Actuaries and Reserve Adequacy

By Susan Forray and Zachary Ballweg

Common methods used by property/casualty actuaries to determine insurance reserves may actually contribute to the reserving cycle.

FOR MORE THAN THREE DECADES, reserve adequacy for the property and casualty (P/C) insurance industry has been highly cyclical, alternating between periods of adverse and favorable reserve development.

Figure 1 offers a dramatic picture of just how widely reserve adequacy has varied between 1989 and 2011, based on industry aggregate Schedule P data. The bars rising above the $0 line represent adverse reserve development, while bars below show favorable development. Development is measured on a statement-year basis, meaning the reserve development in Figure 1 represents the aggregate of all reserve development (through Dec. 31, 2012) subsequent to the booking of reserves for the given annual statement date.

No one knows for certain what factor or factors cause these swings. It's commonly thought that internal industry influences—such as claims department practices, changes in pricing, or management decisions—are potential sources. Although we expect these elements do play a role, there's no evidence to suggest they are the primary reason for the reserving cycle.

What few have considered, on the other hand, is the possibility that common methods used by actuaries to determine appropriate reserves may themselves be an important contributing factor to movements in the reserving cycle.

We decided to assess the potentially cyclical behavior of various actuarial reserving methods, including the paid and incurred (i.e., paid plus case) chain ladders and the Berquist-Sherman and Munich Chain Ladder methods, along with 47 others (including variants of different methods). As the general pattern we observed was consistent across all of the methods

that we examined, we will focus principally on the paid and incurred chain ladder methods most commonly used by actuaries.

We found that a material portion of the industry's historical deficiencies and redundancies can be attributed to the results of actuarial methods and that the deficiencies and redundancies that result from using these methods appear to be highly correlated with the economic cycle.

As others have observed, we also saw a strong relationship between the underwriting cycle and carried reserve adequacy, although from the data available it can't be determined whether pricing was affecting the reserving cycle or vice versa.

It's difficult to consider that the methods we actuaries have been using daily for decades may be subject to some bias, potentially exacerbating movement in the reserving cycle. Nevertheless, there appears to be a relationship—at least on an industry aggregate level—between the development indicated by actuarial methods and the development that ultimately manifests, as shown by carried reserves over time.

Similar research conducted by British actuaries in 2003 also concluded that a reserving cycle does exist (in that case, in the United Kingdom) and that standard actuarial methods are probably a contributory cause. That study, however, did not examine the relationship between the reserving and economic cycles. To the best of our knowledge, that relationship has not been considered previously by anyone in the field.

FIGURE 1 Reserve Development by Statement Year (in billions)
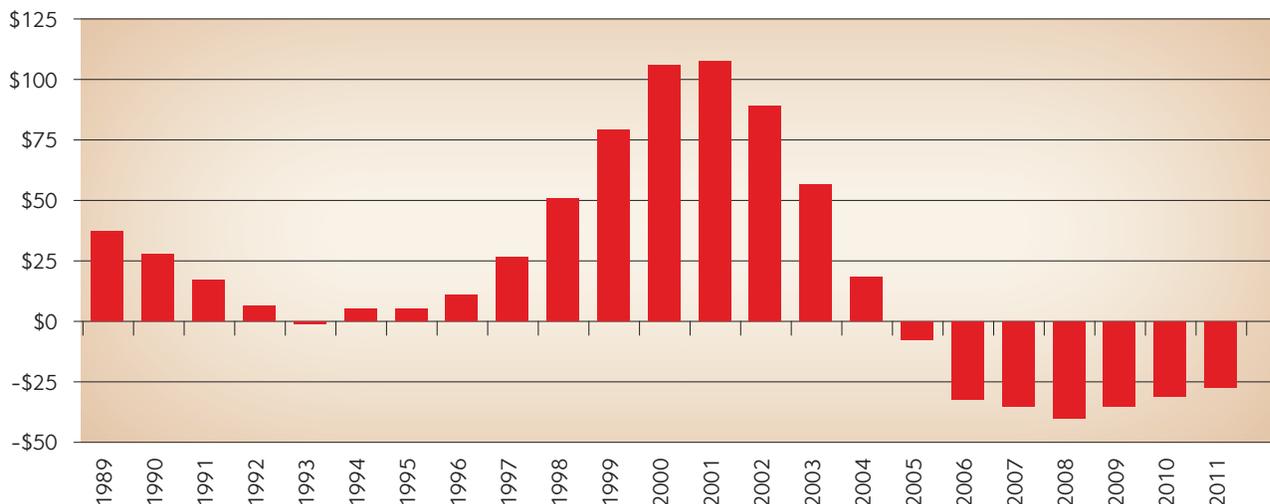
Source: Authors

