Practical Considerations in Assessing the Impact of Inflation on Carried Reserves

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Abstract: As the U.S. economy recovers from its most recent financial crisis, concerns are rising that inflation could increase dramatically in the near term. This paper attempts to quantify the effects that accelerated inflation could have on a company's balance sheet using the methodology proposed by Mr. William Richards in his 1981 paper titled, "Evaluating the Impact of Inflation on Loss Reserves." Data were evaluated regarding the appropriate loss components to use for modeling (loss, salvage/subrogation recoveries, loss adjustment expense) and the identification of appropriate indices in conjunction with the timing of the inflationary impact. In addition to testing several of Richards' key assumptions, the methodology is utilized in a slightly different fashion than originally proposed. Instead of using a single index to deflate historical losses, a selection of reasonable indices was implemented so that a range of expected outcomes could be evaluated for each level of assumed future inflation.

Keywords: Discounting of Reserves, Exploratory Data Analysis. Inflation, Reserving Methods, Reserve Variability.

1. INTRODUCTION

Once again the P/C insurance industry has cycled back to asking questions about the impact of inflation on carried reserves, given current economic circumstances and the not-too-unreasonable expectation that the industry could soon enter a period of aggravated inflation. In 1981, Mr. William F. Richards published an approach to quantifying this effect titled, "Evaluating the Impact of Inflation on Loss Reserves"[1]. Mr. Richard Woll contributed a review of his publication [2], raising three concerns with Richards' process. Woll states that the primary issue is different types of losses inflating at different rates do not necessarily settle at the same rate. The second concern was that Richards' approach assumes that all losses are affected by inflation until paid. Woll instead suggested the derivation of a matrix representing the degree to which losses paid in a particular year of development are affected by inflation subsequent to the year of occurrence. Finally, Woll raised concerns over the application of Richards' method to incurred loss triangles due to complications in adjusting case reserves for inflation and the need to forecast future payment and reserve patterns.

This paper will attempt to address and test several of the stated assumptions in using Richards' methodology, provide practical examples of its application, and address Woll's concerns. Data from a large P&C company was utilized by (approximate) Schedule P lines of business. Although the obvious focus is on those segments which have a longer "tail" and are therefore susceptible to inflationary impacts, all lines are included in the appendices for completeness and reasonability

testing. The first goal was to estimate the possible effects of major inflationary shifts on corporate P/C reserve balances with special focus on personal and commercial auto liability (which together comprise 57% of direct reserves). A second and related goal was to identify which indices best predict inflationary impacts on reserves so that the company's investment division could simultaneously model inflation scenarios against the asset and liability portions of the balance sheet.

2. DATA CONSIDERATIONS

The first step in Richards' methodology was to establish a profile of loss costs by component (medical, wage, legal fees, pain and suffering, etc.). Our approach looked at multiple snapshots of data, depending on the line of business.

- Homeowners/Farmowners—Liability, property non-storm, storms, all combined property.
- Auto liability—Personal versus commercial business separately and combined (Parts B and C of Schedule P). Property damage liability was also evaluated separately.
- Workers Compensation—Medical versus indemnity and combined.
- Commercial Multi-Peril - Liability, property non-storm, storms, all combined property.
- Other Liability—In total.
- Special Property—In total.
- Auto Physical Damage—Personal versus commercial business, separately and combined; storm versus non-storm and combined.
- Other—In total (this includes a small book of individual health products).

All analyses were conducted direct of reinsurance. Individual loss components were studied as well:

- Gross loss paid
- Salvage/subrogation received
- Net loss paid
- D&CC (Defense & Cost Containment) expense paid
- Gross loss/D&CC paid
- Net loss/D&CC paid

3. EVALUATING THE TIME ELEMENT

Richards' next step was to identify those economic indices which best measure the inflation in loss costs and the timing of the inflationary impact. The first issue addressed was the timing of the impact of the inflationary effect. We organized losses by accident year, report year, and closed year, then considered total claims (with case reserves as of 12/2009) and closed claims in calculating severities. Each evaluation included data from 1995-2008, where an ordinary linear regression on claim severity was fit against a plethora of individual economic indices. For the report-year and closed-year analyses, the oldest accident year included was 1990. Included in Exhibit 1 below are the resulting coefficients of determination for this evaluation against the average annual Consumer Price Index (CPI), sorted in decreasing order by reserve volume and increasing predictability for Auto Liability:

Exhibit 1
Measuring Goodness-of-Fit by Time Period

Segment	Percentage of 12/2009 Reserves	Closed Claims by Accident Year	All Claims by Accident Year	All Claims by Report Year	Closed Claims by Report Year	Closed Claims by Closed Year
Auto Liability	57%	1%	38%	42%	67%	70%
Commercial Liability	19%	55%	20%	63%	31%	98%
Fire Lines Property	9%	90%	95%	95%	4%	98%
Fire Lines Liability	4%	16%	58%	66%	22%	95%
Work Comp Medical	3%	18%	83%	84%	10%	96%
Commercial Property	3%	89%	93%	92%	3%	93%
Work Comp Indemnity	3%	50%	46%	53%	20%	96%
Auto Physical Damage	1%	96%	97%	96%	64%	91%
Health	1%	79%	87%	92%	75%	92%
All Lines	100%					

It was observed that the most predictive relationship between claim severity and economic index was found when evaluating closed claim severity by closed date. Surprisingly, this was true across most lines of business, the only exception being Auto Physical Damage. Workers Compensation–Indemnity (WCI), for example, intuitively should track better with the date of accident, yet the historical data did not bear this out. Even including the current case reserves did not significantly improve predictability for WCI on an accident year basis. To test the sensitivity of our analysis, we also repeated the analysis by varying the number of years included. This did not significantly affect the outcomes.

