# *Ratemaking for Excess Workers Compensation*

Owen M. Gleeson, FCAS, MAAA

## Ratemaking for Workers Compensation

By Owen M. Gleeson, FCAS, MAAA

Abstract

The market for Excess Workers Compensation in the United States has grown rapidly over the last two decades. These are estimates that the annual premium volume in the excess $500,000 attachment segment of this market is now in excess of $1 billion. This paper presents a method of estimating rates for this type of coverage. The method generates loss distribution of the total cost of individual large claims. Medical costs are estimated form data samples. Indemnity costs, however, are for the most part estimated from the benefits mandated in the Workers Compensation statutes.

## I. Introduction

### A. General Remarks

The market for property/casualty insurance in the United States has evolved rapidly in the past 15 years. In particular, the alternative market for Workers compensation insurance has shown explosive growth. Many of the entities that incur workers compensation costs are now self-insured on the lower cost layer, e.g. the first $100,000 per claim. These self-insured firms or groups still purchase insurance protection above retentions that are $100,000 higher. The market for this type of coverage is now very large and in premium dollar terms easily exceeds $1 billion. Another measure of the size of the market is that the Self-Insurance Institute of America has over one thousand corporate members.

The task of estimating rates for this type of business is made difficult by several of the characteristics of large workers compensation claims. The first is that large workers compensation claims are infrequent and thus the amount of data available for ratemaking is severely limited. A second characteristic is that large workers compensation claims develop very slowly with the result that the ultimate cost of an individual claim, particularly those involving medical may not be known for many years. Another aspect of these claims is that there are distinct components of the loss:medical and indemnity. The view adopted here is that the medical costs and the indemnity costs follow separate and distinct distributions. As a result the distribution of the variable which is the sum of these costs is quite complex. It is thus very difficult to model the underlying distribution of these costs by using a sample of incurred losses.

Currently there is no pricing mechanism in the United States for this class of business that provides comfort to the users and is widely accessible. The objective of this paper is to provide a solution to the problem of pricing this line of business which will be seen as generally satisfactory. There are of course no claims implied that what is presented in the following is the only solution or the solution that is "best" in some sense. In addition, this paper will not explore the issue of risk loading or required profit. Rather the paper will focus on the sufficiently difficult task of estimating the pure loss cost.

### B. Types of Claims

The focus of this paper is excess workers compensation costs. It follows that only those types of claims whose cost might exceed a given limit e.g. $100,000 would be of interest. Workers Compensation claims are often classified into six types: Medical Only, Temporary Total, Minor Permanent Partial, Major Permanent Partial, Permanent Total and Fatal. It's assumed for the purposes of this paper that no claim falling into one of the first three classifications will be large enough to pierce the limits of interest. Therefore only the remaining three types of claims will be analyzed.

At this point a discussion of the characteristics of each of the three types of claims will be presented. It is hoped that this will provide motivation for the methods and tactics used in producing the cost estimates. Each of the types of claims to be discussed, i.e. Fatal,

Permanent Total, and Major Permanent Partial have a medical component of the total claim cost and an indemnity component of the cost. These will be discussed separately.

1. Fatal
   a. Indemnity Benefits

The statutory specification of the indemnity benefits associated with fatal claims can be quite complex. In highly simplified terms the parameters specifying the benefits might be described as (1) period of benefits (2) basic percentage of wage and (3) degree of dependency. For example, the period of benefits could be lifetime. However the period of benefits could be limited by attained age, say age 65, or limited by amount (the maximum amount of fatal benefits in Florida is $100,000). The basic percentage of wage is usually expressed in terms such as "66 2/3 percent of the fatally injured individuals average weekly wage." (Many workers in the United States do not receive the same amount of compensation every week. As a result, it is necessary to determine the amount that should be deemed the average weekly wage in the event of injury. Each state has developed a complex set of rules to decide this question. This subject will not be explored here.) The degree of dependency in a fatal case is determined generally by familial status e.g. spouse, spouse and dependent children, dependent parents or siblings, etc.

The specifications vary from one state to another. Thus the first step in dealing with the costs of fatal claims is to analyze the laws of the state for which rates are being estimated. Another step in the process is to decide on the simplifying assumptions that need to be made in order to make the calculations tractable.

An example of the detail that should be considered in analyzing the excess workers compensation costs for a given state is the mandates of the State of Pennsylvania. This is to be found in Appendix A.

   b. Medical Costs

It would be reasonable to think that there are probably little or no medical costs associated with a Fatal claim. However, the data sets that the author and his associates have reviewed have virtually all presented some fatal claims with related medical costs. For the majority of fatal claims the medical cost is found to be zero. However, there are medical costs associated with the other fatal claims and these seem to fall into the following categories: small, medium and very large. We speculate that the small costs are ambulance and emergency rooms fees for individuals who survive a matter of hours. The medium costs may be associated with claims where the injured party survived for a matter of days and then expired.

The very large costs were likely the result of heroic and extensive efforts to treat a very seriously injured person with the result that life was sustained for a year or

two followed by the expiration of the injured person. This last group averages over $1,000,000, but seems extremely rare.

The above view has been developed by examining claim files, discussions with claims adjusters and from conversations with others personally familiar with the details of high cost workers compensation claims

2. Permanent Total
   a. Indemnity

As in the case with fatal claims, the statutory specifications of indemnity benefits due an impaired party can be fairly complex. The general parameters are 1) the period of benefits 2) limitations and/or offsets and 3) basic percentage of wage. The period of benefits for permanent total claims in most states is lifetime. Many states mandate payment of full benefits to injured individuals as long as they survive. However in other states there are limitations or offsets most of which are associated in one way or another with Social Security. For example, some states mandate payments only until eligibility for Social Security. On the other hand some states require that the basic benefits be offset by benefits obtainable under the Disability provisions of Social Security. The offsets vary widely from state to state and can have significant impact on the cost of permanent total claims. Finally there is the question of the basic percentage. This is usually expressed as something like 66 2/3 percent of wages. However the percent is different from one state to another and may be expressed as a percent of spendable income.