FIGURE 2 Hindsight Development Ratio—Example (in billions)
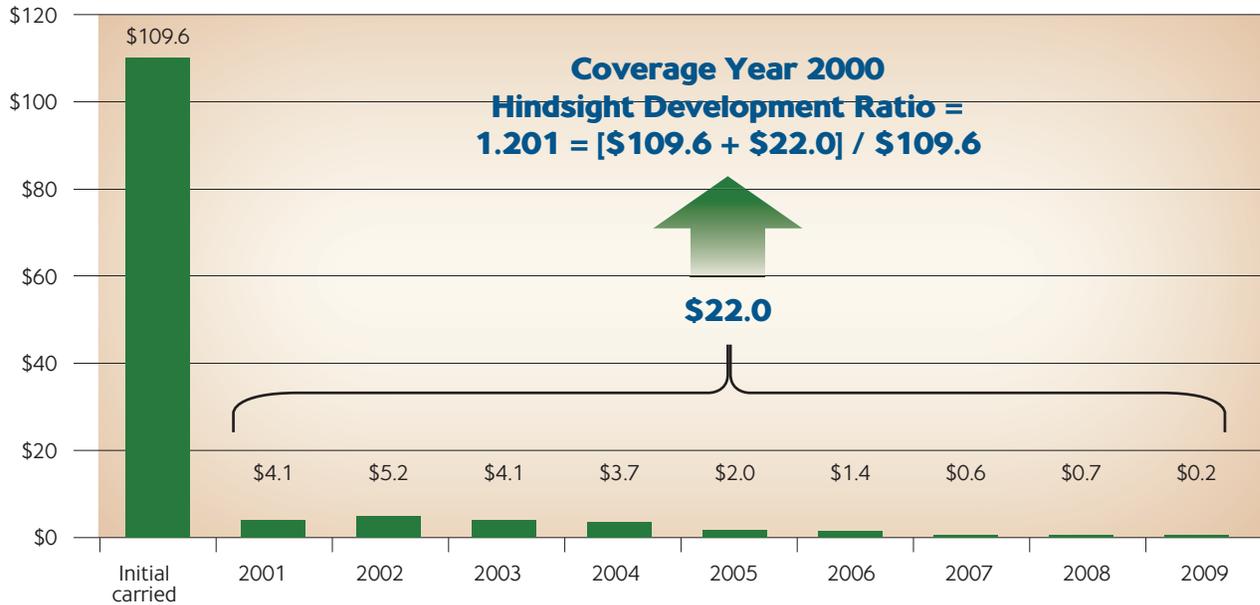
Source: Authors

To conduct our analysis, we obtained aggregate P/C industry statement-year data from the beginning of the 1980s through 2012, and developed a measurement for reserve development that we are calling the "hindsight development ratio" (HDR), which is explained in more detail below.

Carried Reserve Development in Hindsight

Our data for 1996 and subsequent evaluations came from SNL Financial LC, while data for all prior evaluations were obtained from AM Best's Aggregates & Averages. We then applied standard actuarial methods to these data at an industry aggregate level. We used these results to calculate the HDR, which is the ratio of the industry's hindsight unpaid loss and defense and cost containment expense (DCCE, the numerator) to the initial carried loss and DCCE reserve at 12 months of development (the denominator).

Figure 2 demonstrates how the HDR for any given coverage year (i.e., accident year or report year) is computed, using Coverage Year 2000 as an example. There's nothing special about Coverage Year 2000; we are simply using it to illustrate how carried reserves held at the end of a particular coverage year develop, based on information that becomes available as those claims continue to develop over time (i.e., in hindsight).