One of Woll's concerns is that not all losses may be inflation-sensitive through the paid date. Our finding that severity tracks best with the CPI (and other indices) when organized by closed year

suggests that the closed date assumption may in fact be most appropriate for the dataset analyzed. Since the best "fit" of economic inflation versus severity is found by closing (as a proxy for paid) date rather than accident or report date, this concern was laid to rest as regards our data. Though it is possible that some losses indeed are not inflation-sensitive beyond the accident date, these losses are not prominent in the observed data, either due to a relatively smaller volume of these types of losses, or perhaps that these losses tend to be closed very soon after the accident date—in either case, any "misclassification" on our part of these losses as being inflation-sensitive through the closing date will likely have little impact on reserve volatility due to inflation. All subsequent analyses on the relationship between severity and economic indices were completed on a closed claim by closed year basis. It may be helpful to note that we considered an additional evaluation of severity by paid date, but complications with claim counts on claims with payments spanning multiple years made this impractical.

4. IDENTIFYING THE "BEST" ECONOMIC INDICATORS

To next quantify which indices best measure the inflation in loss costs, Appendix 1 shows the R-squared values for claim severity and loss costs regressed against various publicly available economic indices, on an annual average basis where available. Where two values are shown for a given cell, there was statistically significant autocorrelation present in the data (the second number is the R-squared of the auto-regressed data). These results were derived using a univariate Regression Analysis with Autoregressive Errors procedure in SAS. The first observation is that the predictive relationship between claim severity and index appeared stronger than was true for loss cost and the same index. This makes intuitive sense as the commingling of frequency trends with severity trends can produce a dampening effect on loss costs. The notable exception is for Auto Liability, where the loss cost analysis produced a similar fit as was true for severity.

A review of these R-squared values for severity by line of business versus the assorted indices showed high predictive power, commonly above 80%. While this suggests strong relationships, a reasonably high R-squared value is to be expected for any increasing series of data. We would generally expect severity to increase at a stable rate over time. If we expect this severity increase to be approximately linear, then any other linear trend should regress fairly well against this data (the index in this case would serve as a proxy for time). Exhibit 2 demonstrates this concept.

Exhibit 2
Increasing Time Series Example

Closed Year	Auto Liability Paid Severity	Index		
		CPI	Linear1	Linear2
1990	1,386	130.7	1	1
1991	2,068	136.2	2	3
1992	2,643	140.3	3	5
1993	2,837	144.5	4	7
1994	2,873	148.2	5	9
1995	3,060	152.4	6	11
1996	3,020	156.9	7	13
1997	3,441	160.5	8	15
1998	3,615	163.0	9	17
1999	3,672	166.6	10	19
2000	3,730	172.2	11	21
2001	3,852	177.1	12	23
2002	4,078	179.9	13	25
2003	4,248	184.0	14	27
2004	3,885	188.9	15	29
2005	3,900	195.3	16	31
2006	4,000	201.6	17	33
2007	4,074	207.3	18	35
2008	4,190	215.3	19	37
2009	4,190	214.5	20	39
	Correlation	83.8%	87.6%	87.6%
	R-Sq	70.1%	76.7%	76.7%
	Slope of regression	15.4	75.1	37.6

This does not mean there is no predictive power in our indices, only that the relative predictive power is somewhat clouded in this statistic by the expected increasing trend. We expect severity to rise on average, and so we should expect a high R-squared for any increasing index. However, we should also find additional predictive power (i.e., relatively higher R-squared) from indices whose overall increasing trend fluctuates more closely with varying levels of inflation.

To further refine the list of indices to use in subsequent analysis, we next evaluated the percentage change in severity versus the percent changes in the various inflationary indices. Fit statistics for this data are not impacted by relationships of the index through time—that is, we will not find more predictive power simply because an index is higher in 2009 than it was in 2000, as we would expect to find using the raw index vs. raw severity. In Appendix 2, predictive power is measured by the linear correlation between the change in severity and the change in a given index during the same period. As expected, correlations were found to be lower using change in indices as

compared to the raw index, but appear to generate additional insight into which indices might be best to use in Mr. Richards' methodology. Based on the range of resulting correlations, we judgmentally termed any correlation above 30% as "moderate," and above 50% as "strong." As was true for the initial regressions on severity versus index value, please note that some of the lines showed moderate to strong correlations with counterintuitive indices (e.g., Auto Physical Damage with CPI Housing). Some observations on the data for longer-tailed business:

1. Commercial Liability exhibits strong correlations with CPI Medical Services and CPI Total Medical Care.
2. Fire Liability exhibits very strong correlations with CPI Medical Services and CPI Total Medical Care indices.
3. Workers Comp showed moderate correlations with the CPI Less Food index.
4. No reasonable relationships were seen in Long Tail Auto or Other Liability.

In hopes of further reducing the volatility in our severity data, we also explored the linear correlations of three-year-moving-average changes in severity vs. three-year-moving-average in index changes, as shown in the bottom section of Appendix 2. To accomplish this, we first calculated the year over year changes in these figures, and then took three-year-moving averages of the changes. Many lines showed improved correlations with the various indices, though some of these indices had counterintuitive relationships with the line of business. The process was repeated for loss cost correlations as shown in Appendix 3. Three long-tail lines had notable changes:

1. Commercial Liability and Auto Liability loss cost correlations improved for CPI Total Medical Care and CPI Medical Services. This improvement was not evident in the severity analyses.
2. Workers Comp loss cost correlations increased dramatically for total CPI and the CPI Medical Indices. This was not observed among the severities.

