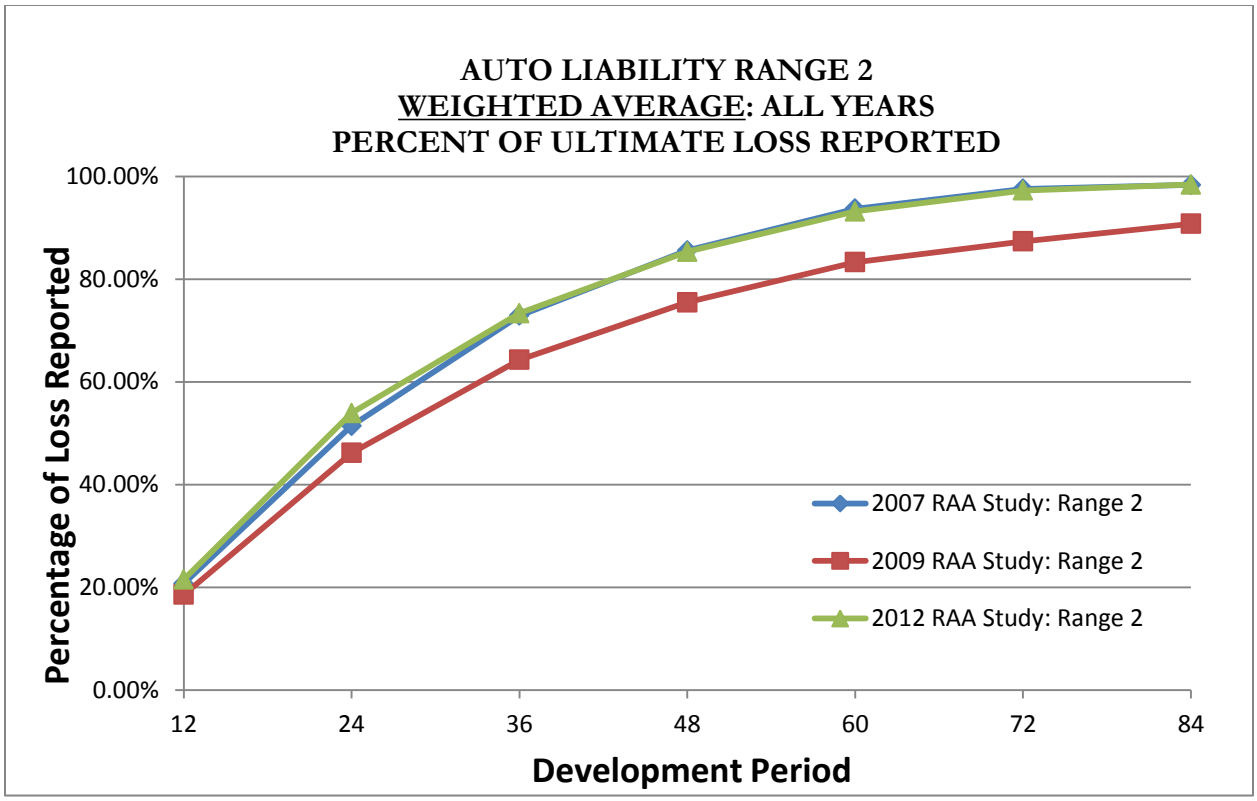
One possible explanation is that to ensure that a single company's data does not dominate the triangle in the latest study put out in 2012, the RAA scaled individual company data and adjusted the data volume by applying a certain percentage to the entire triangle. Although the magnitude of the actual development factors is not affected, the volume of losses is affected (RAA Historical Loss Development Study 2012 edition). Given that the patterns were calculated using volume weighted averages, it is quite possible that the volume of data in the 2012 study has been artificially changed, resulting in a different reporting pattern than would otherwise have been calculated.

If instead of using volume weighted averages, we use straight averages we can eliminate the distortion caused by any artificial change to the actual data. For example, if we look at the straight averages for both the Range 2 and Range 3 triangles, we see that the 2009 study is still slower than the other studies. This would indicate that the difference between the studies is not solely affected by the volume of data. However, being that the difference between the RAA studies is less when we use the simple averages, as opposed to using the weighted averages, this does lend support to the idea that the artificial change to the volume of data is affecting the comparison.