At the end of Coverage Year 2000, the P/C insurance industry held a combined total of $109.6 billion of carried reserves for unpaid loss and

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FIGURE 3 Hindsight Development by Evaluation Month
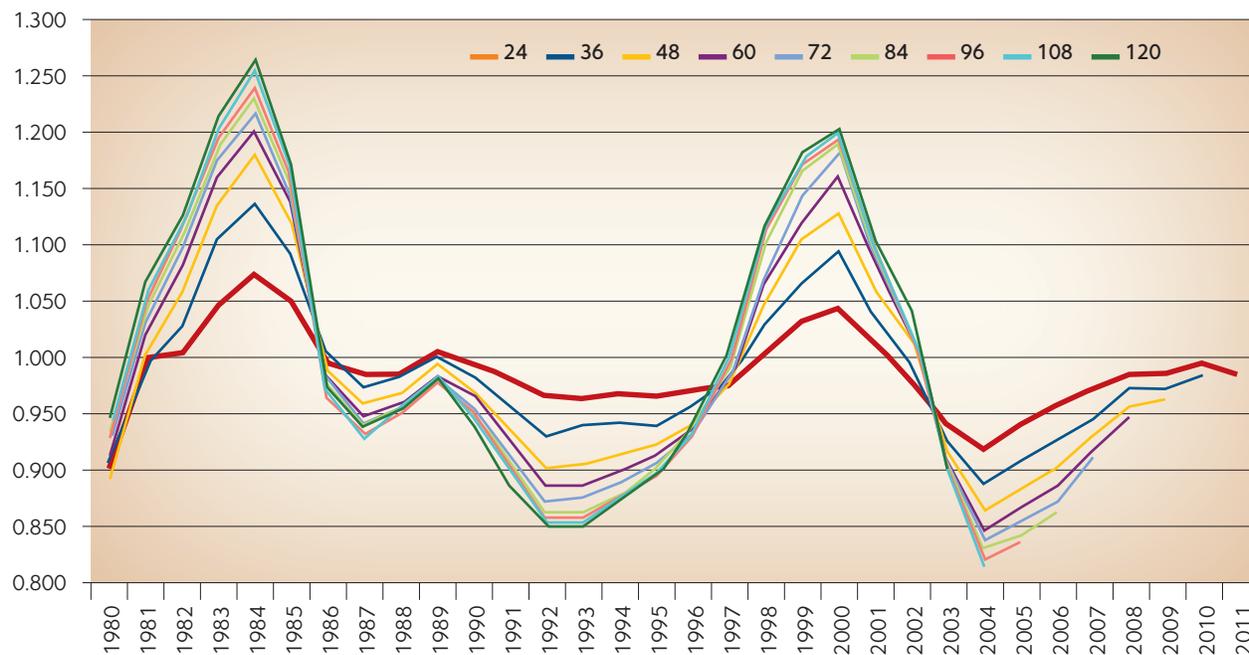
Source: Authors

DCCE from Coverage Year 2000. We take this as our starting point for purposes of this example.

The industry as a whole had added $4.1 billion more in reserves to Coverage Year 2000 as of the end of 2001. In other words, the industry experienced $4.1 billion of adverse net reserve development during Calendar Year 2001 related to Coverage Year 2000. During 2002, the industry added $5.2 billion to its carried reserves for Coverage Year 2000. And so on, year after year, for nine years, eventually reaching a total $22.0 billion of reserves added to cover expected loss and DCCE for Coverage Year 2000. That's just over 20 percent more in reserves, over nine years, than originally booked at the end of 2000: a carried reserve HDR of 1.201.

Figure 3 shows the 10-year HDRs from the carried reserve development for Coverage Years 1980 to 2011 by evaluation month, at 12-month intervals, beginning at 24 months of development, then proceeding on up to 120 months.

We can see here that—corresponding to the Coverage Year 2000 example employed in Figure 2—the 24-month red line for Coverage Year 2000 measures an HDR at the end of 2001 that corresponds to the $4.1 billion in new reserves the industry added that year (an HDR of just under 1.040), and the 36-month blue line indicates the $5.2 billion added at the end of the second year, or 36 months of development from the beginning of 2000 (an HDR of 1.085).

Continuing on at 12-month intervals, we see that all of the coverage years develop in one direction. In other words, when a coverage year begins to develop unfavorably, it continues to

develop unfavorably over time. Likewise, when a coverage year begins to develop favorably, it continues to develop favorably.

Using the HDR, we were able to establish relationships between carried reserve development and three other cycles: the underwriting cycle; the economic cycle; and, most surprisingly, the results of actuarial methods applied to data of the same evaluations.