Most disconcerting was the observation that Auto Liability correlations did not emerge as significant in any snapshot of the data and seemed to behave differently from other lines of business. It is possible that we still have not yet solved for the most appropriate data presentation. One theory is that we might need to break out the data on a coverage and/or state level for better results. Nonetheless, faced with no clear choice of economic index we took a step back to review the entire purpose of the exercise.

5. CIRCLING BACK

The goal of this project was to understand the potential impact of changes to inflation on needed reserves. Although several published economic indices appear to track well with average severity, none can be clearly seen as demonstrating a strong cause/effect relationship as we might have hoped. We therefore asked ourselves again the question of what we are trying to accomplish.

The overall result from these analyses suggests that each index likely explains some base level of pure inflation in the severity, but may not fully explain the change in severity over time. This makes intuitive sense in that claim severity is subject to random fluctuation, coverage enhancements, changes in the tort environment, etc.—all items that can be independent of pure inflation, but often serve to affect severity over time. Richards assumes that data which has been appropriately adjusted for inflation will show neither an increasing nor decreasing trend in the loss costs. We assert that given the reality and nuances of competing forces operating in what is paid to claimants over time, simply correcting for inflation should not eliminate *all* of the trend seen in the severities and loss cost. In fact, the construction of the CPI explicitly attempts to remove the impact of price changes due to changes in the quality of goods over time. Any deflation based solely on CPI-type indices should be expected to leave behind "quality trends" in the deflated data—these trends reflect real, non-inflationary cost changes to the insurance industry. One example of this phenomenon has been shown for auto physical damage: with the advent of airbags in new cars, the average severity increases because the replacement of the airbag necessitates the replacement of the entire dashboard. Greater safety for the passengers (possibly decreasing BI and Med Pay severities) comes at the cost of higher physical damage severity. A second example, also affecting auto physical damage, is the recent industry trend toward higher deductibles which generates higher claims severity as well.

We therefore believe a practical (and even more useful) application of Richards' methodology would be to deflate the paid triangles using a selection of indices with good "fits" and evaluate the range of expected reserves needed under different inflation assumptions. In this endeavor, special attention should be given to those indices which exhibit higher R-squared on the raw data, show moderate to strong correlations for the change in values over time and make intuitive "sense." Net paid losses (plus D&CC expense) were analyzed using Richards' Paid Loss Deflation methodology for 19 indices which attempt to quantify inflationary pressures. Indices can be grouped into two major categories according to whether they are specifically designed to calculate inflation (CPI measures, Houses Sold PI, Fisher and GDP indices, Unskilled wage) or other potential "indicators" of price changes over time (stock market indices, Gold Price, Oil Price). As would be expected, the first category of indices produces more intuitive results. The results of this study are contained in Appendix 4.

6. DEFLATING PAID VERSUS INCURRED TRIANGLES

For long tail lines of business, where paid loss development is of limited use in early years, Richards presents a similar method for deflating incurred loss triangles. For this method paid losses and case reserve are deflated separately—losses deflated from the date paid, and case reserves from the date outstanding. Woll brings up two complications with this method—(1) case reserves are estimates of payments to be made at a variety of future dates and may include expectations of future inflation, and (2) the method requires forecasts of paid losses and case reserves to properly re-inflate the incurred losses after development.

Depending on how case reserves are established, Woll's first concern is not an issue. Consider two extremes: (A) case reserves are established in today's dollars, and so represent a present value of future payments, and (B) case reserves represent the nominal or full value amount to be paid in a future period. In (A), applying a single deflation factor from the date the reserve is held is appropriate—the lag time to when the reserve is ultimately paid is irrelevant since it is held at its present value. In (B), Woll's concern is valid, but adjustments can be made to first bring the case reserves to a present value basis, and then a deflation factor can be appropriately applied as prescribed by Richards. We will address this process next.

Discounting case reserves requires the assumed future inflation rate and expected payment patterns. For simplicity, we assume that expected future inflation can be determined by a 10-year exponential trend on the CPI, or about 3% in this case. For payment patterns we will use those implied by the standard paid loss triangles and resulting ultimate loss estimates. Case reserves likely have faster payout patterns since they are not elongated by losses yet to be reported, but we continued with our simplified assumptions.

A case reserve discount factor can then be calculated for each accident year, at each evaluation period as the weighted average discount factor for all prospective payments, with weights equal to the portion paid at each prospective maturity. For example, the following exhibit comes from the Auto Liability paid loss triangle, with an exponential trend used to determine LDFs for years 10-15:

Exhibit 3
Case Reserve Discount Factors for Auto Liability

	(1)	(2)	(3)	(4)	(5)	(6)
Maturity	LDF	CDF	Remaining % Unpaid	Incremental % Paid	Prospective % Paid	Case Discount Factor
12	1.674	2.460	59.35%	40.65%	100.00%	0.938
24	1.202	1.470	31.96%	27.39%	59.35%	0.937
36	1.104	1.223	18.24%	13.72%	31.96%	0.938
48	1.054	1.108	9.78%	8.46%	18.24%	0.938
60	1.024	1.052	4.91%	4.87%	9.78%	0.932
72	1.009	1.027	2.59%	2.32%	4.91%	0.924
84	1.006	1.017	1.67%	0.91%	2.59%	0.925
96	1.003	1.011	1.04%	0.63%	1.67%	0.925
108	1.002	1.007	0.71%	0.33%	1.04%	0.931
120	1.002	1.005	0.48%	0.24%	0.71%	0.938
132	1.001	1.003	0.28%	0.20%	0.48%	0.943
144	1.001	1.002	0.16%	0.12%	0.28%	0.950
156	1.001	1.001	0.09%	0.08%	0.16%	0.960
168	1.000	1.000	0.03%	0.05%	0.09%	0.971
180	1.000	1.000	0.00%	0.03%	0.03%	1.000