Again the law of the state under consideration must be analyzed carefully. Also as is the case with fatal claims, it may be necessary to make some simplifying assumptions.

   b. Medical

Many Permanent Total claims are characterized by extremely large medical costs. Not only are the costs large but the costs seem to develop upwards throughout the life of the claim which may be on the order of several decades. Unfortunately, most data collecting agencies do not follow the development on individual claims for a sufficiently long time. This is not to be construed as criticism but rather recognizes the fact that the development in PT claims while perhaps very large for an individual claim may not contribute a significant amount of development to the overall workers compensation total loss cost. As an example, if the developed medical cost on PT's through say 10 years is 4% of the total loss cost dollar and the remaining development is 50% (probably too negative a view) then the overall pure premium might be underestimated by 2%.

However, the interest here is not in aggregates but in the size of individual claims. The data used by the author is drawn from a number of private well-maintained databases of individual workers compensation claims. In each of these, there are claims from many accident years. The open claims are developed individually. The method will be addressed in a later section. Both closed and open are then trended to the experience period. Since Permanent Total claims are rather rare it seems virtually impossible to generate a data set that can be used to provide an empirical size of loss distribution that

can be used without resorting to some smoothing. Thus, some smoothing (graduation) must be introduced before the "tail" of the distribution can be used for pricing.

3. Major Permanent Partial

It's customary in Workers Compensation data preparation to rely on "C" values to distinguish between Major Permanent Partial and Minor Permanent Partial. The problem with using this definition is that the c-values vary by state and by accident year.

The approach used here was to obtain data by state on claims designated Major Permanent Partial and to examine the characteristics of the data. This was supplemented by information drawn from Workers Compensation Loss Cost filings from New York and Pennsylvania which contain considerable detail State Workers Compensation laws were also consulted with respect to benefits provided for permanent partial.

Evaluation of this body of information led to conclusions with respect to the medical distribution and the indemnity distribution. The expected value and the range of the distribution as well as some general characteristics are discussed in the following.

a. Indemnity

The indemnity associated with a Permanent Partial claim generally depends on the type of injury. Examples of the type of injury are "Loss of a hand", "loss of an arm", "Loss of a foot", and so forth. An example of the compensation is "Loss of a hand –335 weeks". The amount of compensation is usually a percent of wage, e.g. 66 2/3 percent. As shown in Appendix A, state workers compensation law list many specific types of injury each of which entitles the injured party to a particular set of benefits.

The large number of categories alone would make modelling of the costs difficult even if there were good data on the frequency of type of injury. However this is not the case. In addition, analysis indicates that Permanent Partial claims do not contribute significantly to the overall excess costs. This is due to the fact that review of an extensive amount of data shows that, while the Permanent Partial claims are serious with a large average value, the frequency of claims in excess of say $500,000 is low and that there are also no truly catastrophic claims.

Given the above it was decided to resort to analysis of sample data to estimate the distribution of indemnity of Major Permanent Partial claims.

b. Medical

Indemnity costs on Major Permanent Partial are relatively well constrained by the limitations resulting from statutorily defined benefits. However, injuries resulting in Permanent Partial disability can result in a large range of incurred medical costs. In some cases, such as loss of a hand, the injury maybe satisfactorily treated rapidly and at a low medical cost. On the other hand there are catastrophic injuries such as severe burns or injuries to the spinal column where the injured party will require significant medical

treatment but will eventually be able to return to work. At this point it might be observed that there are some individuals who find that their quality of life is enhanced if they are able to resume some sort of gainful employment no matter how serious the injury. Thus, these individuals cannot be considered to be permanently and totally disabled.

C. Discussion of Lack of Data

It's probably worthwhile at this point to recall that the objective is to determine rates for excess workers compensation coverages. Thus by far the largest number of claims incurred under Workers Compensation coverages are, by definition, of no interest. For example, consider the following data extracted from a Pennsylvania Compensation Rating Bureau Loss Cost filing.

Table 1
Ultimate Number of Injuries

| Period | Fatal | Permanent Total | Major Permanent Partial | Minor Permanent Partial | Temporary Total |
|---|---|---|---|---|---|
| 1991 | 150 | 207 | 2480 | 3411 | 39,571 |
| 1992 | 167 | 205 | 2449 | 3375 | 39,124 |
| 1993 | 132 | 201 | 2393 | 3304 | 38,154 |
| 1994 | 163 | 203 | 2394 | 3308 | 38,093 |
| 1995 | 110 | 211 | 2449 | 3406 | 39,004 |
| | 722 | 1,027 | 12,165 | 16,804 | 193,946 |

From the point of view of credibility standards, it can be seen that there are insufficient claims of the type of interest for rate making purposes even if the claims were restricted to basic limits as found in other lines of business. Of course as previously mentioned the size of some of the claims encountered in Statutory Workers Comp range up to $20 million. While it would be interesting to determine the number of claims necessary for full credibility on claims of this size the knowledge gained is probably not worth the effort. However, we suspect that it is well in excess of all the claims of the size under consideration that are incurred in the United States in the span of a decade. Thus the answer is irrelevant since the number required exceeds the number available. Therefore it is necessary to develop an approach that circumvents this lack of data.

Excess Workers comp rates are needed by state since the statutory benefits vary by state with respect to the indemnity portion of the claim. This compounds the data availability problem in that a smaller number of claims are available in a given jurisdiction. Also whereas relatively large states like Pennsylvania and Texas which have respective populations of approximately 12 million and 17 million might have enough claims to provide basis for a reasobably accurate estimate, the problem of constructing rates for states like Iowa and Oregon with populations of approximately 3 million each remains.

