ESTIMATING ACCIDENT YEAR LOSSES FROM SELF-INSURED WORKERS' COMPENSATION 'PAY-AS-YOU-GO' DATA

Walter J. Haner

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Abstract

The annual costs of workers compensation for many businesses are small compared to total payroll or total costs of production. As a result, many such entities do not maintain loss data in accident or injury year detail, do not reserve for open claims, and maintain records only for paid loss amounts on a calendar year basis without regard to injury year. Often with a change in ownership or management, the new management team requests an estimate of the funding levels on a fully accrued basis. This paper presents an approach to determining the expected injury year ultimate loss amounts from a combination of calendar year exposure and loss payment data.

INTRODUCTION

Several years ago, I was asked to assist in the due diligence associated with the sale of a large strip-mining company. I was given the task of testing the liabilities that the company had accrued for its self insured workers' compensation exposure and I arranged a visit to its main offices to collect the requisite evaluation history data by injury year to test the loss development of the company and to perform my projections. While I received an awe inspiring tour of the mining operations, I received no evaluation history by injury year, nor did I receive even the most recent evaluation of losses by injury year.

Despite being fully self insured since the advent of workers' compensation in its state, the company did not keep data segregated by injury year and did not have an accrual for unpaid workers' compensation benefits, but operated completely without regard to date of injury on a "pay-as-you-go" basis.

Choosing to approach workers' compensation on a pay-as-you-go basis was a simple and logical choice for this company. While the scale of its mining operations was stupendous, they were not **labor** intensive. And in fact, the few workers who ran the machinery did so from reinforced cabs, fully air conditioned and filtered, exposed to very little hazard. The cost of work place injuries was therefore trivial compared to the costs of the other aspects of production, and minimal resources were assigned to track the costs of those injuries.

Since then, I've come across several other pay-as-you-go workers' compensation self insureds, in largely the same circumstances, where the annual costs of employee injuries are small compared to payroll and/or where payroll itself is but a small part of the total costs of production. Almost all these companies also remarked at how easy it was to allocate paid costs among subsidiaries, and how much that task would be complicated if they adopted a full accrual cost approach. Examples of the companies encountered are an airline, a newspaper publisher and several political subdivisions. In each situation, it was an outside agency that was asking for an analysis of costs on a more traditional, fully

accrued basis. The technique developed for the strip mine due diligence, which is herein described, was useful in accomplishing such estimates.

THE MODEL - An Overview

The model's basic structure came to me because at the time of the original mining company engagement, I was in the midst of work being done for several insurance company clients which use retrospective and run-off tests to monitor actual versus expected payments during the period between calendar year-end reviews. Payment patterns and previously selected ultimate losses by accident year are used to test the expected versus actual amounts paid in the most recent calendar year. Reversing the process -- taking payment patterns and the calendar year payment amounts -- could be useful in constructing reasonable estimates of ultimate loss amounts by injury year. This technique also draws heavily upon the modifications to expected value reserving described by Ron Bornhuetter and Ron Ferguson in their paper "The Actuary and IBNR". Used as a reserving tool, their technique creates a "snap shot" of losses at a particular evaluation point. Extending that technique from a single picture into a series of pictures would allow us to deduce the expected payments which would be attributable to a calendar year.

Briefly, the model begins with the construction of a set of initial expected losses by injury year. A payment pattern is applied to those expected losses, and the sum the payments "along the diagonals" produces estimated calendar year payment amounts. We can then

compare these sums of expected payments with the actual amounts paid and, using a recursive process, adjust the initial expected injury year losses to minimize the differences between actual and expected calendar year payments.

THE DATA AVAILABLE

Within each company noted as an example above, the data available for analysis was largely the same as what was available in the original mining company assignment. The company had a usable history of the amounts paid by calendar year, in the form of a separate operating expense category for workers' compensation expenses. In addition, because it is generally required to keep records of payroll for tax reasons (both its own and its workers' W-2 forms), unemployment compensation and other purposes, it generally had a reliable history of total payroll amounts, although the retention of such records in one situation was only five years.

In at least one case, some data on large losses was available. Large losses cause considerable variation. Since this model examines the variation between actual and expected losses, ascribing some of that variation to the impact of specific large settlements will add some detail to the estimation method, and will likely improve the overall efficacy of the model.