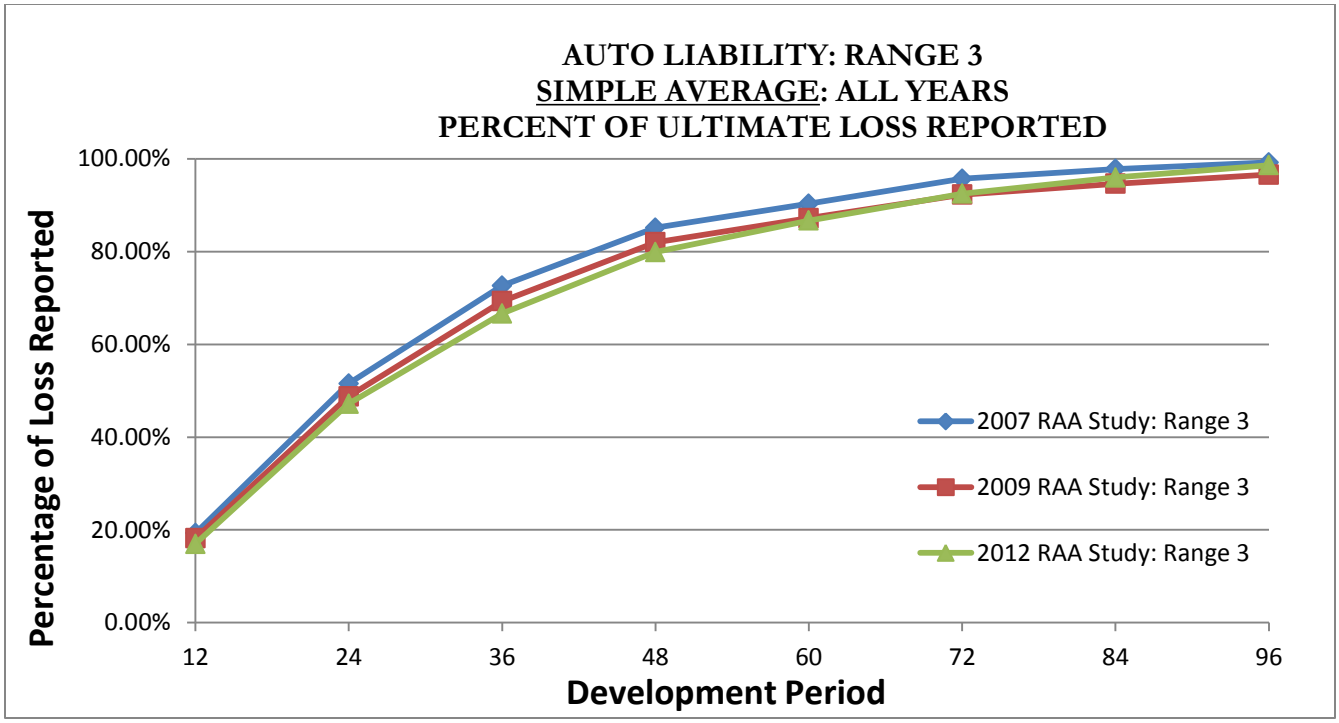

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 23.3% | 55.8% | 76.4% | 88.0% | 94.6% | 99.1% | 98.8% |
| 2009 | 21.7% | 52.9% | 72.0% | 83.0% | 89.7% | 93.5% | 95.8% |
| % difference | -6.8% | -5.1% | -5.8% | -5.6% | -5.2% | -5.6% | -3.0% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 21.7% | 52.9% | 72.0% | 83.0% | 89.7% | 93.5% | 95.8% |
| 2012 | 22.8% | 57.3% | 75.6% | 87.3% | 94.0% | 98.6% | 99.2% |
| % difference | 5.0% | 8.3% | 5.0% | 5.1% | 4.8% | 5.5% | 3.5% |