Another issue that surfaced in the process of the construction of the rates is that the indemnity portions of the serious workers compensation claim develops much differently from the medical portion of the claim. The data in the table below has been generated by using data drawn from a recent Pennsylvania Loss Cost filing to demonstrate that the indemnity costs develop much more rapidly that medical costs. This stands to reason. Consider a typical Permanent Total claim. Within a matter of five to ten years it should be certain that the claimant is entitled to Permanent Total benefits. At this point, the cost of the indemnity portion of the claim has been precisely determined. However the medical costs are a function of how well the claimant responds to treatment, indicated alternative treatment paths that emerge, new developments in medical care and so forth.

Required Reserve/
Current Reserve

| Period | Medical | Indemnity |
|---|---|---|
| 12 months | 2.8180 | 3.6879 |
| 24 months | 2.6563 | 2.3059 |
| 36 months | 2.7917 | 1.6556 |
| 48 months | 2.8603 | 1.3140 |
| 60 months | 3.1292 | 1.1207 |
| 72 months | 3.2063 | 1.0000 * |

*approximate

The above suggests that applying a single development factor to the total of indemnity and medical will likely produce less satisfactory results than the process of applying development factors separately if possible or avoiding the use of development factors if feasible.

Another aspect of the data problem is the question of combining data from different states. Because the indemnity benefits (which account for about 50% of Major Permanent Partial and 2/3 of Permanent Total costs) vary so significantly from one state to another as a result of offsets, limitations, etc not to mention escalation it was decided that the approach that would produce the most accurate results would be to estimate the indemnity costs by state if at all possible.

On the other hand medical costs are not statutorily determined. While costs of some of the more minor aspects of medical care such as bandages, splints, emergency room costs probably display regional variations, the larger dollar costs such as treatment at national burn care units or spinal treatment centers demonstrate more homogeneity than indemnity. In addition the treatment proposed for estimating state indemnity costs has no analogue for medical cost.

The above characteristics of serious workers compensation claims: low frequency, high severity, different types of development for component costs and lack of comparability of cost from state to state led to the solution proposed on the next section.

## II. General Approach to Solution of Estimating Excess Workers Compensation Costs

### A. Outline of Basic Solution

The basic solution to modeling the distribution of costs of large claims consists of two steps. The first step was to create a distribution of costs for each type of serious claim: Fatal, Permanent Total and Major Permanent partial. This step required the creation of separate of distributions for indemnity and medical. These distributions were then used to create a joint distribution for each of the type of claims. Excess cost factors are then generated for each type of claim.

The second step was to determine the portion of the pure premium that is Fatal, Permanent Total or Major Permanent Partial and then weight the excess factors of the individual components.

The statement of the solution is fairly simple. However, the physical execution of it is not. For example, given the above, the number of cost outcomes or cells for Permanent Total Costs is numbered in the millions using an approximating method of calculating the costs. Essentially what is determined is the frequency function CPT (m,w,a,l) where m is medical cost, w is wage, a is age at time of injury and l is the number of years lived after the injury. The distribution of the costs of fatal claims CF(m,w,a,l) is calculated in a similar manner. The cost distribution for Major Permanent Partial is obtained in a slightly different manner. One component is the medical cost. The other is the indemnity. However the awards are not so life or age dependent since there are certain lump sums statutorily provided for regardless of age or wage. Thus for this type of injury the distribution of indemnity is determined from a statistical sample. The compound distribution of costs is denoted CMPP(m, I).

For a given retention, R, the excess costs as a percentage of total costs are obtained by type of injury for a given state. These percents are then weighted by the percent of the pure premium ascribable to that type of injury. For example, suppose the retention for State G is 500,000. Further suppose that 58.8% of total PT costs are excess 500,000; 2.48% of total Fatal costs are excess 500,000 and 3.36% of Major Permanent Partial are excess 500,000. Also suppose that 12.2% of the pure premium (loss cost only) is the cost of PT's, 3.1% is the Fatal cost and 63.3% is the Major PP cost with 21.2% of loss costs attributable to other types of injuries.

Then the excess factor for 500,000
is (58.8%)(12.2%)+(2.48%)(3.1%)+(3.36%)(63.3%) = 9.38%

The problem to be solved, the difficulties, motivation and methodology have been outlined above. What follows are some examples that are designed to assist in the understanding of the methodology.

B. Examples

1. Example #1

In this example it is assumed that there are three types of claims which account collectively for all the incurred loss. The goal is to determine that excess costs for an attachment point of $500,000. Each type of claim is comprised of two components. The components are considered to be independent. The distribution of the components of each type of claim are given in the tables below.

Claim Type 1

| Component A(1) | | Component B(1) | |
|---|---|---|---|
| Amount | Prob. | Amount | Prob. |
| 100,000 | 6.0% | 150,000 | 8.0% |
| 150,000 | 8.0% | 225000 | 9.0% |
| 200,000 | 9.0% | 300000 | 12.0% |
| 250,000 | 10.0% | 375,000 | 14.0% |
| 300,000 | 12.0% | 450,000 | 18.0% |
| 350,000 | 14.0% | 525,000 | 16.0% |
| 400,000 | 16.0% | 600,000 | 14.0% |
| 450,000 | 11.0% | 1000000 | 6.0% |
| 500,000 | 9.0% | 1500000 | 2.0% |
| 550,000 | 5.0% | 2,000,000 | 1.0% |

Claim Type 2

| Component A(2) | | Component B(2) | |
|---|---|---|---|
| Amount | Prob. | Amount | Prob. |
| 25,000 | 2.0% | 50,000 | 4.0% |
| 75,000 | 3.0% | 100,000 | 6.0% |
| 125,000 | 5.0% | 150,000 | 10.0% |
| 175,000 | 15.0% | 200,000 | 12.0% |
| 225,000 | 25.0% | 250,000 | 18.0% |
| 275,000 | 25.0% | 300,000 | 18.0% |
| 325,000 | 15.0% | 350,000 | 12.0% |
| 375,000 | 5.0% | 400,000 | 10.0% |
| 425,000 | 3.0% | 450,000 | 6.0% |
| 475,000 | 2.0% | 500,000 | 4.0% |

