TITLE: EVALUATING THE IMPACT OF INFLATION ON LOSS RESERVES

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INTRODUCTION

Over the past decade, the senior management of P/L insurers have expressed an ever increasing concern regarding the impact of inflation on loss reserves. They want to know:

1. What inflationary assumptions underlie their current reserve levels?

2. How much will current reserve adequacy be changed if future inflation is different than this assumption.

The concern is real and the request for answers is understandable, particularly in the "long tail" lines such as Auto Liability, Other Liability, Medical Malpractice and Workers' Compensation where claims are often settled many years after the accident occurs. Those future settlements on liabilities we have already incurred are likely to be paid in a very different economic environment than the one in which the reserve was established.

The priority assigned to this concern is proportional to the stability of inflation. When the historical and future trends in inflation are similar, reserve estimates based on historical data are likely to adequately reflect future inflation scenarios.

However, the inflationary environment of the past decade as well as the great uncertainty for the future has placed this concern high on the list of questions to be answered.

Most of the reserving methodologies actually being used to establish a company's reserve level claim to consider inflation at some step in the process. In most cases, inflation is brought into the process as a judgemental adjustment or is assumed to be implicitly considered as part of some other step. Forecasting trends in severity as a function of economic indicators is the most common area where inflation is assumed to be considered. However, no technique which deals with inflation indirectly can accurately answer management's concerns.

This paper is not intended to present a new reserving methodology, but rather to demonstrate how an existing reserve model can be modified to explicitly deal with inflation and therefore answer management's questions regarding the impact of inflation on loss reserves.

TECHNIQUE

The technique for evaluating the impact of inflation involves the addition of one step prior to implementing an existing reserving methodology and one step after the forecasts are completed.

These steps are designed to factor out the effects of inflation from historical loss data prior to forecasting, forecast the reserve using the current methodology and then replace the effects of inflation including an assumption of future inflation.

In order to illustrate this technique, let us define a rather simple reserving model based on loss payment patterns by accident period and lapse period (i.e., number of periods beyond the accident date).

<u>Reserving Model</u>:

This simple model assumes future payments will emerge at the same rate as an average of the past. The historical data consists of a matrix P of cumulative payments.

Cumulative Paid Loss Matrix

Lapse Period	Accident Period: o	1	....	n-m	....	n-1	n
o	$P_{o,o}$	$P_{1,o}$	....	$P_{n-m,o}$	....	$P_{n-1,o}$	$P_{n,o}$
1	$P_{o,1}$	$P_{1,1}$	....	$P_{n-m,1}$	....	$P_{n-1,1}$	
⋮	⋮	⋮			⋰		
m	$P_{o,m}$	$P_{1,m}$	....	$P_{n-m,m}$			

m = lapse period of assumed final payment

n = current accident period

The model used to forecast the ultimate loss $P_{k,m}$ for the k^{th} accident period is:

$$P_{k,m} = \left[\prod_{j=n-k+1}^{m} \left(\sum_{i=n-j-t+1}^{n-j} P_{i,j} \div \sum_{i=n-j-t+1}^{n-j} P_{i,j-1} \right) \right] \times P_{k,n-k}$$

For: $n-m < k \leq n$

$n \geq m+t$

Where: i = o,n accident period

j = o,m lapse period

t = number of periods averaged in ratioing process

The reserve R valued at the end of the k^{th} accident period is:

$$R_k = \sum_{i=k-m+1}^{k} \left(P_{i,m} - P_{i,n-i} \right)$$

This model is illustrated using actual data in the first table of Exhibit I. The actual cumulative payments for Auto Bodily Injury by accident year and lapse year appear above the line and the forecasts below the line, where $n = 1979$, $m = 7$ and $t = 6$.

The reserve of $459 million is determined by summing the differences between the ultimate for each accident year at AY+7 and the last actual cumulative payment just above the line. Note: Only data for accident years 1972 through 1979 is shown; however, data back to accident year 1967 was used in order to complete the forecasting process.

Removing the Impact of Inflation:

In order to modify this reserving model to account for inflation, we will remove the effects of inflation from the historical values in the P matrix prior to forecasting. In order to do that, we must establish some facts or make some assumptions:

1. Establish a profile of loss costs. What portion of the loss payments is medical, wage, legal fees, pain and suffering ... etc.

2. Identify those economic indices which best measure the inflation in those costs.

3. Determine the timing of the inflationary impact. (i.e., accident date, report date, paid date ... etc.)

4. Test these relationships on historical loss development patterns and find the combination which best explains the long term growth in claim costs.

Norton E. Masterson published a paper in the 1968 Proceedings of the Casualty Actuarial Society entitled "Economic Factors in Liability and Property Insurance Claim Costs, 1935 - 1967". Mr. Masterson's paper and supplement published one year later includes extensive work on identifying a profile of claim costs and their relationship to economic indices. However, this paper does not address the timing of the inflationary impact.