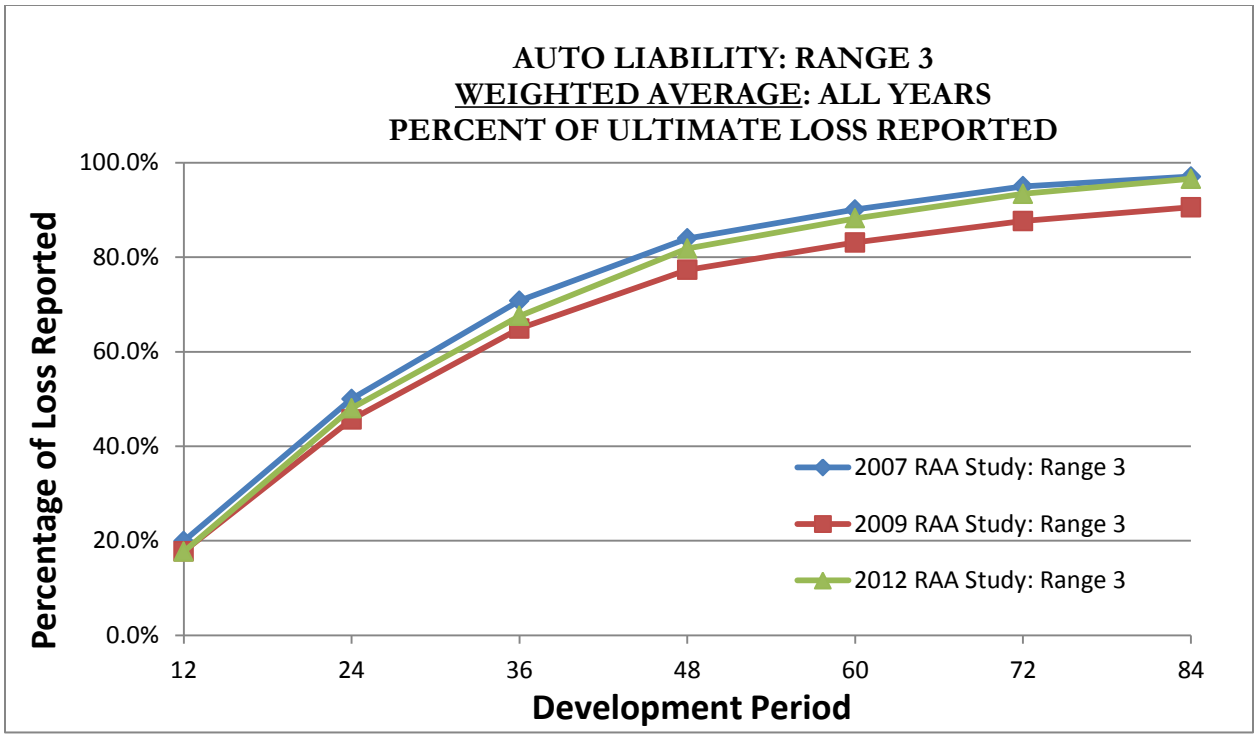

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 20.7% | 51.4% | 72.9% | 85.6% | 93.7% | 97.6% | 98.3% |
| 2009 | 18.6% | 46.2% | 64.3% | 75.5% | 83.3% | 87.3% | 90.8% |
| % difference | -10.4% | -10.2% | -11.8% | -11.8% | -11.1% | -10.5% | -7.7% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 18.6% | 46.2% | 64.3% | 75.5% | 83.3% | 87.3% | 90.8% |
| 2012 | 21.5% | 53.9% | 73.4% | 85.3% | 93.2% | 97.3% | 98.4% |
| % difference | 11.7% | 11.4% | 13.3% | 13.4% | 12.5% | 11.7% | 8.3% |




| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 19.3% | 51.5% | 72.6% | 85.1% | 90.3% | 95.7% | 97.8% |
| 2009 | 18.2% | 48.8% | 69.3% | 82.0% | 87.2% | 92.3% | 94.6% |
| % difference | -5.8% | -5.3% | -4.6% | -3.7% | -3.5% | -3.6% | -3.2% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 18.2% | 48.8% | 69.3% | 82.0% | 87.2% | 92.3% | 94.6% |
| 2012 | 17.0% | 47.2% | 66.7% | 79.9% | 86.7% | 92.5% | 96.0% |
| % difference | -6.7% | -3.3% | -3.8% | -2.6% | -0.6% | 0.2% | 1.4% |




| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2007 | 19.9% | 50.0% | 70.8% | 83.9% | 90.1% | 95.0% | 97.1% |
| 2009 | 17.8% | 45.7% | 64.9% | 77.3% | 83.1% | 87.7% | 90.6% |
| % difference | -10.9% | -8.6% | -8.3% | -7.9% | -7.7% | -7.7% | -6.7% |

| | 12 | 24 | 36 | 48 | 60 | 72 | 84 |
|---|---|---|---|---|---|---|---|
| 2009 | 17.8% | 45.7% | 64.9% | 77.3% | 83.1% | 87.7% | 90.6% |
| 2012 | 17.7% | 48.0% | 67.6% | 81.8% | 88.2% | 93.4% | 96.6% |
| % difference | -0.2% | 5.2% | 4.1% | 5.8% | 6.2% | 6.5% | 6.6% |

### 2.2.2 Commutation Effect

A second possible explanation is that the RAA study is net of commutations. It is quite possible that by the time the 2012 study was done, several reinsurers took steps to commute the unprofitable business from these years.[7] Without the bad business from the soft market years in the triangle, the effect on the reporting patterns would not be as severe as it is in the 2009 study. This could explain why the reporting patterns for the 2012 study are more similar to the 2005 and 2007 study than they

[7] It is also possible that some of the unprofitable reinsurers dropped out of the RAA study.

are to the 2009 study. Although one would still see a slower reporting pattern in the 2012 study for the soft market years, the pattern would follow more closely the 2005 and 2007 study.

However, this explanation is not very likely. The soft market years were from 1997-2001, and the deteriorating results should have already been apparent to companies after a few years. This is especially true with Auto Liability, which has a shorter tail than other casualty lines. If there were any significant commutations, the impact on the triangles should have already been noticeable in the 2005 and 2007 RAA studies. Furthermore, a look at the data seems to lend support that commutations are not an adequate explanation. If we compare the actual reported losses in Range 3 for both the 2009 and 2012 studies we see the following results.