Assumed Inflation	3%
(7) One Period Discount Factor	0.971

The Remaining % Unpaid in (3) is equal to [(1)-1/(2)]. The Incremental % Paid in (4) is the change in (3) from the earlier maturity to the current maturity. The Prospective % Paid is an upward sum of (4). The Case Reserve Discount Factors for each maturity are then calculated using the subsequent maturity values [(6 * (5) * (7) + (4)*(7)]/(5). Multiplying these factors by the case reserves held at the corresponding evaluation date will bring full value case reserves to the present value at that date, which can then be deflated in the same manner as paid losses.

Woll's second concern is that Richards' formulas require accurate paid loss and reserve forecasts. These are easily derived from the standard paid and incurred loss triangles by selecting paid loss to incurred loss ratios from the history. For our data, these ratios were quite stable, and could be projected into the tail using various methods.

Using Richards' formula for incurred loss triangles, we tested the two case reserve scenarios mentioned above (set at full value, and set at present value) on Auto Liability and Workers Compensation. Two interesting discoveries emerged:

- With reasonable LDF selections both case reserve scenarios produced essentially the same unpaid loss estimates.

- Both scenarios had the same sensitivity to changes in inflation, which was the same as the inflation sensitivity to the deflated paid loss method (see below).

Exhibit 4

Comparison of Deflated Incurred Methods at Various Inflation Levels

Work Comp: Relativity of Unpaid Loss Indication to Regular Incurred Method Indication

Inflation	Deflated Inc (Full Val Case)	% Chg	Deflated Inc (PV Case)	% Chg	Deflated Paid	% Chg
3%	0.99		1.00		0.99	
4%	1.04	5.0%	1.05	4.7%	1.05	5.4%
5%	1.10	5.1%	1.10	4.8%	1.11	5.5%
6%	1.15	5.2%	1.15	4.8%	1.17	5.6%
7%	1.21	5.2%	1.21	4.9%	1.23	5.7%
8%	1.28	5.3%	1.27	5.0%	1.31	5.8%

Auto Liability: Relativity of Unpaid Loss Indication to Regular Incurred Method Indication

Inflation	Deflated Inc (Full Val Case)	% Chg	Deflated Inc (PV Case)	% Chg	Deflated Paid	% Chg
3%	1.00		1.00		1.01	
4%	1.02	2.3%	1.02	2.3%	1.03	2.2%
5%	1.05	2.3%	1.05	2.3%	1.05	2.2%
6%	1.07	2.3%	1.07	2.3%	1.08	2.2%
7%	1.09	2.3%	1.10	2.3%	1.10	2.2%
8%	1.12	2.3%	1.12	2.3%	1.12	2.2%

The first observation is that the choice of the adjuster to set case reserves at full or present value appears to be irrelevant—that is, we can move forward with either assumption regardless of what practice exists in reality and get a similar indication. The reason is that the increase in case reserve to account for inflation is a function of two variables: expected inflation and payment patterns; in an environment of relatively stable historical inflation (as we have had in the CPI the last 10 years) and stable loss payment patterns the variables are constant and produce a fixed factor. Thus, the adjuster's choice to incorporate expected inflation is just a decision of whether or not to increase every case reserve by a constant factor. Since the factor is stable we can deal with it two ways: (1) back out the factor directly, then determine development factors, or (2) make no adjustments, and have the factor unwind implicitly in the unadjusted development factors. Given reasonable LDF selections in both cases, it should not matter which approach we choose.

An issue arises when inflation, reserving or payment patterns are not stable throughout the historical data. If inflation spikes are present in the history then deflated incurred loss triangles that have not been adjusted for the assumed inflation built into case reserves will produce unreliable LDFs—in this case, historical LDFs would not all be inflated by a single stable factor (the factor

varies with adjusters' changing perception of inflation over time). In such a case it would be necessary for case reserves to be stated on a present value basis in the triangles. For this, clear communication is required between the reserving actuary and the claims department to determine if there have been changes in assumed inflation, or in other payment or reserving practices over time. It may be necessary to use different case reserve discount factors for different evaluation periods in the incurred loss triangles.

The second observation, that both deflated incurred methods and the deflated paid methods have similar sensitivity to inflation, should not be surprising. Regardless of what method is used, a matrix of incremental prospective loss payments is easy to derive based on the selected LDFs and assumed payment patterns or paid-to-incurred loss ratios. If all methods are using similar reasonable assumptions and have appropriate judgment applied in selecting the LDF factors, then the prospective paid loss matrices should be similar. It is this paid loss matrix that is sensitive to the assumed prospective inflation rate and so we should expect similar sensitivities in the methods.

For Workers Compensation, the Deflated Paid method was slightly more sensitive to changes in inflation (5% versus 4% per point increase in inflation). This is because the LDFs selected in the deflated paid method resulted in a greater proportion of losses projected to be paid in the tail compared to the deflated incurred method. That is, the difference in inflation sensitivity is due to a judgmental factor selection rather than an inherent difference in the two methods.

7. RESULTS AND CONCLUSIONS

At the most extreme levels of prospective inflation tested there would be significant reserve deficiencies among all lines of business. Even more modest inflation levels of 4% still show slight deficiencies among short-tail lines, and deficiencies as high as 10% for Workers Compensation (based on CPI Total Medical Services deflation). The results make intuitive sense since the economy has benefitted from low inflationary effects over the last couple of decades. While one would expect more of an effect of increased inflation for Auto Liability, most of the exposure is from Private Passenger Auto with limited development beyond 24 months.

