TITLE: LOSS RESERVING AND RATEMAKING IN AN INFLATIONARY ENVIRONMENT

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LOSS RESERVING AND RATEMAKING
IN AN INFLATIONARY ENVIRONMENT

Along with the rest of the economy, the insurance industry has felt the profound effects of the fluctuating inflation rates of the last several years. Insurance rates must be set to pay for future events; therefore, they have to consider future inflation in claim costs. Similarly, because losses often are paid considerably after the event causing the loss, inflation will affect the adequacy of loss reserves.

This paper investigates the effects of an increase in the inflation rate on a company's loss reserving and ratemaking capabilities. We show that during a period of spiraling inflation, losses are underestimated, inevitably leading to rates that are too low and consequent underwriting losses. On the other hand, if the inflation rate drops, reserves become redundant and rates too high, resulting in larger than average profits. Although there may be no way to avoid completely the profit-and-loss cycles in today's economy, using reserving and ratemaking techniques that are more finely attuned to inflationary swings will significantly mitigate the effect of these cycles.

LOSS RESERVING

A simple loss reserving and pricing model will show the impact of fluctuating inflation rates. Assume that a company is operating in a non-inflationary environment and its permissible loss ratio is 50%. For the past several accident years, losses have been reported and paid as follows:

Accident Year X

First 12 months:	2 claims reported and paid at $1,000 each
	3 claims reported and reserved at $1,000 each
Next 12 months:	3 outstanding claims paid at $1,000 each
	1 new claim reported and reserved at $2,000
Next 12 months:	1 outstanding claim paid at $2,000

Thus, the reported and paid patterns are:

		Valued as of		
		12 Months	24 Months	36 Months
Year X	Reported	$5,000	$7,000	$7,000
	Paid	2,000	5,000	7,000

Because its permissible loss ratio is 50%, the company charges premiums of $14,000. Now, assume that losses reported and paid follow this pattern for five non-inflationary years. In Years 6 and 7, however, inflation occurs at a 5% level. In Year 8, it subsides and the non-inflationary environment returns. Because inflation affects the value of outstanding losses (both reported and unreported), the reporting and payment pattern will change. Losses incurred in accident Year 5 will develop as follows:

		Valued as of		
		12 Months (Year-End 5)	24 Months (Year-End 6)	36 Months (Year-End 7)
Year 5	Reported	$5,000	$7,250	$7,355
	Paid	2,000	5,150	7,355

In the first 12 months, $5,000 is reported, which includes three outstanding claims of $1,000 each. These three claims are paid in Year 6 but, because of inflation, they are paid at $1,050 each. Another claim is reported and reserved, but at $2,100 not $2,000. This claim is paid the next year at $2,205 because of Year 7's inflation rate. Thus, it is clear that inadequate claim reserving goes back to Year 5.

Using similar calculations, we can derive annual loss patterns, as Exhibit 1 shows.

It is important to note from Exhibit 1 that although inflation does not occur until Year 6, it affects losses as far back as Year 4, because some losses incurred in that year were not paid until Year 6. Clearly, at the end of Year 3, when rates must be set for Year 4, there is no way to predict the onset of inflation two years in the future. But that is precisely what would have had to be done to set the correct rate for Year 4. Thus, to a certain extent, cyclical results are inevitable in an economy with a variable inflation rate.

Let's assume that the company sets its loss reserves by the reported loss development method. The last two loss development factors are averaged to determine ultimate loss. If, at the end of Year 3, the company considers the reported losses and loss development factors, it would find:

Year	12		24		36
0	$5,000		$7,000	1.000	$7,000
1	5,000	1.400	7,000	1.000	7,000
2	5,000	1.400	7,000		
3	5,000				
Avg. LDF		1.400		1.000	

Ultimate losses are estimated as:

Year 2	$7,000 x 1.000 =	$ 7,000
Year 3	$5,000 x 1.400 x 1.000 =	7,000
		$14,000

Because $7,000 of loss has been paid for Years 2 and 3, the carried reserve is $7,000 (14,000 - 7,000). As Exhibit 2 illustrates, the reserve is accurate because the ultimate losses have been correctly valued.