**Range 3: Difference between 2012 and 2009 study (in millions)**

| Accident Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1993 | (6.3) | (12.5) | (15.1) | (13.6) | (12.8) | (10.2) | (9.0) | (9.1) | (8.2) |
| 1994 | (7.6) | (14.1) | (22.8) | (26.0) | (26.5) | (26.2) | (24.6) | (24.4) | (24.4) |
| 1995 | (7.2) | (12.9) | (16.1) | (18.8) | (14.5) | (15.0) | (15.8) | (15.2) | (14.8) |
| 1996 | (11.3) | (20.3) | (25.3) | (23.0) | (21.4) | (21.3) | (20.4) | (21.3) | (22.5) |
| 1997 | (11.4) | (14.8) | (15.2) | (20.9) | (19.9) | (18.9) | (16.2) | (15.8) | (16.3) |
| 1998 | (8.7) | (18.0) | (20.3) | (19.2) | (19.8) | (20.1) | (19.5) | (19.9) | (21.4) |
| 1999 | (5.0) | (16.8) | (20.1) | (18.3) | (19.2) | (16.7) | (15.2) | (14.7) | (21.4) |
| 2000 | (13.4) | (19.4) | (32.5) | (37.3) | (40.6) | (37.7) | (34.9) | (44.2) | (53.1) |
| 2001 | (2.9) | (0.5) | 6.5 | 0.5 | 0.4 | (1.8) | (9.0) | (15.7) | |

**Range 3: Percentage Difference between 2012 and 2009 study**

| Accident Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1993 | -39.3% | -35.0% | -33.5% | -28.4% | -25.6% | -20.2% | -17.6% | -17.5% | -16.0% |
| 1994 | -39.8% | -37.1% | -44.1% | -44.6% | -43.4% | -41.9% | -38.7% | -37.3% | -37.3% |
| 1995 | -44.8% | -36.8% | -33.7% | -35.1% | -26.9% | -26.0% | -26.7% | -25.5% | -25.1% |
| 1996 | -65.9% | -54.5% | -50.4% | -43.4% | -38.1% | -37.1% | -36.4% | -37.3% | -38.6% |
| 1997 | -60.9% | -38.0% | -29.2% | -31.8% | -28.5% | -25.4% | -21.1% | -20.2% | -20.6% |
| 1998 | -51.7% | -41.5% | -33.0% | -26.0% | -24.9% | -23.2% | -22.1% | -22.4% | -23.7% |
| 1999 | -23.3% | -22.1% | -20.3% | -16.1% | -15.9% | -13.5% | -12.0% | -11.5% | -15.9% |
| 2000 | -47.7% | -33.4% | -35.9% | -32.3% | -31.4% | -28.0% | -25.7% | -30.3% | -34.2% |
| 2001 | -22.9% | -0.9% | 8.4% | 0.5% | 0.4% | -1.5% | -7.0% | -11.6% | |

The Range 3 reported losses for the years 1997-2001 in the 2012 study are significantly less than the 2009 study. However, a look at other accident years also shows a significant decrease in losses in the 2012 study as compared to the 2009 study. This would suggest that the first

explanation of a data volume offset is a more probable explanation. It would be interesting to compare the future studies to the 2012 study and see if the data volume is consistent or has changed.