Claim Type 3

| Component A(3) | | Component B(3) | |
|---|---|---|---|
| Amount | Prob. | Amount | Prob. |
| 0 | 85.0% | 200,000 | 8.0% |
| 50,000 | 10.0% | 250,000 | 9.0% |
| 100,000 | 4.0% | 300,000 | 10.0% |
| 500,000 | 1.0% | 350,000 | 11.0% |
| | | 400,000 | 12.0% |
| | | 450,000 | 12.0% |
| | | 500,000 | 11.0% |
| | | 550,000 | 10.0% |
| | | 600,000 | 9.0% |
| | | 650,000 | 8.0% |

If a joint distribution is created for each type of claim and the excess of 500,000 percent is calculated for each, the excess percent is as shown in the following table.

Excess Cost

| Claim Type | Prcnt. |
|---|---|
| #1 | 39.50% |
| #2 | 13.40% |
| #3 | 7.70% |

Further assume that percent of the pure premium is known to be distributed as follows

Distribution of Loss Cost

| Claim Type | Prcnt. |
|---|---|
| #1 | 5.2% |
| #2 | 71.3% |
| #3 | 23.5% |

Then the percent of the cost excess 500,000 is calculated as
(39.5%)(5.2%)+(13.4%)(71.3%)+(7.7%)(23.5%) = 16.55%

2. Example #2

This example illustrates some of the calculations involved in estimating the distribution of costs for Fatal claims. In order to estimate the distribution of indemnity costs for a fatal claim a number of parameters need to be specified. These are as follows:

a. Wage Distribution

| Ratio AWW to SAWW* | Percent Workers Earning AWW |
|---|---|
| 0.30 | 5.0% |
| 0.60 | 30.0% |
| 1.00 | 40.0% |
| 1.35 | 10.0% |
| 1.50 | 15.0% |

*AWW = Average Weekly Wage, SAWW = State Average Weekly Wage

b. State Average Weekly Wage

SAWW = $600

c. Distribution of Ages at time of death

| Age | Percent of Workers at Age |
|---|---|
| 20 | 20.0% |
| 30 | 20.0% |
| 40 | 20.0% |
| 50 | 20.0% |
| 60 | 20.0% |

d. Benefit Assumptions

Surviving spouse receives 66 2/3% of wage at time of death.

Maximum = 100% SAWW
Minimum = 20% SAWW

e. Life Table

US Life Table – 1980
See Appendix B.

f. Distribution of Indemnity Costs

Given data in a., b., d., and e. above the distribution of indemnity costs for fatalities suffered by individuals aged 40 is as given in the following table.

Distribution of
Indemnity Costs
at Age 40

| Group | Probability | Amount | Group | Probability | Amount |
|---|---|---|---|---|---|
| G1 | 1.78% | 60,545 | G13 | 3.65% | 1,245,619 |
| G2 | 3.88% | 158,419 | G14 | 2.54% | 1,343,204 |
| G3 | 6.76% | 256,890 | G15 | 2.80% | 1,447,386 |
| G4 | 7.94% | 354,637 | G16 | 1.59% | 1,553,684 |
| G5 | 9.89% | 458,065 | G17 | 1.15% | 1,646,886 |
| G6 | 11.19% | 554,423 | G18 | 0.64% | 1,743,391 |
| G7 | 10.20% | 647,978 | G19 | 0.30% | 1,836,176 |
| G8 | 7.89% | 748,037 | G20 | 0.15% | 1,938,251 |
| G9 | 7.96% | 854,019 | G21 | 0.03% | 2,051,441 |
| G10 | 8.30% | 955,471 | G22 | 0.01% | 2,144,589 |
| G11 | 6.21% | 1,051,717 | G23 | 0.003% | 2,215,200 |
| G12 | 5.10% | 1,144,313 | | | |

The figures in the above table were obtained by first calculating the costs for each individual cell. For example, suppose a fatally injured worker was earning $810 per week. Then the surviving spouse's weekly benefits would be (662/3%)($810) = $540 or an annual amount of $28,080. Also assume that the spouse receives benefits for exactly twenty years and then dies. The amount received is (20)($28,080) = $561,600 and the probability of this event is (10%)((84,789 - 83,726)/94,926) = .112% (see wage distribution and Appendix B). The outcomes were then grouped into intervals of $100,000. The outcome of the above described event would fall into group G6.

A graph of the distribution of indemnity costs for a person age 40 is shown in Figure #1. This is followed by a graph of the distribution of costs for a person age 30 in Figure #2.

A few things should be noted about the two graphs. One is that the distribution of costs in the age 30 graph is somewhat to the right of the age 40 distribution. This would be intuitively expected since the individuals age 30 at time of death would provide about an additional 10 years of benefits to their survivors.