At the end of Year 4, the data grid is as follows:

Year	12		24		36
1	$5,000		$7,000	1.000	$7,000
2	5,000	1.400	7,000	1.000	7,000
3	5,000	1.400	7,000		
4	5,000				
Avg. LDF		1.400		1.000	

The ultimate loss estimates are:

Year 3	$7,000 x 1.000	= $ 7,000
Year 4	$5,000 x 1.400 x 1.000 =	7,000
		$14,000

Once again the carried reserve is $7,000. This time, however, the actual loss for Year 4 is $7,100. Therefore, the company is under-reserved by $100 because of an inflation that has yet to occur and that the company has not anticipated.

Similar calculations can be carried out for each year. Below are the details of the reserve calculation at the end of Year 7. At this point, inflation has been in effect for two years:

Year	12		24		36
4	$5,000		$7,000	1.014	$7,100
5	5,000	1.450	7,250	1.014	7,355
6	5,250	1.450	7,612		
7	5,510				
Avg. LDF		1.450		1.014	

The ultimate loss calculation is:

Year 6	$7,612 x 1.014	= $ 7,717
Year 7	$5,519 x 1.450 x 1.014 =	8,101
		$15,818

Because the losses paid for Years 6 and 7 are $7,612, the reserve carried is $8,206. Exhibit 1 shows that the actual losses for Years 6 and 7 are $7,612 and $7,717, respectively. The loss data have not yet reflected the fact that the inflation has ended, and the company is now $489 over-reserved. Exhibit 2 shows the reserves actually required.

The inflationary cycle leads to a pattern of under-reserving followed by over-reserving. If a more responsive loss reserving method had been used -- the last factor rather than an average of the last two factors -- the error would have been smaller. If a less responsive method had been used -- the average of the last three factors -- the error would have been larger and extended over a longer period of time.

RATEMAKING

Now let's look at the effect of inflation on ratemaking. Take a company that uses a pure premium method of ratemaking. To determine the premium for Year X, losses for accident Year X-1 are developed to ultimate. These losses are then trended to reflect any inflation. Dividing the trended losses by .50, the permissible loss ratio, yields the new premium. Trend is estimated by considering the average paid claim cost for the last two calendar years and calculating the percentage change. Use of paid claim cost is common in ratemaking. (We assume that there are no changes in claim frequency.) It is possible from the model to show that the average paid claim cost for each calendar year is:

1.	$1,167	6.	$1,225
2.	1,167	7.	1,286
3.	1,167	8.	1,286
4.	1,167	9.	1,286
5.	1,167	10.	1,286

To make rates for Year 3, we use the estimated accident Year 2 losses -- $7,000 -- at the end of Year 2. Because the average paid claim cost has not changed between Year 1 and Year 2, the trend factor is 1.00, and the premium for Year 3 will be ($7,000 x 1.00) ÷ .50 = $14,000. Note that the losses to be incurred in accident Year 3 are $7,000. Thus, the rates are correct, producing the planned 50% loss ratio.

At the end of Year 3, rates for Year 4 must be calculated. Year 3 losses are estimated at $7,000. Again the trend factor is 1.00 and the new premium is $14,000. We know from Exhibit 1, however, that losses for accident Year 4 will develop to $7,100. Thus, the rates are too low, producing a loss ratio of 50.7% rather than 50%.

Premiums can be similarly calculated for each year. For example, to make rates for Year 8, we would use losses for accident Year 7. At the end of Year 7, these losses are estimated at $8,101. The average paid claim cost has risen 5% from Year 6 to Year 7; thus, the trend factor is 1.05. The calculated Year 8 premium is ($8,101 x 1.05) ÷ .50 = $17,012. Losses for Year 8 will develop to $7,717 and so the loss ratio will be 45.4%. The rates are too high.