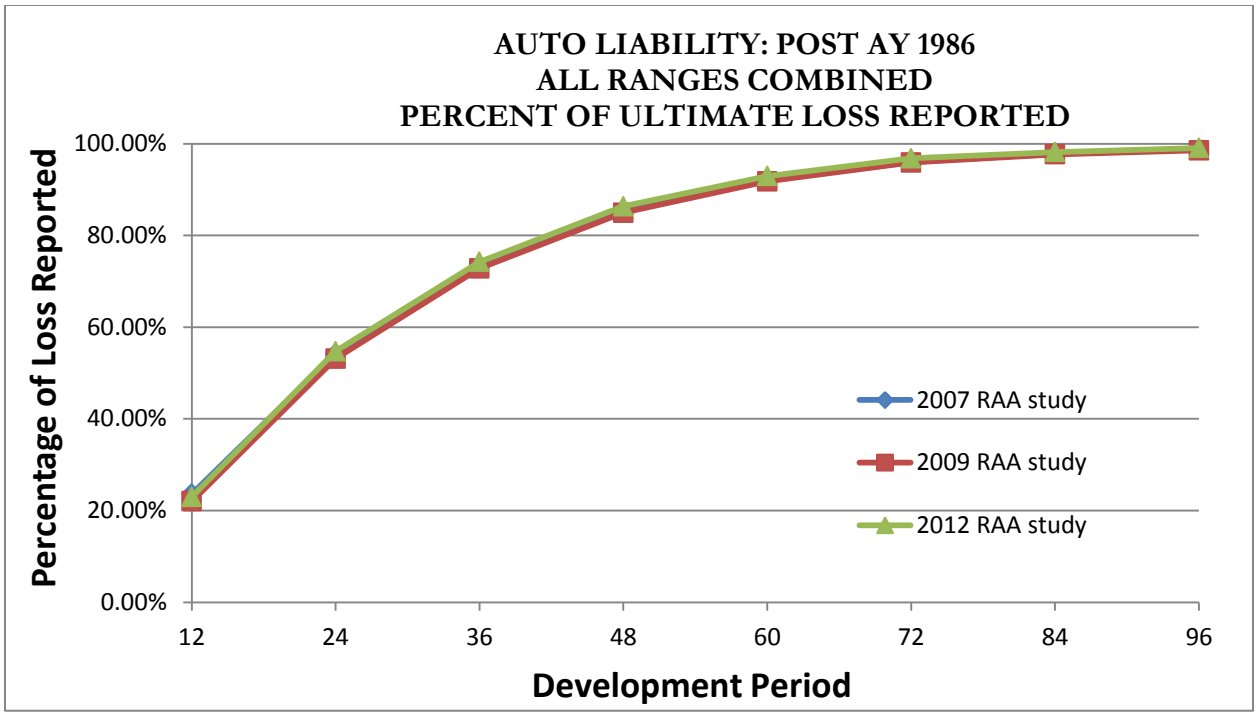
## 2.3 Other Explanations

### 2.3.1 Change in Volume of Data by Attachment Point

Another explanation for the differences is something that the RAA cautions about and that is the availability of the data by attachment point. The RAA relies on its members to not only provide the data but to also segment the data by attachment point. It is quite possible that a particular company did not have the data available by attachment point for one study, yet it was available for a prior or subsequent study. If this would be the case, then there could be a change in the data reported from one study to the next.

To check this, we can look at the data for all ranges combined to see how the patterns compare.[8]

[8] The Auto Liability triangle for the total reported losses starts with AY 1973 while the attachment point data starts with AY 1986. However, the RAA points out that the data before 1986 can be distorted due to the existence of long tailed PIP claims. Therefore, I have shown the total data starting from 1986.




In looking at the patterns, it seems that in the aggregate the reporting patterns for the various RAA studies are similar. It is only when the data is broken out by attachment point range, is there a difference. This does lend support to the hypothesis that the breakout of data by attachment point has changed from study to study. However, we previously showed that the differences in the studies are isolated to the soft market years. Therefore, it is quite possible that when looking at the total triangle, the volume of data for the non-soft market years compensate for the differences in the soft market years.

### 2.3.2 Number of Companies Reporting Data

It is also possible that there was a change in the volume of data being reported. As the tables below show, the number of companies reporting data changed from study to study. It is quite possible that the change in volume due to the number of companies reporting data had an impact on the reporting patterns. Furthermore, there was also a change in the number of companies reporting data for a particular attachment point. This also could have had an impact on the reporting patterns.

# Number Of Companies Reporting Data

| Total | | | |
|---|---|---|---|
| AY | 2007 | 2009 | 2012 |
| 1995 | 17 | 9 | 10 |
| 1996 | 16 | 9 | 10 |
| 1997 | 16 | 9 | 10 |
| 1998 | 15 | 9 | 10 |
| 1999 | 15 | 9 | 10 |
| 2000 | 16 | 9 | 12 |
| 2001 | 16 | 11 | 13 |
| 2002 | 15 | 12 | 14 |
| 2003 | 15 | 14 | 16 |
| 2004 | 15 | 14 | 16 |
| 2005 | 15 | 14 | 16 |
| 2006 | 15 | 15 | 16 |

| Range 1 | | | |
|---|---|---|---|
| | 2007 | 2009 | 2012 |
| 1995 | 6 | 5 | 5 |
| 1996 | 6 | 5 | 5 |
| 1997 | 6 | 4 | 5 |
| 1998 | 7 | 5 | 5 |
| 1999 | 7 | 5 | 5 |
| 2000 | 7 | 5 | 6 |
| 2001 | 7 | 5 | 7 |
| 2002 | 6 | 4 | 7 |
| 2003 | 7 | 5 | 7 |
| 2004 | 7 | 5 | 8 |
| 2005 | 7 | 6 | 8 |
| 2006 | 7 | 7 | 8 |

| Range 2 | | | |
|---|---|---|---|
| | 2007 | 2009 | 2012 |
| 1995 | 7 | 5 | 5 |
| 1996 | 7 | 5 | 5 |
| 1997 | 7 | 5 | 5 |
| 1998 | 7 | 4 | 4 |
| 1999 | 7 | 5 | 5 |
| 2000 | 8 | 5 | 7 |
| 2001 | 9 | 6 | 7 |
| 2002 | 7 | 6 | 7 |
| 2003 | 8 | 7 | 8 |
| 2004 | 9 | 8 | 9 |
| 2005 | 9 | 7 | 8 |
| 2006 | 9 | 7 | 7 |

| Range 3 | | | |
|---|---|---|---|
| | 2007 | 2009 | 2012 |
| 1995 | 5 | 7 | 5 |
| 1996 | 5 | 7 | 5 |
| 1997 | 5 | 7 | 4 |
| 1998 | 5 | 7 | 5 |
| 1999 | 5 | 7 | 5 |
| 2000 | 5 | 7 | 6 |
| 2001 | 6 | 8 | 6 |
| 2002 | 6 | 7 | 5 |
| 2003 | 7 | 8 | 5 |
| 2004 | 7 | 8 | 4 |
| 2005 | 8 | 8 | 5 |
| 2006 | 7 | 8 | 7 |