The apparently odd results from the stock indices are likely due to the impact of real returns dwarfing the impact of the inflation component. The base level year is 1999 in these calculations, which is just before a crash in stock value. Thus, the "implied inflation" in the stock indices is negative over the observed period. Prospective inflation levels that are even slightly positive could be interpreted as "well above historical levels" given this perspective, so the deficiencies look severe. In a less volatile time period, or using a different base year the results may be less dramatic. We also

tested the loss severity fit against the S&P 500 Operating Results PE, with similar results to that observed for the S&P index.

For a given level of prospective inflation, the relative deficiency varies slightly depending on which index was used to deflate the loss triangles. As stated previously, removing the effect of real inflation is not likely to eliminate all trend observed in the data and each index provides insight into what that real historical inflation might have been. To the extent a given index over- or understates the true historical inflation, the resulting projected deficiency or redundancy can vary.

The final conclusion from this endeavor is that by applying Richards' methodology for a variety of indices and comparing the resulting range of estimates, one can glean valuable insight into understanding the potential impact on needed reserves when inflation changes.

Appendix 1: Coefficient of Determination (Ordinary Linear Least Squares/Linear Regression with AutoRegressive Errors)

Closed Claims by Closed Year

If two values are shown for a given cell, statistically significant autocorrelation was present in the error term.

Severity

Segment	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index
Commercial Liability	98	98	85	96	98	96	98	98	91	94
Commercial Property	93	93	77	89	92	89	92	93	90	93
Fire Lines Liability	95	96	79	93	96	94	96	96	94	96
Fire Lines Property	98	98	79	95	97	97	97	98	95	97
Health	92	91	81	89	91	88	91	92	89	92
Auto Liability	70/82	72/83	43/76	70/83	69/82	77	68/81	70/82	62	63
Other Liability	87	87	78	85	87	85	87	87	83	87
Auto Physical Damage	92	93	64	89	91	94	89	93	90	92
Special Property	90	91	78	93	93	93	92	90	80	82
Workers Compensation	96	95	91	97	97	93	97	96	83	87
All Lines	98	98	81	95	97	96	96	98	92	95

Segment	Dow Jones Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage
Commercial Liability	32/80	70/91	86	18/84	11/86	98	97	97	93
Commercial Property	35/75	64	90	21/78	14/80	93	94	94	87
Fire Lines Liability	34/84	64/88	83	19/87	11/88	96	96	96	91
Fire Lines Property	42/82	63/90	83	26/85	17/87	97	99	99	94
Health	27/74	69/85	89	14/77	7/79	92	91	91	85
Auto Liability	47	23/72	40/67	27/66	23/67	65/81	72	71	81
Other Liability	25	65	82	14/59	8/61	88	86	86	82
Auto Physical Damage	49	44/82	70	30/77	22/79	89	95	94	95
Special Property	39/76	63/80	64	22/75	14/74	90	88	89	89
Workers Compensation	36/79	78/89	80	22/81	14/82	98	93	95	90
All Lines	40/77	64/88	84	23/81	16/84	97	98	98	95

Loss Cost

Segment	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index
Commercial Liability	64	63	67	62	65	58	66	64	64	66
Commercial Property	71	70	70	68	67	63	68	71	57	64
Fire Lines Liability	33	32	47	32	33	25	35	33	30	33
Fire Lines Property	56	56	49	53	52	51	52	57	46	52
Health	87	88	56/83	82	86	90	84	88	93	93
Auto Liability	74	74	63	70	75	71	75	74	82	81
Other Liability	45	44	52/85	46	44	41	45	45/73	35	40
Auto Physical Damage	6	6	0	4	4	7	3	6	3	4
Special Property	42	42	31	42	40	45	39	42	34	37
Workers Compensation	82/90	82/91	84	82/91	84/92	77/91	85/92	82/90	81/91	84
All Lines	66	66	52	61	61	62	61	67	58	63

Segment	Dow Jones Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage
Commercial Liability	5/60	65	77	1/62	0/63	67	61	62	54
Commercial Property	21	63	79	11	7	71	69	69	65
Fire Lines Liability	0	52	53	1	3	37	30	31	23
Fire Lines Property	26	39	55	17	13	55	56	56	55
Health	46	37	70/89	27/77	19/80	83	91	90	55
Auto Liability	16/73	54	77	7/75	2/76	75	74	74	89
Other Liability	7	48/70	46/77	3	1	46	41	42	66/80
Auto Physical Damage	14	1	1	9	11	3	6	6	41/62
Special Property	32	20	24	20	17	39	41	41	11
Workers Compensation	26/84	79	82	17/86	10/86	87/93	81/91	82/91	47
All Lines	30	39	63	18	14	64	67	66	70/87

Appendix 2: Correlations Between Annual Changes in Severity by Line and Annual Changes in Various Indices

Correlations: Change in Index vs Change in Severity (1995-2009)

Segment	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index
Commercial Liability	17%	22%	-13%	5%	55%	17%	55%	19%	37%	33%
Commercial Property	40%	19%	34%	44%	17%	27%	13%	-52%	24%	23%
Fire Liability	20%	34%	-13%	-9%	82%	30%	78%	29%	41%	40%
Fire Property	-2%	-1%	-17%	-8%	-10%	-14%	-3%	-3%	40%	24%
Health	30%	33%	33%	41%	6%	15%	8%	9%	26%	12%
Auto Liability	-8%	-13%	-26%	0%	-13%	0%	-18%	-37%	-20%	-18%
Other Liability	22%	8%	5%	3%	-1%	26%	-6%	-27%	18%	27%
Auto Physical Damage	35%	52%	-23%	-2%	39%	-7%	38%	17%	30%	38%
Special Property	-55%	-42%	-40%	-51%	-1%	-8%	1%	28%	-7%	-21%
Workers Compensation	-13%	16%	-34%	-41%	-13%	-19%	-14%	44%	8%	10%