Figure #1

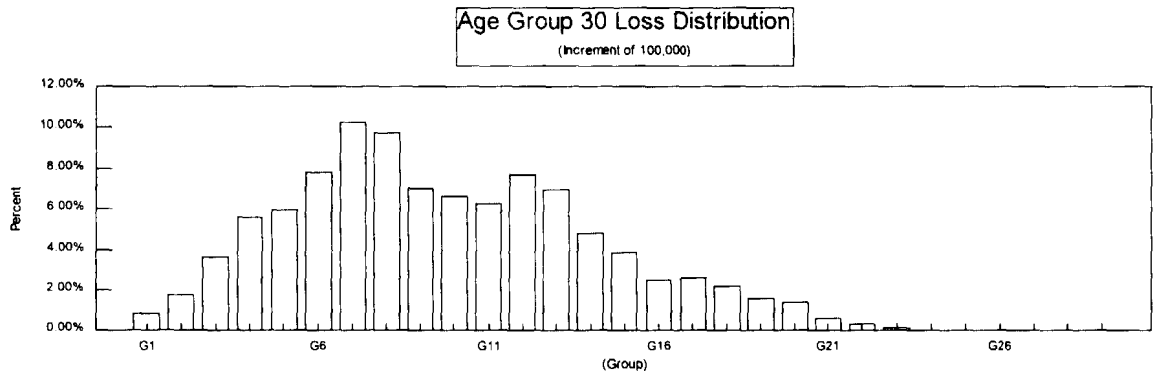
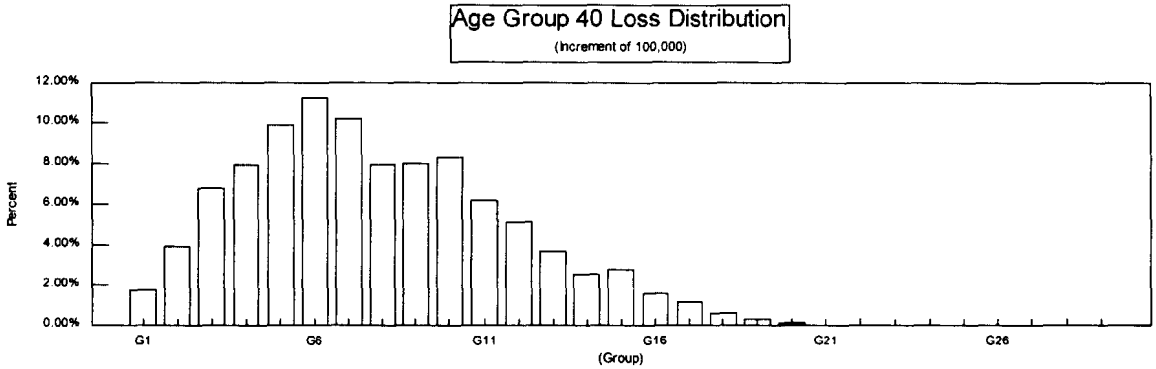

Age Group 30 Loss Distribution
(Increment of 100,000)
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Percent
G1
G6
G11
G16
G21
G26
(Group)

Figure #2


Age Group 40 Loss Distribution
(Increment of 100,000)
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Percent
G1
G6
G11
G16
G21
G26
(Group)

It's also interesting to note that both of the distributions are somewhat "lumpy". The distributions have been created from a life table which is fairly smooth, and the combination of a wage distribution and certain benefits assumptions.

It seems that the fact that the wage distribution shows an uneven distribution of wages and the statutory benefits display certain maximums and minimums is the cause of the unevenness. Thus it is doubtful that there is any existing statistical distribution currently widely used that would fit these curves.

The graph in Figure 3 shows the distribution of costs for all ages 20 through 60. Note that some of the "lumpiness" still remains. The right hand portion of the graph is of greatest concern to excess reinsurers and it is important to test the assumptions that go into the creation of this tail.

The medical costs are assumed to be distributed as follows

Fatal Medical
Distribution

| Amount | Probability |
|---|---|
| $0 | 99.0% |
| $100,000 | 0.75% |
| $1,000,000 | 0.25% |

When a joint distribution is created using the above distribution and the distribution of indemnity costs shown in Figure 3, the distribution shown in Figure 4 is obtained.

The distribution of loss and medical combined is presented in numerical form in Appendix C. The percent of costs excess $500,000 is found to be 43.08%. The interested reader with access to a spreadsheet should be able to duplicate these results.

III. Claim Characteristics, Details and Considerations

A. General Remarks

Previously the three types of claims that needed to be considered were discussed in very general terms. However, as noted earlier, changes in estimates that are small relative to ground up costs can be large with respect to Excess costs. Thus it is necessary to analyze the characteristics of these claims and contributions to the costs in a fair amount of detail. A detailed explanation of some of the cost characteristics and variation by state follows.

Figure #3

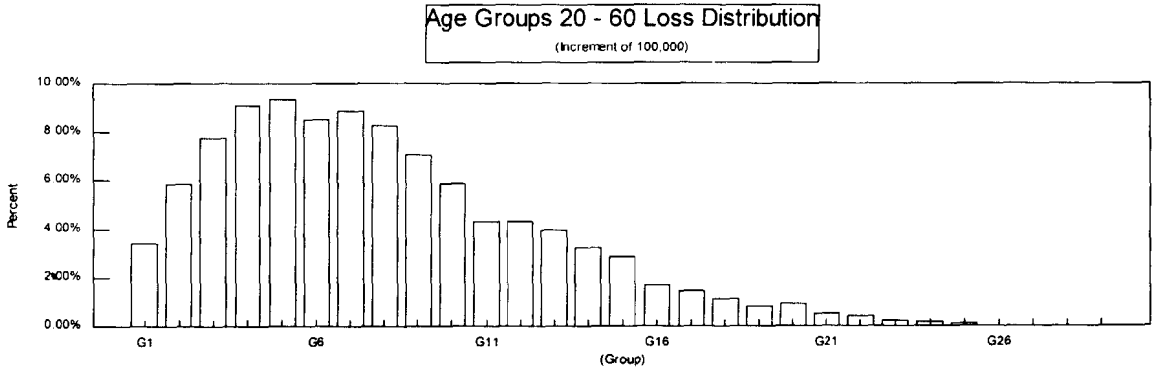
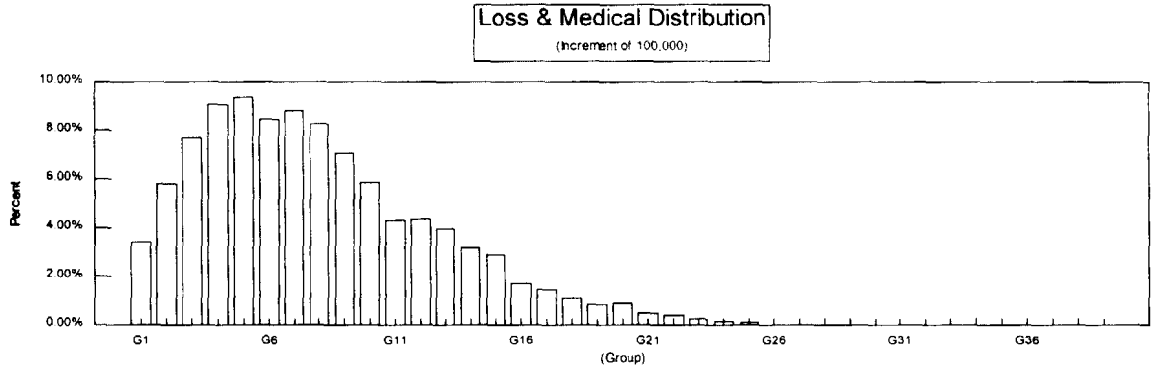