# 3 SOME PRACTICAL APPLICATIONS

It would be instructive to take a look at some of the explanations offered in this paper, and understand how it might affect the reserving process.

We have shown that some of the RAA data might have been manually adjusted to limit the impact of any one company and that this manual adjustment has an effect on the volume weighted averages. Therefore, it would be prudent for the actuary to keep this in mind and to realize that one's LDF selections might be distorted due to the adjustments made to the data volume. It would not be unreasonable to suggest that simple averages rather than volume weighted averages should be used in projecting RAA benchmarks.

Although the RAA triangles can be used as benchmarks in the reserving process, care must be taken when using them to make sure that the appropriate set of triangles are used. Obviously, if one uses a triangle by attachment point then one must make sure that it matches the attachment point of the experience. However, one must also be careful to determine if the RAA data is a good proxy for the company's experience. There a couple of procedures that can be used to adjust the RAA data to fit the company experience. Let us see if any of the issues mentioned above would have an impact on these procedures.

## 3.1 Adjusting the Triangle Using Relativities

One procedure that can be used is for a situation where the experience triangle has a different attachment point mix for different accident years. However, rather than using development factors derived from the RAA data, one might still want to project the losses based on the actual experience. There will be a concern that the historical development for a particular development period is not on a consistent basis because of the fact that the attachment point levels are not consistent across all the accident years. In the example we will use, the losses for AY 1984-1991 consists of contracts attaching at RAA Range 4, while AY 1992-2001 attach at RAA Range 3.

One can use the RAA data to bring the triangle onto the same attachment point basis through a procedure which is conceptually similar to the Berquist-Sherman Method (Berquist & Sherman). The Berquist-Sherman Method adjusts the historical paid loss data based on the current settlement rate, resulting in an adjusted paid development pattern. Similarly, in this procedure we can restate part of the triangle using a set of relativities calculated from the RAA data.

The first step is to select age-to-age development factors for both the Range 3 and Range 4 triangles. We then select which range will be restated. In our example, we will restate Range 4, AY 1984-1991 to be on a Range 3 basis so that the entire triangle is equivalent to a Range 3 attachment point triangle. We will take the selected factors from the RAA Range 3 triangle at each period and divide by the RAA Range 4 selected factors for that period. We now have relativities for each of the 12-24, 24-36 etc. periods. These relativities are then applied to each of the age-to-age factors from the portion of the triangle that contains Range 4 data. We now have an entire triangle that attaches at Range 3. When we look at the development in this adjusted triangle, we can assume that any differences one sees in one particular development period between two or more accident years are not due to the change in attachment point.

| | (1) Range 3 Age-to-Age | (2) Range 4 Age-to-Age | (1)/(2) Relativity |
|---|---|---|---|
| 12 | 2.25126 | 2.42411 | 92.9% |
| 24 | 1.27361 | 1.26709 | 100.5% |
| 36 | 1.24862 | 1.14338 | 109.2% |
| 48 | 1.14113 | 1.23178 | 92.6% |
| 60 | 1.13399 | 1.12219 | 101.1% |
| 72 | 1.09131 | 1.04160 | 104.8% |
| 84 | 1.07609 | 1.16705 | 92.2% |
| 96 | 1.04185 | 1.13838 | 91.5% |

Original Triangle: Range 4

| AY | (1) 12-24 | (2) 24-36 | (3) 36-48 | (4) 48-60 | (5) 60-72 |
|---|---|---|---|---|---|
| 1984 | 2.813 | 2.513 | 2.555 | 2.112 | 1.731 |
| 1985 | 1.101 | 42.313 | 2.136 | 1.053 | 1.520 |
| 1986 | 1.417 | 1.512 | 13.592 | 2.128 | 1.013 |
| 1987 | 1.006 | 1.088 | 1.736 | 2.355 | 1.006 |
| 1988 | 1.101 | 3.390 | 5.178 | 1.696 | 1.119 |
| 1989 | 1.101 | 5.273 | 1.366 | 1.808 | 1.487 |
| 1990 | 1.149 | 1.124 | 1.115 | 1.506 | 0.864 |
| 1991 | 2.331 | 1.154 | 0.874 | 1.022 | 1.013 |
| | 12 | 24 | 36 | 48 | 60 |
| Relativity Factor | 92.9% | 100.5% | 109.2% | 92.6% | 101.1% |