Lacking quantitative data, qualitative knowledge becomes important. However, because workers' compensation costs are immaterial compared to total costs, it is very likely that while the risk manager may have solid knowledge of third party liabilities, EPA regulations, and even with non insurance issues such as the financial consequences arising from a one-cent increase in fuel costs, compensation issues are not foremost on his or her mind. In one instance, it was not the risk manager but the employee benefits director who had responsibility for workers' compensation. As noted above, in each of these assignments I was engaged by someone outside the company under study, and therefore did not know beforehand who had responsibility for compensation. Perhaps the Human Resources department is the place to start the investigation, since it often gets workers' compensation responsibility because of its kinship to employee medical coverage.

Other tools which may be employed are external, presented in the following chart.

Source	Data Available
NCCI Annual Statistical Bulletin	Quantifies historical benefit level changes by state.
A.M. Best's Aggregates & Averages	Shows compiled industry payment data which can be used to estimate injury year payment patterns (paid loss development data may also be available from the NCCI by special request).
Consumer Price Index	Charts movements of costs of many types if goods and services within the economy.
Statistical Abstract of the United States	Presents movements in wages for various categories of employment over the past several years.

THE MODEL - In Detail

Described in detail below are the three steps involved in the use of this model:

- the creation of initial expected losses by injury year;
- the distribution of those injury year losses into calendar year payment amounts;
- the recursive comparison of actual versus expected calendar amounts to optimize the initial expected losses by injury year.

Initial Estimated Expected Losses by Injury Year

Creation of an initial estimate of the expected losses by injury year is the first step in the construction of the model. To do this, we need payroll by injury year, and pure premiums to apply to those payroll amounts to produce expected losses.

Payroll

As noted earlier, payroll for at least the latest few years was available from each entity I have examined thus far; it was not, however, available in standard rating bureau class detail. The relative unimportance of workers' compensation costs intrudes again -- payroll by rating class is not maintained -- so unless most of the employees can be assigned to one rating class, we would be unable to use NCCI published rates or pure premiums to calculate initial expected losses.

As an aside, having payroll by rating class would clearly enhance the estimates produced by this model. With payroll by class and rates, our first estimate of expected losses would essentially use the guaranteed cost premium which would have been charged by the commercial marketplace - in many states, pure premiums by class are available, which would lead to a direct estimate of expected losses. With respect to payroll statistics, it is therefore worthwhile to spend some time investigating what information is available which might allow the use of rates by class in these estimates.

Depending upon the number of years of available payroll data and the length of the payment pattern chosen (discussed below), it may be necessary to extrapolate payroll amounts for years prior to the earliest year for which actual amounts are available. The Statistical Abstract of the United States has proven useful in several of these exercises. This publication shows changes in wages for several different employment types over the past several years. Bear in mind that despite its long tail reputation, 75% of workers' compensation losses are paid within the first five years. Therefore, the expected paid loss contributions of early injury years to the most recent calendar years will not be that material, and a reasonable approximation of the movements in wage rates will likely suffice for this exercise. One note of caution - if there has been a significant acquisition or divestiture during the period for which actual payroll data is unavailable, or if there was some other large increase or decrease in work force, this should be reflected in the best possible fashion.

Pure premiums

Given payroll by injury year, we need pure premiums to apply to these payroll amounts to produce expected losses. The approach that I have taken to producing these pure premiums is to pick a "seed" pure premium for the most recent year, and then derive prior years' pure premiums from that seed by reflecting changes in benefit levels, other general economic or societal changes, and specific operational changes (if any) which may have occurred in the concern under study.

The "Seed"

The initial selection of the seed pure premium for the most recent year is not altogether critical to the results produced by the model, since the seed pure premium that we will ultimately use will be arrived at recursively. However, you should strive to select a seed which approximates the costs of the company under study, to reduce the iterations of the recursion. Several recent articles in the trade press have estimated that average compensation costs vary between 2 and 4% of total payroll. If you have nothing to suggest that your subject is very different from average, a 3 per cent rate is probably a good initial pick.