Age Groups 20 - 60 Loss Distribution
(Increment of 100,000)
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Percent
G1
G6
G11
G16
G21
G26
(Group)

Figure #4


Loss & Medical Distribution
(Increment of 100,000)
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Percent
G1
G6
G11
G16
G21
G26
G31
G36
(Group)

B. Permanent Total

1. Medical

a. Comments/Range of Amounts

As mentioned previously it is difficult to obtain a single body of data that is sufficiently large and reasonably error free to be used in this process. Claims up to $20 million have been observed in the industry and it is thus reasonable to construct a distribution that accommodates claim costs of this amount even though the data on hand may not contain a claim of that size.

On the other end of the spectrum, ultimate incurred medical amounts that are less than $25,000 have been observed. This is difficult to explain. However, it has been suggested the accidents that are disabling such as blinding might be one explanation. Another is that some states have customarily awarded permanent total status for what seems to be minimal injuries. An example of this is an actual case where permanent total disability was awarded for tendinitis of the elbow. The medical costs of treating an injury of this type would be expected to be nominal.

Intuitively, the data may not be satisfying but given that the same thing is shown in several data sets it is reasonable to accept the indications.

b. Data/Quality, Amount, Culling

Given some of the observations above, it was found necessary to thoroughly review data sets almost on a claim by claim basis to eliminate claims which for one reason or another seem to have been erroneously included. For example claims whose incurred medical was below a certain cutoff point as of a given time e.g. two years after the date of accident were excluded. Also claims that demonstrated incurred medical but no indemnity were excluded. Other filtering protocols were also employed that resulted in data set felt to be free of at least obvious errors.

c. Development

Having cleaned up the data as much as possible the next step taken was to project individual costs to ultimate. At this point the only type of costs under discussion are the medical incurred amounts. Data was drawn from a recent Pennsylvania Loss Cost filing was used to develop the estimates in the following table.

| Period | Case Res. Devl. Factor | Period | Case Res. Devl. Factor | Period | Case Res. Devl. Factor |
|---|---|---|---|---|---|
| 12 mos. | 2.82 | 84 mos. | 3.26 | 156 mos. | 2.61 |
| 24 mos. | 2.66 | 96 mos. | 3.42 | 168 mos. | 2.39 |
| 36 mos. | 2.79 | 108 mos. | 3.37 | 180 mos. | 2.20 |
| 48 mos. | 2.86 | 120 mos. | 3.02 | 192 mos. | 1.90 |
| 60 mos. | 3.13 | 132 mos. | 2.84 | 204 mos. | 1.81 |
| 72 mos. | 3.21 | 144 mos. | 2.70 | | |

These factors are applied to the case reserves on individual open claims where the factors are selected according to the accident year of the claim. For example, suppose the year in which the data is being analyzed is 1999 and the accident year is 1992. Also assume that the undeveloped medical incurred is $272,312 where paid = $118,705. Then the ultimate medical incurred is (3.26)(153,607)+118,705 = 619,464.

This method sometimes will produce ultimate values that seem unreasonable and in that case judgement may have to be employed to temper the results.

d. Trending

The next step is to trend the cost on individual claims up to the current date. A good source of data for this purpose that is easily accessible is the Bureau of Labor Statistics. The web site address is www.bls.org. The medical increases for the last 10 years have been in the 3+% range.

After bringing the costs up to current level the costs are then projected to the middle of the period for which the rate will be applicable. Use of a future trend factor of approximately 3.5% at the writing of this paper seems reasonable.

e. Statistical Modeling

In previous applications of this method it has been found that the data even after the previously described adjustments is not smooth enough over various intervals to be used immediately. In particular it is often the case that there are ranges of several million dollars where there are no claims. Conversely – but occurring less often – there are instances when a fairly narrow interval might include two or more fairly large claims. "Fairly large" as used in this context means over 5 million.

Because of the large range of values and the characteristics of various types of medical claims associated with Permanent Total claims there is no reason to expect that any known statistical distribution will describe the distribution of medical claims. This is especially true with respect to

fitting a single curve over the whole range of values. Some fitting over limited ranges may seem workable but the benefits seem questionable.

One well known curve that initially seemed appealing was the log-normal curve. However when a goodness of fit test was used (Komolgorov-Smirnov) on a medium size set of data the results were found to be inconclusive. Later when testing on a much larger body of data it become clear that the test results were indicating that it was unlikely that the data was generated as a sample from a log-normal distribution.

The solution adopted was to simply use the data as a foundation for an empirical curve. Before final construction of the curve, smoothing was conducted over consecutive intervals. A facsimile of the final curve is shown in Figures 5a-f.

2. Indemnity

a. Sampling vs. Modeling?

As indicated previously the objective of modeling of this component of the claim cost is to avoid estimation based on sampling of claims. In the case of the medical portion the nature of the actual causative mechanism is unknown. Thus it is necessary to resort to samples. However, that is not necessary with respect to indemnity and it was felt that a model could be constructed to estimate the costs with the resulting estimates possessing significantly less error than estimates produced by a sampling procedure.

b. Use of Statutorily Mandated Benefits

(1) Variation by State

Indemnity benefits vary by state with parameters associated with each of the following items displaying differences from one state to another.