Adjusted Triangle: Range 4 * Relativity Factor

| AY | (1) 12-24 | (2) 24-36 | (3) 36-48 | (4) 48-60 | (5) 60-72 |
|---|---|---|---|---|---|
| 1997 | 2.612 | 2.526 | 2.791 | 1.957 | 1.749 |
| 1998 | 1.022 | 42.531 | 2.333 | 0.976 | 1.536 |
| 1999 | 1.316 | 1.519 | 14.843 | 1.971 | 1.024 |
| 2000 | 0.935 | 1.094 | 1.895 | 2.182 | 1.017 |
| 2001 | 1.022 | 3.408 | 5.655 | 1.571 | 1.131 |
| 2002 | 1.022 | 5.300 | 1.492 | 1.675 | 1.503 |
| 2003 | 1.067 | 1.130 | 1.217 | 1.395 | 0.873 |
| 2004 | 2.165 | 1.160 | 0.955 | 0.947 | 1.024 |

In this example, the accident years we are adjusting were not from the soft market years. However, the RAA benchmarks we are using includes the slower development attributed to the soft market years. Is the underwriting year cycle effect distorting the calculated relativities? We can check this by calculating relativities from an RAA triangle that excludes the soft market years. Here are the results.

Relativity Excluding Soft Market

| | (1) | (2) | (1)/(2) |
|---|---|---|---|
| | Range 3 Age-to- Age | Range 4 Age-to-Age | Relativity |
| 12 | 1.85240 | 2.43082 | 76.2% |
| 24 | 1.18198 | 1.25624 | 94.1% |
| 36 | 1.17540 | 1.13989 | 103.1% |
| 48 | 1.11454 | 1.22035 | 91.3% |
| 60 | 1.10902 | 1.13657 | 97.6% |
| 72 | 1.11861 | 0.98295 | 113.8% |
| 84 | 1.07652 | 1.21306 | 88.7% |
| 96 | 1.04258 | 1.17257 | 88.9% |

Original Triangle: Range 4

| AY | (1) 12-24 | (2) 24-36 | (3) 36-48 | (4) 48-60 | (5) 60-72 |
|---|---|---|---|---|---|
| 1984 | 2.813 | 2.513 | 2.555 | 2.112 | 1.731 |
| 1985 | 1.101 | 42.313 | 2.136 | 1.053 | 1.520 |
| 1986 | 1.417 | 1.512 | 13.592 | 2.128 | 1.013 |
| 1987 | 1.006 | 1.088 | 1.736 | 2.355 | 1.006 |
| 1988 | 1.101 | 3.390 | 5.178 | 1.696 | 1.119 |
| 1989 | 1.101 | 5.273 | 1.366 | 1.808 | 1.487 |
| 1990 | 1.149 | 1.124 | 1.115 | 1.506 | 0.864 |
| 1991 | 2.331 | 1.154 | 0.874 | 1.022 | 1.013 |
| | 12 | 24 | 36 | 48 | 60 |
| Relativity Factor | 76.2% | 94.1% | 103.1% | 91.3% | 97.6% |

Adjusted Triangle: Range 4 * Relativity Factor

| AY | (1) 12-24 | (2) 24-36 | (3) 36-48 | (4) 48-60 | (5) 60-72 |
|---|---|---|---|---|---|
| 1984 | 2.143 | 2.365 | 2.635 | 1.929 | 1.689 |
| 1985 | 0.839 | 39.812 | 2.203 | 0.962 | 1.483 |
| 1986 | 1.080 | 1.422 | 14.015 | 1.943 | 0.989 |
| 1987 | 0.767 | 1.024 | 1.790 | 2.151 | 0.982 |
| 1988 | 0.839 | 3.190 | 5.339 | 1.549 | 1.092 |
| 1989 | 0.839 | 4.961 | 1.409 | 1.651 | 1.451 |
| 1990 | 0.876 | 1.058 | 1.149 | 1.375 | 0.843 |
| 1991 | 1.776 | 1.086 | 0.901 | 0.934 | 0.988 |

If we compare the all year average from each adjusted triangle, we can conclude that the underwriting cycle effect can have an impact on the relativities. Therefore, if one decides to calculate relativities from the RAA study, one must keep in mind the possibility that the effects of underwriting cycle will influence the results.