Benefit level and Other Changes needed to modify the "Seed"

Benefit level changes are the easiest to reflect, in that the NCCI's Annual Statistical Bulletin provides a ready source of these changes for all states. For multiple location

risks, separate estimates could be accomplished for each state, or a "blended" benefit level change could be used (based upon the distribution by state) if an estimate for all states combined is all that is required.

Factors other than changes in the mandated benefit levels are more difficult to measure and reflect. Almost everyone currently discussing workers' compensation costs would agree that there are economic and societal changes beyond payroll and benefit level changes which have been exerting upward pressure on compensation costs for some companies and industries. Such factors include increased utilization of the compensation system, increased involvement of attorneys in claims litigation, and the inclusion within compensation of an increasingly broader set of injuries (for example, stress and repetitive injury syndrome). One or more of these may be affecting the costs of the entity under study. If they are, the magnitude of their influence might be reflected in the level of awareness of compensation issues among the company's staff. If no one seems concerned, then there has likely been no effect. On the other hand, a militant effort "to bring escalating costs back into line" could suggest that a considerable effect has been felt within the recent past.

A related factor which often (adversely) affects the frequency of compensation claims is plant closings or other "downsizing" type events. Information concerning such events

should be readily available and should be kept in mind when establishing injury year costs for the years in which such events occurred, and possibly in the years immediately after.

Incorporating a quantitative measure of factors such as those discussed above clearly requires more judgment than does the inclusion of benefit level changes. The effect of a plant closing which generated a rash of hearing loss claims could be reflected by using a one-time factor of 1.15 for the year of the closing, to reflect the expected increase in frequency. Similarly, an increase in utilization that has affected the past three years might call for an extraordinary "de-trending" factor from year three to year four, to bridge the gap between current elevated levels and the more "normal" levels of the past. In any such case, some quantitative measure of these effects will add to the detail of this model and enhance the estimates it produces.

The steps in establishing initial expected losses are shown on Exhibit 1. An example of the extraordinary factors discussed above can be seen in this example. This client was relatively certain that recent compensation costs had been increasing more rapidly than mere changes in payroll. As shown in the foot note, Pure Premium Trend Factors were applied to the latest four years in an attempt to reflect this observation by the client.

Distributing Injury Year Losses to Calendar Year of Payment

Given the initial estimated injury year losses shown in Column (7) of Exhibit 1, it is a straight forward exercise to apply a payment pattern to these to arrive at a trapezoid of loss payments by maturity year which will yield the calendar year expected payment amounts. The difficulty in this segment of the model is the selection of the payment pattern itself, and the reflection of any information concerning large settlements that may be available.

Selection of a Payment Pattern

Without an evaluation history, clearly we must rely completely upon patterns drawn from "external" data. Patterns derived from the industry data compiled in A.M. Best & Co.'s Aggregates & Averages, or from work done in other situations, or as indicated above, obtained from the NCCI, are a logical first choice, but one thought should be kept in mind. A likely reason the company under study has persisted with pay-as-you-go is that the settlement period for their claims is probably shorter than those patterns derived from general industry data. Again, the only source of information which would be useful in determining modifications to the settlement periods will be interviews with the risk manager. Often, the higher visibility of the larger, later settling claims will work to our advantage, and we might elicit information concerning "worst cases," or perhaps some personal assessments of the likely maximum length of the settlement period. Even without specific information, you probably should be receptive to shortening the payment

patterns which would otherwise be used, unless there is sufficient evidence that the ordinary pattern should apply.

Exhibit 2 shows the two elements of this segment of the model. At the bottom of the exhibit is the payment pattern which was actually employed in spreading the payments. Shown immediately below that is the reference pattern which I would have otherwise used for workers' compensation. Here, I have shortened the pattern (which ordinarily stretches to 20 years) to eight years by spreading the unpaid amount of 14% at the end of year eight proportionately across all years. This may not the most theoretically correct way to shorten the pattern, but it is convenient and conforms to the general level of accuracy that we can legitimately expect from this model. The remainder of the exhibit shows the arithmetic of spreading the payments across maturity years.