(a) Function of Average Weekly Wage of Injured Individual

Most states define that indemnity benefits as a percent of wages. E.g. Alabama-66 2/3%; Georgia-66 2/3%; Idaho-67%; and so forth. However other states use different measures. E.g. Connecticut-75% of after tax income; Iowa-80% of spendable earnings; Michigan-80% of spendable earnings; Maine-80% of after tax AWW, etc. In addition, there are a few other states with somewhat more complex rules.

(b) Maximum and Minimums

As in the above states display differences in the Maximum indemnity awards. Most states define the maximum in terms of the state average weekly wage. For example, Alabama-100% SAWW; Colorado-91%

SAWW; Florida-100% SAWW; Iowa-200% SAWW Mississippi-66 2/3% SAWW. The maximum for New York is a dollar amount = $400.

Minimum show similar variations. Alabama-27.5% SAWW; Idaho 45% SAWW; Illinois-50% SAWW; Louisiana 20% SAWW; Michigan 25% SAWW etc. It should be noted here that there seems to be more variations in the Minimum than the Maximums. Many states have dollar amount minimums.

(c) Limits

In addition to the specifications in (1) and (2) above some states have limits specified in either time and/or amounts. Usually when there are limits these are expressed in both time and amounts. For example, South Carolina-500 weeks, $241,735; Mississippi-450 weeks, $131,787. For the most part however, the benefits are granted for life, although some states have offsets and other types of limitations that are discussed in the next section.

(d) Offsets

Some states have introduced Offsets and this trend has continued into the present time. For example: Arkansas-Reduce PP 50% of non-employee portion of public/private funded retirement/pension plan of 65 years or older; Colorado-Social Security, unemployment compensation, an employer-paid pension plan; Michigan-Disability, unemployment compensation, pension, old age Social Security retirement; New Jersey-Social Security; Pennsylvania-unemployment compensation, Social Security Old Age and certain severance and pension payments.

These offsets can be difficult to evaluate due to the vagueness of summaries of the law which are to be found in the most often used reference documents. However each state has contacts that will attempt to answer the questions. It must be kept in mind though that sometimes the answers are not correct with the implication that more than one source should be used if possible.

(e) Escalation

In most states the amount of weekly indemnity payable is determined close to the time of injury and remains at that level as along as payments are made. However some states mandate escalating benefits during part or all of the payment period. For example Florida requires escalation at 5% per year for 10 years with the escalation being an arithmetic increase, rather than a geometric increase. Connecticut and

Massachusetts mandate escalation tied to the CPI but limited to 5% in Massachusetts. Nevada's benefits are increased by an amount equal to the change in the SAWW.

(2) Estimation of Parameters by State

(a) Wage/Benefit Distribution

As an example of the way the distribution of benefits is calculated, the following is presented. It's assumed in the state of interest that the minimum benefit is 20% of the SAWW and that the maximum is 100% of the SAWW. Wage distribution data was obtained from the NCCI and the following table created

Wage Distribution

| Wage Group | Wtd Avg | Wage Dist. | Wage Group | Wtd Avg. | Wage Dist. |
|---|---|---|---|---|---|
| 1 | 0.300 | 4.1% | 13 | 0.943 | 4.2% |
| 2 | 0.354 | 1.9% | 14 | 0.995 | 3.8% |
| 3 | 0.411 | 2.8% | 15 | 1.043 | 3.5% |
| 4 | 0.460 | 4.3% | 16 | 1.092 | 3.3% |
| 5 | 0.518 | 4.6% | 17 | 1.140 | 2.9% |
| 6 | 0.566 | 4.8% | 18 | 1.210 | 2.8% |
| 7 | 0.625 | 5.3% | 19 | 1.249 | 2.6% |
| 8 | 0.672 | 5.1% | 20 | 1.310 | 2.5% |
| 9 | 0.732 | 5.0% | 21 | 1.352 | 2.3% |
| 10 | 0.783 | 4.9% | 22 | 1.410 | 2.0% |
| 11 | 0.836 | 4.8% | 23 | 1.454 | 1.9% |
| 12 | 0.891 | 4.6% | 24 | 1.500 | 16.0% |

If it is assumed that the SAWW is 600 and the benefit 66 2/3% times AWW, then the figures in the Wtd. Avg. column should be multiplied by 400 producing the following table.

Benefit Distribution

| Wage Group | Wtd Avg | Wage Dist. | Wage Group | Wtd Avg | Wage Dist. |
|---|---|---|---|---|---|
| 1 | $120.00 | 4.1% | 13 | $377.20 | 4.2% |
| 2 | 141.60 | 1.9% | 14 | 398.00 | 3.8% |
| 3 | 164.60 | 2.8% | 15 | 417.20 | 3.5% |
| 4 | 184.00 | 4.3% | 16 | 436.80 | 3.3% |
| 5 | 207.20 | 4.6% | 17 | 456.00 | 2.9% |
| 6 | 226.40 | 4.8% | 18 | 484.00 | 2.8% |
| 7 | 250.00 | 5.3% | 19 | 499.60 | 2.6% |
| 8 | 268.80 | 5.1% | 20 | 524.00 | 2.5% |
| 9 | 292.80 | 5.0% | 21 | 540.80 | 2.3% |
| 10 | 313.20 | 4.9% | 22 | 564.00 | 2.0% |
| 11 | 334.40 | 4.8% | 23 | 581.60 | 1.9% |
| 12 | 356.40 | 4.6% | 24 | 600.00 | 16.0% |

This is one of the building blocks of the excess costs.