Segment	Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage
Commercial Liability	-18%	-18%	4%	-22%	-20%	11%	25%	24%	-10%
Commercial Property	-35%	10%	23%	-31%	-30%	16%	23%	21%	46%
Fire Liability	2%	-15%	5%	-3%	-4%	22%	23%	24%	7%
Fire Property	4%	24%	38%	3%	0%	-7%	19%	18%	-10%
Health	-38%	37%	50%	-44%	-45%	27%	24%	21%	8%
Auto Liability	15%	-36%	-36%	14%	16%	-34%	-4%	-5%	41%
Other Liability	4%	-19%	5%	4%	3%	16%	9%	5%	41%
Auto Physical Damage	18%	-31%	12%	12%	13%	9%	40%	41%	29%
Special Property	38%	12%	-12%	34%	31%	-36%	-25%	-21%	-35%
Workers Compensation	44%	-24%	-13%	52%	51%	6%	12%	16%	-32%

Correlations: 3-Year Rolling Change in Index vs Change in Severity (1995-2009)

Segment	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index
Commercial Liability	-22%	3%	-44%	-48%	52%	21%	44%	24%	61%	53%
Commercial Property	22%	53%	27%	21%	71%	25%	68%	16%	69%	69%
Fire Liability	-2%	37%	-10%	-12%	85%	28%	78%	22%	71%	66%
Fire Property	-26%	19%	-12%	-22%	61%	29%	56%	10%	76%	67%
Health	34%	57%	61%	58%	68%	15%	70%	26%	40%	41%
Auto Liability	-50%	-53%	-74%	-50%	-60%	31%	-72%	-58%	-42%	-49%
Other Liability	18%	40%	-22%	-8%	39%	53%	26%	6%	45%	42%
Auto Physical Damage	-28%	-12%	-76%	-62%	-3%	32%	-17%	-14%	15%	9%
Special Property	-65%	-34%	-21%	-17%	27%	33%	20%	-36%	9%	-4%
Workers Compensation	8%	-10%	-32%	-47%	-54%	-47%	-47%	22%	2%	6%

Segment	Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage
Commercial Liability	7%	-23%	-12%	5%	3%	-13%	18%	18%	-10%
Commercial Property	-55%	34%	63%	-46%	-49%	39%	12%	5%	-24%
Fire Liability	-39%	6%	28%	-38%	-41%	11%	2%	-2%	-10%
Fire Property	-32%	9%	39%	-25%	-30%	5%	5%	2%	-21%
Health	-81%	60%	87%	-75%	-78%	54%	-12%	-20%	-28%
Auto Liability	59%	-83%	-71%	47%	52%	-87%	3%	15%	77%
Other Liability	-15%	-27%	40%	-22%	-21%	-15%	34%	35%	38%
Auto Physical Damage	46%	-72%	-44%	36%	38%	-61%	24%	32%	53%
Special Property	-31%	-10%	0%	-35%	-36%	-37%	-48%	-44%	21%
Workers Compensation	78%	-20%	-40%	84%	82%	0%	49%	50%	-27%

Appendix 3: Correlations Between Annual Changes in Loss Cost by Line and Annual Changes in Various Indices

Correlations: Change in Index vs Change in Total Loss Cost (1995-2009)

Segment	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index
Commercial Liability	32%	27%	22%	17%	60%	1%	65%	14%	19%	26%
Commercial Property	55%	29%	46%	46%	24%	40%	19%	-28%	10%	18%
Fire Liability	34%	37%	18%	9%	66%	19%	64%	32%	12%	20%
Fire Property	45%	39%	17%	18%	29%	20%	28%	32%	3%	8%
Health	52%	65%	9%	39%	10%	28%	6%	4%	47%	40%
Auto Liability	43%	34%	8%	12%	55%	-4%	59%	9%	31%	35%
Other Liability	15%	-5%	-1%	-5%	-15%	7%	-17%	-31%	6%	15%
Auto Physical Damage	48%	39%	-9%	15%	23%	10%	21%	14%	-3%	2%
Special Property	11%	4%	23%	20%	-39%	-16%	-37%	-22%	-5%	4%
Workers Compensation	1%	30%	10%	-21%	22%	-21%	29%	44%	43%	44%

Segment	Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage
Commercial Liability	-24%	12%	13%	-29%	-29%	37%	10%	8%	-1%
Commercial Property	-30%	4%	16%	-35%	-34%	42%	19%	16%	58%
Fire Liability	-11%	-8%	5%	-14%	-14%	42%	13%	13%	3%
Fire Property	-2%	-8%	17%	-14%	-13%	42%	28%	26%	26%
Health	-28%	-10%	62%	-32%	-32%	13%	55%	54%	36%
Auto Liability	-7%	3%	23%	-13%	-13%	35%	22%	19%	12%
Other Liability	17%	-17%	-1%	17%	16%	9%	4%	0%	37%
Auto Physical Damage	13%	-31%	20%	-4%	-3%	6%	23%	23%	53%
Special Property	12%	32%	-5%	6%	7%	10%	-1%	0%	22%
Workers Compensation	3%	30%	14%	17%	13%	54%	17%	15%	-53%