Large Loss Settlements

At this point, we should address using information that might be available concerning large settlements. In the assignments which I have done to date, no information on large settlements has been available, either because the entity's staff asserted that there had been none, or because the data was not available. However, if information on large settlements is available, we could use it to try to "explain" some of the variation of the calendar year payments. As we will see immediately below, for the example which we have been using, there is a significant upward deviation between actual and expected payments in the latest

calendar year. The model as constructed explains such deviations as entirely the result of variations in injury year loss levels, and thus an increase in the most recent calendar year payments implies an increase in the most recent injury year's loss levels (specifically including the seed pure premium year). On the other hand, if we knew (as I suspect) that a large settlement had been made in 1990 for an injury which occurred in 1986, we could "remove" this settlement from the 1990 payments, and thereby improve the fit between actual and expected. In this instance, we would also likely reduce the seed pure premium, since the "new" explanation for the upward surge in calendar year payments would involve an older injury year, not the level of the 1990 injury year.

As noted, large loss data has not been forthcoming in any of the engagements with which I have been involved thus far -- one might suspect that data on large claims may go hand in hand with an information system with sufficient sophistication to provide us with more traditional projection type data. However, if data on one or several large losses is available, it could prove useful in explaining deviations between actual and expected, and excluding these amounts could enhance the fit to the actual payment data.

Assessing the "Seed" Pure Premium

We now begin the iterative process of finding the best "seed" pure premium for the most recent injury year. We add the payment amounts along the diagonals in Exhibit 2 to produce the calendar year payments which result from our initial seed selection, and

compare these to the actual payment amounts, using the sum of the squared differences as our comparative tool. I've used the square root for appearances, to limit the digits of the measuring tool; it is possible that other "goodness of fit" tools would be more appropriate.

The initial comparison is shown on the top of Exhibit 3, and clearly, given that estimated payments are considerably greater than actual, a pure premium of 3% of payroll is too high for this risk. We begin lowering the seed until the sum of the squared differences reaches a minimum, somewhere between $1.49 and 1.48. [Incidently, I have done all these analyses using spread sheets, and these iterations can be accomplished using very simple macros.

With our seed pure premium determined, we can now use the progression of pure premiums for the past several years, coupled with the estimated payroll amounts and whatever other assumptions we choose to make concerning the upcoming years, to determine future expected loss levels. As an aside, multiplying historical losses by the expected unpaid percentages (for the appropriate maturity), we can also determine the unfunded liability for open claims. As noted earlier, it was the search for this amount that led me into this approach in the first place.

LIMITATIONS ON THE MODEL

Anyone who has assembled a set of initial expected losses and a reporting pattern to be used in the aforementioned Bornhuetter Ferguson reserving technique, and then been confronted with large differences between expected and actual reported losses, is familiar with the limitations of expected value constructions. The parameters of payroll growth, indemnity and medical changes, even when adjusted for the effects of acquisitions, divestitures, downsizing, and perhaps some knowledge concerning large settlements, relate to what should be happening to injury year losses, and the payment patterns employed in Exhibit 2 relate to the way those injury year losses should be paid over time.

It is however a rare event when actual losses behave as expected. Deviations arise from at least two obvious sources -- the true injury year losses could be greater or less than expected, and the amount paid in a particular period could be larger or smaller than predicted. In the Bornhuetter Ferguson reserving technique noted above, we generally have detail by exposure year, and can thus partially separate the effects of these two sources of deviation. In a pay-as-you-go situation, we do not have such detail; we have only the trail left by the aggregate contributions of many years to examine. This will clearly limit the accuracy of the result.

In the engagements where I have used this method, I have not attempted to add any complexity to the model to try to incorporate some reflection of deviations arising from either injury year loss levels or from variations in actual pay outs. However, while writing this paper, I have considered what modifications could be made and would suggest the following.

Injury Year Loss Level Variations

To reflect potential variation arising from injury year departures from expected results, we could insert a Column 6a into Exhibit 1, and add into that column a "Departure from Expected resulting from Process Variance" factor. Initially, all these factors would be set to 1.00. After we had found the minimizing pure premium assuming that process variance had no effect, we could, starting with the most recent year, raise and lower this departure parameters by a small constant, to simulate true losses which were worst or better than expected. If either of these movements lowered the squared differences, we would temporarily hold that year at that departure level, and then go to each of the earlier years, determining what departure from expected (if any) improved our fit. After trying this with a chosen number of the injury years, we could then sweep back through the years toward the most recent year. This process of sweeping back and forth through the years could be continued for as many iterations as we desired.