The Underwriting Cycle and Carried Reserves
The red line on Figure 4 shows the ultimate loss and DCCE ratio, by coverage year, across the entire P/C insurance industry from Coverage Year 1980 to 2011. We can see that this ratio spiked in the mid-1980s, did so again around 2000, then became much lower for the 2004 to 2006 coverage years, rising somewhat since.

The blue line is the HDR, calculated at the latest available evaluation, for those same coverage years, which follows closely the actual loss and DCCE ratio, with a correlation of 82 percent.

Clearly, higher loss ratios occur at the same time as adverse reserve development, but whether the reserving cycle is influencing pricing or vice versa, we cannot know. This relationship is a chicken-or-egg situation—which comes first?

If pricing is leading adverse reserve development, it could be that higher pricing encourages companies to adjust reinsurance retentions or policy limits. Or perhaps higher pricing influences some customers to self-insure, changing the mix of business for insurance companies. Either explanation could significantly affect the results of actuarial methods applied to unadjusted data.
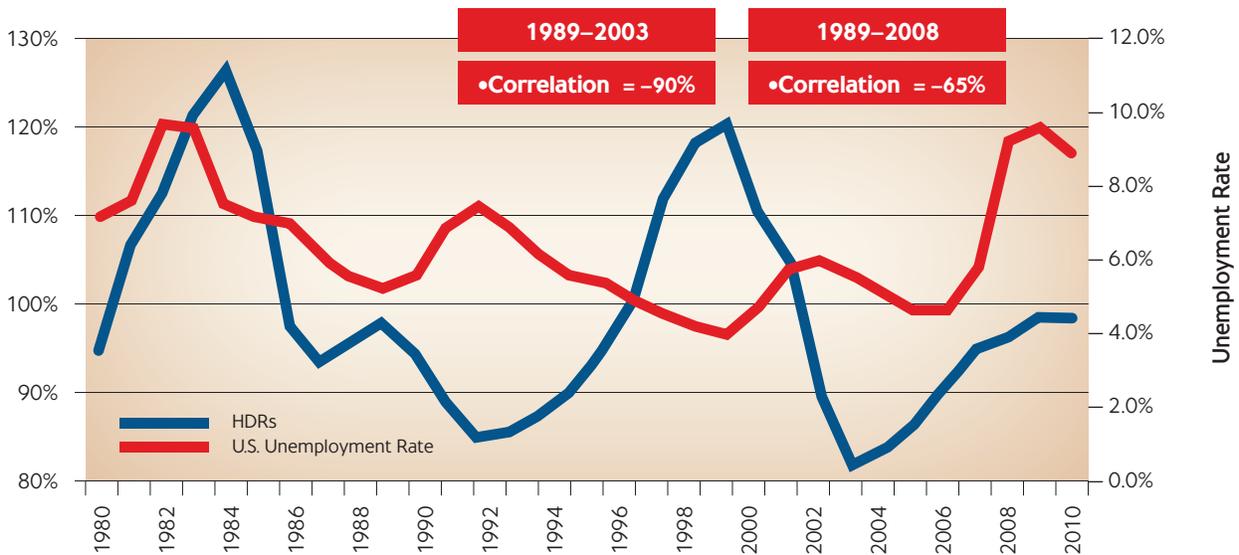
If reserve development is influencing pricing, it could be