A comparison of the premiums that would be charged with the "correct" premiums that would yield a 50% accident year loss ratio follows:

Year	Charged	Correct	% Difference
1	$14,000	$14,000	0
2	14,000	14,000	0
3	14,000	14,000	0
4	14,000	14,200	-1.4
5	14,000	14,710	-4.8
6	14,000	15,224	-8.0
7	15,821	15,434	+2.5
8	17,012	15,434	+10.2
9	15,814	15,434	+2.5
10	15,434	15,434	0

The pattern that emerges is one of rates falling too low followed by rates rising too high. Once again the responsiveness of the ratemaking method will play a part in the swings. More or fewer years may be used to determine experience and trends.

LOSSES AND LOSS RATIOS

Shown below are the accident and calendar year losses and loss ratios that can be derived from the model:

	Losses		Loss Ratios	
Year	Accident Year	Calendar Year	Accident Year	Calendar Year
1	$7,000	$7,000	50.0%	50.0%
2	7,000	7,000	50.0	50.0
3	7,000	7,000	50.0	50.0
4	7,100	7,000	50.7	50.0
5	7,355	7,000	52.5	50.0
6	7,612	7,934	54.4	56.7
7	7,717	8,340	48.8	52.7
8	7,717	7,471	45.4	43.9
9	7,717	7,473	48.8	47.3
10	7,717	7,717	50.0	50.0

The calendar year results display wider swings because of corrections in reserve amounts. This points up the importance of setting reserves as accurately as possible. In a business prone to cycles, reserve errors will serve only to intensify the cycles.

CONCLUSIONS

The foregoing model represents an economic environment in which no inflation existed at first, then inflation occurred, and finally it subsided. Of course, this is not consistent with actual economic trends. However, the model can be adapted to the more realistic situation where some inflation is always present, but the rate changes from one period to the next.

The results would be the same. When the inflation rate accelerates, we would experience under-reserving and inadequate rates. When the inflation rate subsides, we would have over-reserving and redundant rates.

The model shows that errors in ratemaking and loss reserving are inevitable in an environment of fluctuating inflation. Lines with the slowest payment and reporting patterns are most severely affected because these lines -- such as product and professional liability -- have the most claims outstanding when inflation hits. To partially offset these errors, a company must react as quickly as possible to changing economic conditions.

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Exhibit 1

Loss Reporting and Payment Patterns

Year	Inflation		Losses Valued as of: 12		24		36
1	0%	Reported	$5,000	1.400	$7,000	1.000	$7,000
		Paid	2,000		5,000		7,000
2	0	Reported	5,000	1.400	7,000	1.000	7,000
		Paid	2,000		5,000		7,000
3	0	Reported	5,000	1.400	7,000	1.000	7,000
		Paid	2,000		5,000		7,000
4	0	Reported	5,000	1.400	7,000	1.014	7,100
		Paid	2,000		5,000		7,100
5	0	Reported	5,000	1.450	7,250	1.014	7,355
		Paid	2,000		5,150		7,355
6	5	Reported	5,250	1.450	7,612	1.000	7,612
		Paid	2,100		5,407		7,612
7	5	Reported	5,510	1.400	7,717	1.000	7,717
		Paid	2,205		5,512		7,717
8	0	Reported	5,510	1.400	7,717	1.000	7,717
		Paid	2,205		5,512		7,717
9	0	Reported	5,510	1.400	7,717	1.000	7,717
		Paid	2,205		5,512		7,717
10	0	Reported	5,510	1.400	7,717	1.000	7,717
		Paid	2,205		5,512		7,717

Exhibit 2

Carried and Required Reserves

Year End	Accident Year	Estimated Ultimate Loss Last Two Years	Carried Reserve	Required Reserve	Difference
1	0	$7,000	$7,000	$7,000	0
	1	7,000			
2	1	7,000	7,000	7,000	0
	2	7,000			
3	2	7,000	7,000	7,000	0
	3	7,000			
4	3	7,000	7,000	7,100	-100
	4	7,000			
5	4	7,000	7,000	7,455	-455
	5	7,000			
6	5	7,300	7,584	7,717	-133
	6	7,534			
7	6	7,717	8,206	7,717	+489
	7	8,101			
8	7	7,717	7,961	7,717	+244
	8	7,907			
9	8	7,717	7,717	7,717	0
	9	7,717			
10	9	7,717	7,717	7,717	0
	10	7,717			