Initial Estimate of Expected Losses by Injury Year

Exhibit 1

Workers' Compensation
Pay–as–you–go, Inc.

Injury Year	Payroll (1)	Payroll trend (2)	Annual Benefit Change (3a)	Cumulative Benefit Change (3b)	Benefit Adjust. Factor (4)	Cumulative Loss Cost Trend (5)	Loss Cost (Seed P.P. x (4)/(5) (6)	Expected Injury Yr. Losses (1)x(6) (7)
1962	9,695	1.045	1.050	1.025	0.210	0.924	0.68	66.1
1963	10,131	1.045	1.050	1.076	0.220	0.924	0.72	72.5
1964	10,587	1.045	1.050	1.130	0.231	0.924	0.75	79.5
1965	11,064	1.045	1.051	1.187	0.243	0.924	0.79	87.3
1966	11,561	1.045	1.063	1.255	0.257	0.924	0.83	96.5
1967	12,082	1.045	1.077	1.342	0.275	0.924	0.89	107.8
1968	12,625	1.045	1.081	1.448	0.297	0.924	0.96	121.6
1969	13,194	1.045	1.012	1.516	0.310	0.924	1.01	132.9
1970	13,787	1.045	1.084	1.588	0.325	0.924	1.06	145.6
1971	14,408	1.045	1.027	1.676	0.343	0.924	1.11	160.6
1972	15,056	1.045	1.012	1.709	0.350	0.924	1.14	171.1
1973	15,734	1.045	1.025	1.741	0.356	0.924	1.16	182.1
1974	16,442	1.045	1.105	1.854	0.380	0.924	1.23	202.7
1975	17,181	1.045	1.041	1.990	0.407	0.924	1.32	227.3
1976	17,955	1.045	1.036	2.066	0.423	0.924	1.37	246.6
1977	18,762	1.045	1.030	2.135	0.437	0.924	1.42	266.3
1978	19,607	1.045	1.232	2.414	0.494	0.924	1.61	314.7
1979	20,489	1.045	1.089	2.802	0.574	0.924	1.86	381.7
1980	21,411	1.045	1.029	2.968	0.608	0.924	1.97	422.5
1981	22,375	1.045	1.051	3.087	0.632	0.924	2.05	459.2
1982	23,381	1.061	1.029	3.210	0.657	0.924	2.13	499.1
1983	24,805	1.066	1.013	3.278	0.671	0.924	2.18	540.6
1984	26,452	1.057	1.078	3.427	0.702	0.924	2.28	602.7
1985	27,956	1.052	1.083	3.703	0.758	0.924	2.46	688.2
1986	29,420		1.025	3.903	0.799	0.924	2.59	763.4
1987	32,408		1.022	3.994	0.818	0.938	2.62	847.9
1988	35,177		1.072	4.180	0.856	0.956	2.68	944.3
1989	35,264		1.020	4.372	0.895	0.976	2.75	970.7
1990	33,207		1.214	4.884	1.000	1.000	3.00	996.2
							Seed P.P.	

NOTES: Column (1): Payroll data in box is actual data supplied by client. Years prior to 1986 are calculated as subsequent year divided by payroll trend factor in Column (2).

Column (2): Factors for most recent five years were estimated from average payroll data shown in the Statistical Abstract of the United States. The 4.5% factor for years prior to 1982 was selected.

Column (3): Factors shown in 3a for 1965–90 were taken from NCCI Annual Statistical Bulletin; Column 3b is the cumulative factor, adjusted by six months to account for 7/1 benefit effective dates versus 12/31 injury year ends.

Column (4): Column (3b) divided by 1990 entry for column (3b).

Column (5): Most recent four injury years only; factors of 2.5%, 2.0, 2.0 and 1.5 respectively. Included because of client's concern with "rising comp costs".

Spread of Initial Expected Losses to Payment Year

Exhibit 2

Workers' Compensation
Pay–as–you–go, Inc.