FIGURE 4 The Underwriting and Reserving Cycles

- HDRs
- Actual Loss and DCCE Ratio

Correlation •82%
R-Squared •67%
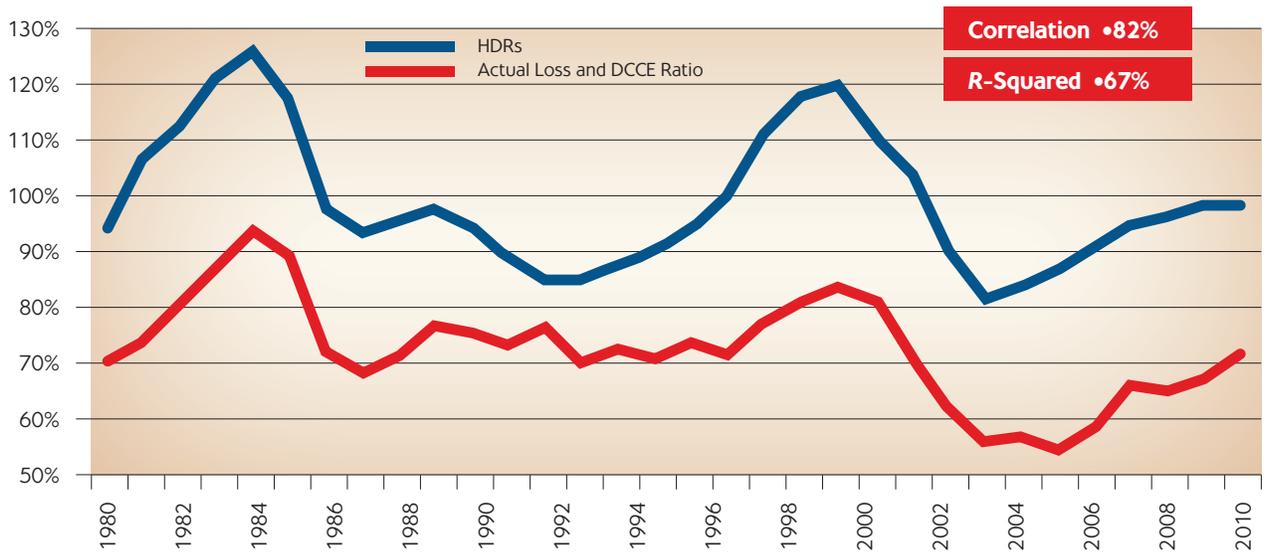
Source: Authors

FIGURE 5 The Economic Cycle and the Reserving Cycle

1989–2003
•Correlation = –90%

1989–2008
•Correlation = –65%

- HDRs
- U.S. Unemployment Rate

Source: Authors

because redundant reserves make loss costs appear greater than they are, resulting in lower loss ratios after the favorable reserve development is realized. Of course, this would be true only if companies underestimated the degree of redundancy in their reserves.

It's more likely, from our point of view, that the economic cycle is the common underlying cause affecting both the underwriting and reserving cycles.

The Economic Cycle and Carried Reserves

Figure 5 shows a compelling, inverse relationship—a negative 90 percent correlation between the economic cycle, as measured by the U.S. unemployment rate, and the reserving cycle—from 1989 until 2003. This seems counterintuitive; one would think a weak economy would lead to less adequate reserves, allowing these two cycles to move in sync.

One explanation could be that more economic activity leads to more human activity in general (e.g., more working, driving, building, and consuming), increasing the likelihood of loss from accidents and therefore the number of claims that develop.

This countercyclical relationship isn't as strongly correlated for all of the years studied. If we include the years after 2003, there's still an inverse relationship—just not as highly correlated. That is, there's a correlation of -65 percent for years between 1989 and 2008, significantly smaller than the -90 percent correlation we see for the 1989-to-2003 range. A potential cause of this drop in correlation is that coverage years from 2004 on aren't fully developed yet; they could still demonstrate a stronger inverse relationship as time goes on. The red U.S. unemployment line is decidedly fixed in time; the blue line, of course, will continue to move, upward or downward, as claims from these coverage years develop.

The more in-step relationship seen prior to 1989 may be the result of the unusually high inflation present during the early to mid-1980s, which very likely contributed to the adverse reserve development in these years. It is probable that our proxy for the economic cycle (the U.S. unemployment rate) may be a less than ideal representation of the economic cycle in these years.

More research is needed here—ideally considering other economic variables—to understand more fully

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the complex relationship between the economy and the reserving cycle. But a generally strong inverse relationship over the past 20 years (and an overwhelming one from 1989 to 2003) is undeniable, based on these data.

Actuarial Methods and HDRs

Using data from industry aggregate triangles from 1989 to 2012, we compared the indications from 51 different methods against the carried HDRs.

Figure 6 summarizes results from our analyses of the two most popular actuarial methods, the paid and incurred chain ladders.

Anytime the red or green lines dip below 100 percent indicates that favorable reserve development resulted from either the paid chain ladder (red) or incurred chain ladder (green) methods, while adverse reserve development was indicated by the methods during any year when the red or green lines rose above 100 percent.

The blue line, moving very closely in tandem with both the red and green lines, represents reserves actually carried by P/C companies on an industry basis from 1989 to 2012. The HDR results from the paid chain ladder method correlate with carried reserve development at 63 percent over those 23 years, while the results of the incurred chain ladder method correlate even more strongly at 94 percent.