Correlations: 3-Year Rolling Change in Index vs Change in Loss Cost (1995-2009)

Segment	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index
Commercial Liability	31%	32%	33%	20%	76%	-24%	82%	38%	43%	45%
Commercial Property	68%	54%	68%	71%	46%	1%	50%	20%	4%	14%
Fire Liability	62%	46%	49%	38%	54%	-41%	64%	50%	21%	28%
Fire Property	50%	10%	27%	37%	-23%	-20%	-19%	15%	-50%	-41%
Health	-18%	35%	-45%	-28%	33%	86%	12%	1%	50%	44%
Auto Liability	18%	17%	-5%	-17%	55%	-24%	58%	30%	51%	48%
Other Liability	14%	-6%	-39%	-28%	-30%	4%	-34%	-10%	-3%	-4%
Auto Physical Damage	-23%	-35%	-64%	-42%	-36%	24%	-47%	-32%	-33%	-38%
Special Property	31%	-9%	33%	34%	-55%	-29%	-47%	-20%	-64%	-52%
Workers Compensation	50%	56%	60%	32%	55%	-49%	70%	58%	56%	62%

Segment	Dow Jones Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage
Commercial Liability	-45%	50%	28%	-42%	-45%	53%	-16%	-24%	-46%
Commercial Property	-61%	54%	57%	-61%	-61%	58%	-8%	-15%	-9%
Fire Liability	-34%	55%	27%	-30%	-32%	67%	-2%	-11%	-48%
Fire Property	8%	8%	-9%	0%	3%	17%	2%	2%	14%
Health	-7%	-53%	31%	-12%	-12%	-43%	39%	43%	51%
Auto Liability	-7%	18%	3%	-6%	-9%	28%	5%	0%	-33%
Other Liability	42%	-42%	-14%	34%	36%	-29%	36%	39%	38%
Auto Physical Damage	53%	-71%	-65%	38%	42%	-66%	6%	16%	69%
Special Property	14%	15%	-10%	11%	13%	11%	-14%	-13%	19%
Workers Compensation	-42%	78%	65%	-27%	-32%	86%	11%	-2%	-85%

Appendix 4: Indicated Ratio of Needed to Carried Reserves at Varying Inflation Assumptions