In order to establish timing, each line of business and type of cost must be examined separately. For example, the wage portion of a Workers' Compensation claim may be at time of accident while the medical portion is at time of payment. For Medical Malpractice, the pain and suffering may be at time of settlement and the legal fees at time of payment. Further, consideration must be given to the changing proportions of types of cost as the lapse periods mature. For example, medical may be paid early and wages later in the development of an accident year.

In our example for Auto Bodily Injury, we are assuming a fixed proportion of 60% medical and 40% wage impacting at time of payment. The following table demonstrates the construction of the inflation Index I.

	Medical	Wage	I = 60% (Med) + 40% (Wage)
1972	100	100	100
1973	104	106	105
1974	114	115	114
1975	127	124	126
1976	139	133	137
1977	153	143	149
1978	166	155	161
1979	181	167	176

Medical = Consumer Price Index for Medical Care

Wage = Index of Hourly Earnings of Production Workers - Total Private Non-Farm.

Prior to forecasting the accident year ultimate loss $P_{k,m}$ in the reserving model, the matrix of payments P can be deflated to constant dollars P' with the following equation.

$$P'_{i,j} = \sum_{k=o}^{j} \left[\left(P_{i,k} - P_{i,k-1} \right) \div I_{i+k} \right]$$

For all: $i = o, n$ Where: $P_{i,-1} = o$

$j \leq n - i \leq m$

This model is illustrated for the Auto Bodily Injury example in the middle table of Exhibit I. The reserve of $225 million expressed in constant 1972 dollars was estimated using the same reserving model described earlier, but substituting P' for P.

Replacing the Impact of Infation:

The final step in the process is to replace the impact of inflation. In order to complete this step, we will require an estimate of future inflation to be applied to future payments. These forecasts can be provided by the corporate economist, outside consulting firms or our own assumption.

The matrix of historical and future payments P' expressed in constant dollars can be inflated to P" with the following equation:

$$P''_{i,j} = \sum_{k=o}^{j} \left[\left(P'_{i,k} - P'_{i,k-1} \right) \times I_{i+k} \right]$$

For all $i = o,n$

$j = o,m$

Note: When $i+k > n$, I_{i+k} is a future inflation index.

This step is illustrated for the Auto Bodily Injury example in the last table of Exhibit I. In this example, future inflation for this index is assumed to be growing at an annual rate of 10% and the forecasted reserve is $481 million.

Testing the Assumptions:

While some of the relationships required to implement this technique can be derived from actual historical data, many of the factors will have to be assumed. These assumptions can be tested by deflating the historical data, adjusting for exposure and examining the resulting trend at each lapse period across accident periods. For example, if the actual timing of the inflationary impact is at time of accident and you assume it is at time of payment, you will observe a decreasing trend in deflated loss payments. In other words, you have over compensated for inflation by reducing an accident year's payments for future inflation. Alternatively, if the sequence is reversed you will have an increasing trend.

Exhibit II shows several trends of ultimate accident year loss costs. The solid line graphs the result of forecasts using deflated dollars (P'). The lower dotted line shows the same result, but adjusted for exposure. Ideally, the average annual growth in the accident years 1972 through 1979 as shown with the dotted line should be close to zero if our assumptions are correct. If this trend were clearly declining, one might conclude our assumption of "inflation at time of payment" was not correct or perhaps our choice of economic indices was inappropriate or perhaps some other factor (e.g., no fault) was influencing the trends.

RESULTS

Now that we have the technique in place, we are ready to answer management's questions. Using the last table on Exhibit I, we can tell management our Auto Bodily Injury reserve estimate of $481 million assumes an annual inflation rate of 10% for 1980 and beyond. In order to answer the question regarding the impact of different future inflation scenarios, we can substitute any series of future growth rates in I_j for $j > n$ prior to calculating P". The following table shows reserve estimates at selected future inflation rates from 5% to 15%.

Future Rate of Inflation	Reserve ($M)	
5%	$440	
6	448	
7	456	459 w/no inflation assumption
8	464	
9	472	
10	481	
11	490	
12	499	
13	508	
14	517	
15	526	

Using this reserving model, we can tell management the adequacy in our current Auto Bodily Injury reserve level will be changed by approximately $8 million or 1.75% for every point change in the annual rate of future inflation. Further, the reserve model in its original form, without adjusting for inflation, has an implicit future inflation assumption of approximately 7.5%. Not suprisingly, this is about the average inflation rate over the past ten years.

Regardless of what reserving model is used, if the end objective is to estimate an ultimate accident year loss and we wish to test the reasonableness of those estimates against some inflation indicator, we can use the accident year economic index which is produced as a by-product of the technique discussed in this paper. The following table shows the Auto Bodily Injury accident year economic index produced by assuming loss costs are 60% medical/40% wage, inflation impacts all losses at time of payment and future inflation is growing at x% annually.