We were surprised when we saw these results. It does appear, based on our formulaic analysis of industry data, that these most traditional actuarial methods of establishing reserves do exhibit a strong cyclical nature—and that this cyclical movement travels in tandem with the reserving cycle.

Why do these methods correlate with cyclical movements in carried reserves? We don't know, and more study will be needed to determine causality. But it's our belief that the underlying economic cycle influences the results of actuarial methods in much the same way it influences carried reserves.

An Unexpected Conclusion

As actuaries, we want to believe that while our projections will never be exactly accurate, the methods we use to calculate reserves are unbiased; that they show the most likely indications of how things are going to develop based on what
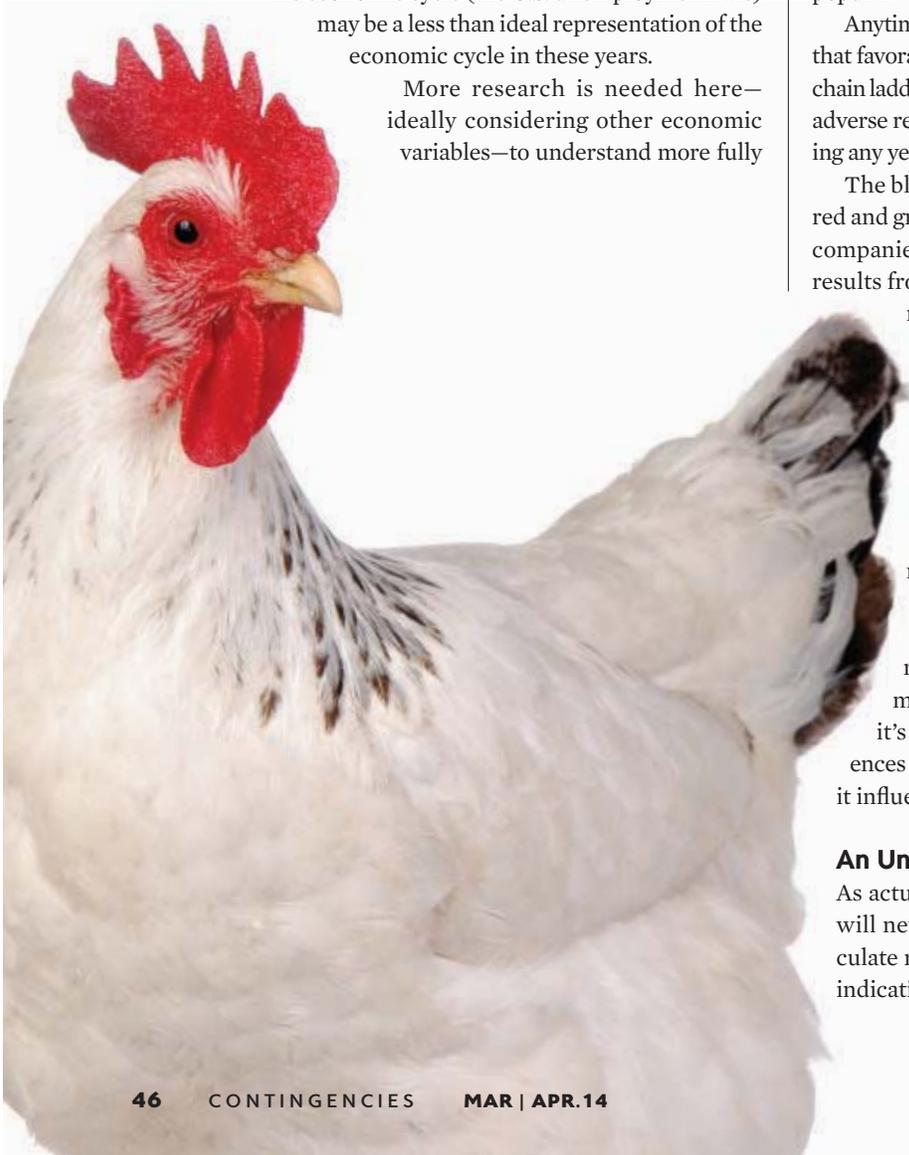
FIGURE 6 Hindsight Development Ratios
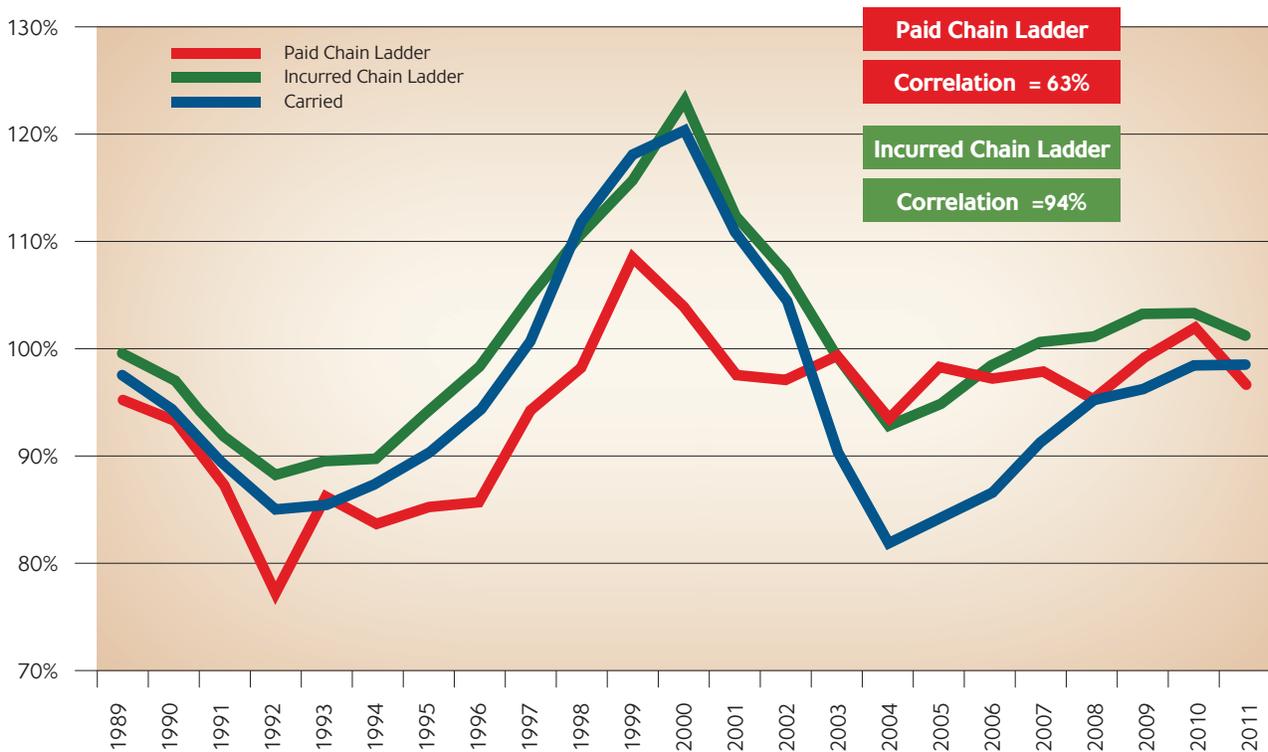
Source: Authors