Injury Year	Expected Injury Yr. Losses (1)	Expected Loss Amounts Paid by Calendar Year 1st (2)	2nd (3)	3rd (4)	4th (5)	5th (6)	6th (7)	7th (8)	8th (9)
1962	$32.8								
1963	36.0								
1964	39.5								
1965	43.4								
1966	47.9								
1967	53.6								
1968	60.4								
1969	66.0								
1970	72.3								
1971	79.8								
1972	85.0								
1973	90.4								
1974	100.7								3
1975	112.9							4	3
1976	122.5						5	4	3
1977	132.2					9	6	4	3
1978	156.3				16	10	7	5	4
1979	189.6			33	19	13	8	6	5
1980	209.8		64	36	21	14	9	7	6
1981	228.1	58	69	39	23	15	10	8	6
1982	247.9	63	75	43	25	16	11	8	7
1983	268.5	68	81	46	27	18	12	9	7
1984	299.3	76	91	52	30	20	13	10	
1985	341.8	86	104	59	35	23	15		
1986	379.1	96	115	65	39	25			
1987	421.1	106	128	73	43				
1988	469.0	118	142	81					
1989	482.1	122	146						
1990	494.8	125							

Total	Injury Year Loss Payment Pattern – Shortened								
100.0%	25.25%	30.30%	17.22%	10.19%	6.64%	4.48%	3.30%	2.63%	
	Injury Year Loss Payment Pattern – Unmodified								Unpaid @ yr 8
100.0%	21.61%	25.93%	14.74%	8.72%	5.68%	3.83%	2.82%	2.25%	14.42%

Comparison of Actual vs. Estimated Calendar Year Loss Payments

Exhibit 3

Workers' Compensation
Pay–as–you–go, Inc.

	Calendar Year Loss Payments										
	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	
Actual	547	416	286	325	365	309	295	225	243	189	
Estimated											Square Root of sum of Squared
	Seed:	$3.00									
	910	859	790	710	638	571	511	465	424	383	1047.55
	Seed:	$1.75									
	531	501	461	414	372	333	298	271	247	224	227.90
	Seed:	$1.60									
	485	458	421	379	340	304	273	248	226	204	158.64
	Seed:	$1.50									
	455	429	395	355	319	285	256	232	212	192	138.08
	Seed:	$1.49									
	452	426	392	353	317	283	254	231	210	190	137.75
	Seed:	$1.48									
	449	424	390	350	315	281	252	229	209	189	137.75
Absolute Dollar Differences atminimum											
	98	(8)	(104)	(25)	51	27	43	(5)	34	(0)	

Initial Estimate of Expected Losses by Injury Year Modified by Injury Year Departure Factors

Exhibit 4

Workers' Compensation
Pay–as–you–go, Inc.

Injury Year Analysis

Injury Year	Payroll (1)	Departure Factor (30 Trials) (2)	Original Pure Premium (3)	Original Expected Losses (1)x(3) (4)	Revised Expected Losses (2)x(4) (5)	Revised Pure Premium (5)/(1) (6)	Annual Changes In Injury Year Losses
1983	24,805	1.040	1.08	274.8	285.8	1.15	
1984	26,452	1.300	1.13	306.4	398.3	1.51	39.4%
1985	27,956	1.190	1.22	349.8	416.3	1.49	4.5%
1986	29,420	0.860	1.29	388.0	333.7	1.13	-19.8%
1987	32,408	0.700	1.30	431.0	301.7	0.93	-9.6%
1988	35,177	0.700	1.33	480.0	336.0	0.96	11.4%
1989	35,264	1.300	1.37	493.4	641.5	1.82	90.9%
1990	33,207	1.190	1.49	511.4	608.6	1.83	-5.1%

Calendar Year Loss Payments

	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	Squared Sum Diff
Actual	547	416	286	325	365	309	295	225	243	189	
Estimated with Departure Factors											
	485	402	322	326	340	329	280	233	210	190	62.86
Difference	62	14	(36)	(1)	26	(20)	15	(9)	33	(2)	
Original Estimated Payments											
	449	424	390	350	315	281	252	229	209	189	137.75
Difference	98	(8)	(104)	(25)	51	27	43	(5)	34	(0)	