Based on methodology derived by Mr. William Richards, 1981

Inflation amount	CPI	CPI Housing	CPI Motor Vehicle Parts	CPI Motor Vehicle Maintenance	CPI Total Medical Care	CPI Medical Care Commodities	CPI Medical Services	CPI All Items Less Food	Houses Sold Pricing Index	Fisher Index	Dow Jones Industrial Average	Gold	Oil	Russell 3000	S&P 500	GDP Deflator	GDP Per Capita	Relative Share of GDP	Unskilled Wage	Max	Min
Commercial Liability																					
2%	99%	99%	97%	97%	96%	100%	95%	100%	100%	99%	114%	79%	69%	122%	122%	99%	96%	95%	100%	122%	69%
4%	106%	106%	104%	105%	104%	108%	103%	108%	108%	106%	124%	85%	74%	132%	133%	107%	104%	102%	107%	133%	74%
6%	115%	115%	113%	113%	112%	116%	111%	116%	117%	115%	134%	91%	80%	143%	144%	116%	112%	110%	116%	144%	80%
8%	124%	124%	122%	122%	121%	126%	120%	126%	126%	124%	145%	98%	86%	155%	156%	125%	121%	119%	125%	156%	86%
10%	134%	134%	132%	132%	131%	136%	130%	136%	137%	134%	157%	105%	93%	168%	169%	135%	131%	128%	136%	169%	93%
Commercial Property																					
2%	101%	101%	100%	100%	100%	102%	99%	102%	104%	103%	115%	86%	102%	120%	120%	101%	100%	99%	101%	120%	86%
4%	103%	104%	103%	102%	102%	104%	102%	104%	107%	106%	118%	88%	105%	123%	123%	104%	103%	102%	103%	123%	88%
6%	106%	106%	105%	105%	105%	107%	105%	107%	110%	109%	121%	90%	107%	126%	126%	107%	106%	105%	106%	126%	90%
8%	109%	109%	108%	108%	108%	110%	107%	110%	113%	111%	124%	92%	110%	129%	129%	109%	108%	107%	109%	129%	92%
10%	112%	112%	111%	110%	111%	113%	110%	113%	115%	114%	127%	95%	112%	132%	132%	112%	111%	110%	112%	132%	95%
Fire Liability																					
2%	96%	97%	95%	95%	94%	98%	93%	98%	100%	98%	115%	71%	76%	123%	123%	97%	95%	93%	97%	123%	71%
4%	101%	101%	99%	99%	99%	102%	98%	102%	104%	103%	120%	74%	79%	128%	129%	102%	99%	97%	101%	129%	74%
6%	106%	106%	104%	104%	103%	107%	102%	107%	109%	108%	126%	77%	82%	135%	135%	106%	104%	102%	106%	135%	77%
8%	111%	111%	109%	109%	108%	112%	107%	112%	115%	113%	132%	80%	86%	141%	142%	111%	109%	107%	111%	142%	80%
10%	116%	116%	114%	114%	113%	118%	112%	118%	120%	118%	139%	84%	90%	148%	149%	117%	114%	112%	117%	149%	84%
Fire property																					
2%	99%	99%	99%	98%	98%	100%	98%	100%	103%	102%	116%	85%	100%	121%	121%	100%	99%	98%	99%	121%	85%
4%	102%	102%	101%	100%	101%	102%	100%	103%	105%	104%	119%	87%	102%	124%	124%	102%	101%	100%	101%	124%	87%
6%	104%	104%	103%	103%	103%	105%	103%	105%	108%	107%	122%	89%	105%	127%	127%	105%	104%	103%	104%	127%	89%
8%	106%	107%	106%	105%	106%	107%	105%	108%	110%	109%	125%	91%	107%	130%	130%	107%	106%	105%	106%	130%	91%
10%	109%	109%	108%	108%	108%	110%	107%	110%	113%	112%	128%	93%	109%	133%	133%	110%	109%	108%	109%	133%	93%
Health																					
2%	90%	90%	89%	90%	91%	90%	91%	90%	91%	91%	94%	108%	97%	96%	96%	90%	91%	91%	90%	108%	89%
4%	95%	95%	94%	96%	96%	95%	96%	95%	96%	96%	99%	115%	102%	101%	101%	95%	96%	97%	95%	115%	94%
6%	101%	101%	100%	101%	101%	101%	102%	100%	102%	102%	104%	123%	108%	107%	106%	101%	102%	102%	101%	123%	100%
8%	107%	107%	106%	108%	108%	107%	108%	107%	108%	108%	110%	131%	114%	113%	112%	107%	108%	109%	107%	131%	106%
10%	114%	114%	113%	115%	115%	114%	115%	113%	115%	115%	117%	140%	120%	120%	119%	114%	115%	116%	114%	140%	113%
Auto Liability																					
2%	93%	93%	93%	92%	91%	93%	90%	93%	90%	89%	99%	77%	64%	102%	103%	94%	91%	89%	94%	103%	64%
4%	98%	97%	97%	96%	95%	98%	94%	98%	93%	93%	103%	80%	66%	106%	108%	98%	94%	93%	98%	108%	66%
6%	102%	101%	101%	101%	99%	102%	98%	102%	98%	97%	108%	84%	69%	111%	113%	102%	99%	97%	103%	113%	69%
8%	106%	106%	106%	105%	103%	107%	102%	107%	102%	102%	113%	87%	72%	116%	118%	107%	103%	101%	107%	118%	72%
10%	111%	111%	111%	110%	108%	111%	107%	111%	106%	106%	118%	91%	75%	122%	123%	111%	108%	105%	112%	123%	75%
Other Liability																					
2%	87%	88%	86%	86%	86%	89%	85%	89%	91%	90%	110%	66%	68%	118%	119%	88%	86%	84%	88%	119%	66%
4%	93%	94%	92%	92%	92%	95%	91%	95%	97%	96%	118%	70%	72%	127%	127%	94%	92%	90%	94%	127%	70%
6%	100%	100%	98%	98%	98%	102%	97%	102%	104%	103%	126%	75%	77%	136%	137%	101%	98%	96%	100%	137%	75%
8%	107%	108%	105%	105%	105%	109%	104%	109%	112%	110%	136%	80%	82%	146%	147%	108%	105%	103%	108%	147%	80%
10%	115%	116%	113%	113%	113%	117%	111%	118%	120%	118%	146%	85%	87%	157%	158%	116%	113%	111%	116%	158%	85%
Auto Physical Damage																					
2%	98%	97%	99%	97%	98%	96%	98%	97%	97%	98%	98%	105%	122%	97%	97%	97%	98%	99%	96%	122%	96%
4%	98%	97%	99%	97%	97%	96%	98%	97%	97%	97%	97%	106%	123%	96%	96%	97%	98%	98%	95%	123%	95%
6%	97%	96%	98%	96%	97%	95%	97%	96%	96%	97%	96%	107%	124%	94%	95%	96%	97%	98%	94%	124%	94%
8%	96%	95%	97%	95%	96%	94%	96%	95%	95%	96%	95%	107%	125%	93%	93%	95%	96%	97%	93%	125%	93%
10%	95%	93%	96%	94%	95%	93%	95%	94%	94%	95%	93%	107%	126%	91%	91%	93%	95%	96%	92%	126%	91%
Special Property																					
2%	100%	100%	100%	99%	99%	100%	99%	101%	103%	102%	114%	91%	109%	118%	118%	100%	100%	99%	99%	118%	91%
4%	102%	103%	102%	101%	102%	103%	101%	103%	106%	105%	116%	93%	112%	120%	120%	103%	102%	102%	102%	120%	93%
6%	105%	105%	105%	104%	104%	105%	104%	106%	108%	107%	119%	95%	114%	123%	123%	105%	105%	104%	104%	123%	95%
8%	107%	108%	107%	106%	107%	108%	106%	108%	111%	110%	122%	98%	117%	126%	126%	108%	107%	107%	107%	126%	98%
10%	110%	110%	110%	109%	109%	111%	109%	111%	113%	113%	125%	100%	119%	129%	129%	110%	110%	109%	109%	129%	100%
Workers Compensation																					
2%	104%	103%	103%	103%	102%	103%	102%	103%	100%	100%	105%	109%	81%	108%	108%	103%	102%	101%	104%	109%	81%
4%	112%	112%	111%	112%	110%	112%	110%	112%	108%	109%	114%	118%	87%	117%	118%	112%	110%	109%	113%	118%	87%
6%	122%	121%	121%	121%	120%	121%	119%	121%	118%	118%	124%	128%	94%	128%	128%	122%	120%	119%	123%	128%	94%
8%	132%	132%	131%	132%	130%	132%	130%	132%	128%	128%	135%	138%	102%	139%	140%	132%	130%	129%	133%	140%	102%
10%	144%	143%	143%	144%	142%	144%	141%	143%	139%	139%	147%	150%	111%	151%	152%	144%	141%	140%	145%	152%	111%

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