1997-2014 All Year Avg. Including Soft Market

| (1) 12-24 | (2) 24-36 | (3) 36-48 | (4) 48-60 | (5) 60-72 |
|---|---|---|---|---|
| 4.358 | 4.355 | 2.154 | 1.365 | 1.109 |

1997-2014 All Year Avg. Excluding Soft Market

| (1) 12-24 | (2) 24-36 | (3) 36-48 | (4) 48-60 | (5) 60-72 |
|---|---|---|---|---|
| 4.246 | 3.814 | 1.890 | 1.239 | 1.019 |

### 3.2 Calculating the Tail

Another area in which the RAA benchmarks can be useful is in calculating the tail factor. In the long tailed casualty lines, very often there is not enough data to calculate a credible tail factor. One approach is to use the tail found in the RAA triangles. However, there are times when one is not confident that the RAA data is a perfect fit for the experience. In such a case one can use a procedure described in a paper written by the CAS Working Party on Tail Factors (The CAS Tail Factor Working Party). In this procedure, one can compare the age-to-age factors from the experience data to the benchmark age-to-age factors prior to the development of the tail. The relativities from these factors can then be used to estimate an adjustment multiplier for the benchmark tail factor. Here is an example using data from the RAA Workers' Compensation Range 2.

| Maturity | (1) Experience Age to Age | (2)= (1)-1 Development Portion | (3) Benchmark Age to Age | (4)= (3)-1 Development Portion | (5)=(2)/(4) Relativity |
|---|---|---|---|---|---|
| 12 | 3.906 | 2.906 | 3.960 | 2.960 | 98.2% |
| 24 | 1.837 | 0.837 | 1.988 | 0.988 | 84.7% |
| 36 | 1.325 | 0.325 | 1.408 | 0.408 | 79.6% |
| 48 | 1.238 | 0.238 | 1.256 | 0.256 | 93.0% |
| 60 | 1.191 | 0.191 | 1.188 | 0.188 | 101.5% |
| 72 | 1.130 | 0.130 | 1.128 | 0.128 | 102.0% |
| 84 | 1.081 | 0.081 | 1.064 | 0.064 | 126.1% |
| 96 | 1.073 | 0.073 | 1.077 | 0.077 | 94.1% |
| 108 | 1.053 | 0.053 | 1.067 | 0.067 | 80.3% |
| 120 | 1.044 | 0.044 | 1.041 | 0.041 | 108.8% |
| 132 | 1.029 | 0.029 | 1.033 | 0.033 | 88.1% |
| 144 | 1.017 | 0.017 | 1.021 | 0.021 | 80.0% |
| 156 | 1.021 | 0.021 | 1.034 | 0.034 | 63.0% |
| | | | | Average (last 6 periods) | 85.7% |
| | | | | Tail | 1.287 |
| | | | | Adjusted Tail | 1.246 |

How would the results be different if we assumed that the development in our experience triangle is not affected by the soft market because these years were commuted? If we adjusted the RAA data to remove the soft market patterns, would our results change?

| Maturity | Experience Age to Age | Development Portion | Benchmark Age to Age | Development Portion | Relativity |
|---|---|---|---|---|---|
| 12 | 3.906 | 2.906 | 3.869 | 2.869 | 101.3% |
| 24 | 1.837 | 0.837 | 1.731 | 0.731 | 114.6% |
| 36 | 1.325 | 0.325 | 1.257 | 0.257 | 126.3% |
| 48 | 1.238 | 0.238 | 1.222 | 0.222 | 107.3% |
| 60 | 1.191 | 0.191 | 1.193 | 0.193 | 98.6% |
| 72 | 1.130 | 0.130 | 1.132 | 0.132 | 98.3% |
| 84 | 1.081 | 0.081 | 1.097 | 0.097 | 83.9% |
| 96 | 1.073 | 0.073 | 1.068 | 0.068 | 105.9% |
| 108 | 1.053 | 0.053 | 1.042 | 0.042 | 128.5% |
| 120 | 1.044 | 0.044 | 1.048 | 0.048 | 93.0% |
| 132 | 1.029 | 0.029 | 1.025 | 0.025 | 114.2% |
| 144 | 1.017 | 0.017 | 1.013 | 0.013 | 130.1% |
| 156 | 1.021 | 0.021 | 1.010 | 0.010 | 221.5% |
| | | | | Average | 132.2% |
| | | | | Tail | 1.203 |
| | | | | Adjusted Tail | 1.268 |
| | | | | % Difference from prior exhibit | 1.8% |

In this scenario, it does not seem that the underwriting cycle effect impacts this procedure. Intuitively, this makes sense as we are comparing the RAA benchmark to the experience and applying the adjustment factor to the RAA tail. When we compare the two scenarios, we see that the adjustment factor for scenario 1 is 35% lower than scenario 2. However, the development portion of the tail factor for scenario 1 is 41% higher. In effect the lower adjustment factor is cancelled out by the higher tail.

# 4 CONCLUSIONS

We have presented evidence to show that the different RAA studies in fact do produce different results. In trying to understand the differences we have suggested several explanations. Among the

explanations presented were the effects of the underwriting cycle and the manual adjustment to the volume of data. We have also shown how both of these suggestions can have an impact on how the RAA data is used in creating benchmarks to be used in a reserving analysis.

**Acknowledgment**

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# 5 REFERENCES

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