Auto Bodily Injury Economic Index

	Assuming Annual Inflation Beyond 1979 Is:				
Accident Year	6%	8%	10%	12%	14%
1976	155	156	157	157	158
1977	168	170	171	172	174
1978	181	184	187	190	193
1979	193	199	205	211	218

ALTERNATIVES

It is important to emphasize that the technique discussed in this paper need not be restricted to the reserving model we have used as an example.

If your model uses payments by accident period and lapse period, simply convert P to P' and use your model. The time periods may be monthly or quarterly; seasonality, cycles and trends may be considered; adjustments for large claims, special Claim Department programs or shifting business mix can still be applied.

If your model considers frequency and severity separately, simply divide P by the matrix of claim counts C and apply the technique to the resulting severity matrix.

If your model uses reported loss by accident year (i.e., paid plus outstanding), an additional modification must be made. If we assume changes in outstanding losses are affected by inflation in the time period in which they are outstanding, the following equations would be used to deflate and inflate the reported loss matrix R.

To Deflate Matrix:

$$R'_{i,j} = \left(R_{i,j} - P_{i,j}\right) \div I_{i+j} + \sum_{k=o}^{j} \left[\left(P_{i,k} - P_{i,k-1}\right) \div I_{i+k}\right]$$

For all $i = o,n$

$j = n-i \leq m$

To Inflate Matrix:

$$R''_{i,j} = \left(R'_{i,j} - P'_{i,j}\right) \times I_{i+j} + \sum_{k=o}^{j} \left[\left(P'_{i,k} - P'_{i,k-1}\right) \times I_{i+k}\right]$$

For all $i = o,n$

$j = o,m$

When forecasting reserves for very slow developing lines such as Product Liability and Medical Malpractice, the use of payments is not very helpful in forecasting recent accident periods and the use of a reported loss matrix is the only viable alternative if historical loss development data is to be used. A major concern in these slow developing lines is the "long tail", which continues for several decades beyond the accident date and shows an ever increasing trend over time. However, when the reported loss matrix is deflated, the "long tail" appears to be much less formidable and relatively more stable.

CONCLUSION

It is obvious that future inflation impacts claims that have already occurred but have not yet been paid. The technique presented in this paper attempts to isolate and quantify that impact.

If future rates of inflation are not significantly different from the recent past, the impact will not be significant relative to other areas of uncertainty regarding the elusive task of forecasting loss reserves. But if inflation gets out of hand, as it already has in many other countries, many P/L insurers are going to discover they are technically insolvent, especially if they have significant exposure to "long tail" lines of business.

AUTO BODILY INJURY
($ MILLION)

EXHIBIT I

PAYMENTS (P)

PAID AS OF	1972	1973	1974	1975	1976	1977	1978	1979	
AY	37	41	42	56	53	56	53	63	
AY+1	107	112	130	149	137	150	157	175	
AY+2	143	157	172	193	183	207	211	236	
AY+3	164	177	193	219	208	235	240	268	
AY+4	175	186	207	234	221	251	255	285	
AY+5	181	192	215	242	229	259	264	294	
AY+6	183	195	219	246	232	263	268	299	
AY+7	185	197	221	248	235	265	270	302	
RESERVE	0	2	6	14	27	58	113	239	= 459

PAYMENTS EXPRESSED IN 1972 DOLLARS (P')

PAID AS OF	1972	1973	1974	1975	1976	1977	1978	1979	
AY	37	39	37	44	39	38	33	36	
AY+1	103	101	106	112	95	96	92	95	
AY+2	135	136	137	141	123	128	120	124	
AY+3	152	151	151	157	137	143	134	139	
AY+4	159	157	159	166	145	151	141	146	
AY+5	163	161	164	170	148	154	145	150	
AY+6	165	163	166	172	150	156	147	151	
AY+7	166	164	167	173	151	157	147	152	
RESERVE	0	1	3	7	14	29	55	116	= 225

FUTURE PAYMENTS ASSUME INFLATION AT 10% (P")

PAID AS OF	1972	1973	1974	1975	1976	1977	1978	1979	
AY	37	41	42	56	53	56	53	63	
AY+1	107	112	130	149	137	150	157	177	
AY+2	143	157	172	193	183	207	212	240	
AY+3	164	177	193	219	208	236	242	274	
AY+4	175	186	207	234	222	252	258	293	
AY+5	181	192	215	242	230	261	267	303	
AY+6	183	195	219	247	234	266	272	309	
AY+7	185	197	222	249	236	269	275	312	
RESERVE	0	2	7	15	28	62	118	249	= 481

EXHIBIT II

ULTIMATE ACCIDENT YEAR LOSS COST ($MILLION)

AUTO BODILY INJURY