we know at a given moment in time. Claims will, of course, continue to develop, perhaps in unexpected ways, from the moment we make our projections. But those developments can't be known.

What these analyses suggest, however, at least on an industry level, is that we actually may be able to predict what direction reserves are going to develop. And not just carried reserves but the actuarial indications underlying them.

It was difficult to see some of these results. The question for actuaries is: What can we do to mitigate the cyclical movement associated with our most commonly used methods? One answer may involve the continued appropriate use of actuarial judgment, especially in situations in which these results might suggest bias in the actuarial methods.

We had expected—and then hoped—that we would find some methods performing better than others when it came to analyzing cyclical market movement. Perhaps different methods might exhibit bias in opposite directions so that a weighting of different methods might be unbiased. But all of the methods we analyzed developed in the same direction. We couldn't get rid of the cyclical movement.

The movement, however, doesn't come from the methods. It comes from the underlying data. How much of it comes from the historical data? How much of it is prospective? Probably some of both.

We may be able to address the cyclical elements in the underlying data, to the extent that they can be quantified. We most likely never will be able to address prospective cyclicality. This suggests we may have to accept some, but not all, of the reserving cycle as inevitable ☐

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Resources

Forray, Susan J., and Zachary A. Ballweg, "Peaks and Troughs: Reserving Through the Market Cycle," Casualty Actuarial Society E-Forum, Fall 2013. http://www.casact.org/pubs/forum/13fforum/10-Forray-Ballweg.pdf

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