(b) Age

It would obviously be very cumbersome to calculate the benefits by wage group across all working ages and then to compound the amounts with amounts from a medical distribution whose approximate range is 0-20 million. On the other hand it would be a mistake to oversimplify and, perhaps, chose as an average age of all workers, say 40 years.

The protocol outlined on this paper is to assume that some workers are age 20 at time of injury, some 25 and so forth in five-year intervals up to age 60. This makes the number of ages more manageable and it seems, through some research and analysis, still provides a good estimate of the costs.

(c) Life Tables

The life tables used in these calculations are the tables from the 1979-1981 experience period and is total population. Thus, it includes males, females and all races. This is obtainable from the Center for Disease Control and can be downloaded from their website.

Theses tables are used based on the assumption that the U.S. work force has the same proportions of men and women as does the general population. Another assumption implicitly made here is that men and women have equal exposure to serious injury.

It could and has been argued extensively that for Permanent Total injuries, or at least certain subsets, an impaired life table should be used. However medical care today has advanced to the point that even

very seriously injured individuals can expect a normal life span. The NCCI undertook a study of impaired lives fairly recently (within the last 10 years) and published a life table based on the study. Review of that table did not offer convincing evidence that other than the total U. S. population should be used

(d) Offsets

It should be noted that the Florida benefit law is being used as an example here in the discussion of "offsets" and the analysis of these benefits should not be construed as applying to any other state. The law of each state must be analyzed on its own. Under Florida law the sum of benefits from both Social Security and the State (Workers Comp) is limited to 80% of ACE (Adjusted Current Earnings). It is assumed in this example that the individual is earning $475.00 per week. Also assume for the sake of specificity that the year of the accident is the year 2000. A simplifying assumption used at this point is that the ACE for this individual in the year 2000 is $475.

Next the Social Security benefits for the disabled workers must be estimated. The benefits are based on earnings through the previous year and hence the earnings are adjusted back to 1999. We then estimate the Social Security benefit based on that number and using the Social Security benefit structure. (This can be obtained form the Social Security benefit website). In this case, the Social Security benefits are found to be $210.34 per week.

The next step is to estimate the benefit under Workers Comp. Since the individual is earning $475 per week and the benefit is awarded at 2/3 AWW the benefit is $316.67 per week. The sum of the Social Security Benefit and the Workers Comp benefit is $527.01 which exceeds 80% of $475 by $147.01. This amount is the "Offset". Thus the Workers Comp benefits are reduced from $316.67 per week to $169.66. This leaves the sum at $380.00 = (.8)(ACE).

It should also be noted at this point that Florida provides for escalating benefits for a period. The interpretation of this part of the law made here is that the 5% increase applies to the amount $169.66.

The law in Florida operates in the above described ways since by agreement with the Social Security Administration, Social Security "pays first". It should be noted that the agreements have been worked out on a state-by-state basis.

(e) State Average Weekly Wage

Since rates are made to be effective for some period in the future historical information must be trended to that period. When a history of State Average Weekly Wage is available, this is used to trend to the rate effective period. An example of this is given in the following table.

Statewide Average Weekly Wage
-Maximum Weekly Benefit-
(Massachusetts)

| | |
|---|---|
| 10/1/97-9/30/98 | $665.55 |
| 10/1/96-9/30/97 | $631.03 |
| 10/1/95-9/30/96 | $604.03 |
| 10/1/94-9/30/95 | $585.66 |
| 10/1/93-9/30/94 | $565.94 |
| 10/1/92-9/30/93 | $543.30 |
| 10/1/91-9/30/92 | $515.52 |

This is taken from the Commerce Clearing House publication "Workers Compensation".

If this type of information is not available, the NCCI Statistical Bulletin can be used in conjunction with wage increase information obtainable form the Bureau of Labor Statistics.

C. Fatal

1. Medical

As noted earlier most Fatal claims do not have any medical cost associated with them. However some Fatal claims do display medical costs in small, medium or even large amounts. The average cost of the medical on Fatal claims is very, very small in comparison to the indemnity costs. However the task here is to estimate the Excess costs and thus the medical costs although small in relation to first dollar costs can add significantly to Excess costs. This is especially true when the Fatal benefits are extremely limited as in Florida where Fatal benefits are limited to $100,000.

The distribution generated for use in this methodology looks something like the following

Fatal Medical
Distribution

| Amount | Probability |
|---|---|
| $0 | 95.0% |
| $500 | 4.0% |
| $100,000 | 0.7% |
| $1,500,000 | 0.3% |

2. Indemnity

As in the case of Permanent Total injuries it was decided during the development of this methodology that the best estimate of the distribution of indemnity costs incurred on Fatal claims would be produced by starting with an analysis of the Statutory mandated benefits. A discussion of the components of these awards following.

a. Age

It assumed here that the ages of workers was uniformly distributed and that the propensity to suffer a fatality was the same at each age. It must be noted here that this is a simplifying assumption. There is some data available that would indicate that the frequency of mortality is slightly higher for workers in their twenties than for workers at higher ages. It has been speculated that this is a result of young workers either not having been fully trained in safety procedures, simply lacking experience, being either more inclined to take risks or being less careful. It should be mentioned here that similar data indicates that workers between fifty and sixty are more inclined to suffer permanent total injuries than younger workers. In this case it has been speculated that older workers are simply less physically fit than younger workers with the following implications. The first is that the execution of a particular task is more likely to result in an injury to an older worker than a younger worker e.g. lifting an object weighing 70 pounds. The second is that, given a particular injury, it may be that a younger worker would have a propensity to heal more quickly and completely than an older worker. These considerations have not been incorporated into the model due to the lack of a highly reliable database.

However the actuary should make an effort to be aware of this and other types of information which are difficult to quantify but which would affect the underlying risk. This naturally should be communicated to any underwriter with whom the actuary might be working on this type of risk.

In order to perform the calculations it is necessary to assume a certain age or potential ages of the deceased worker. As is the case with Permanent Total claims discussed previously the assumption used here is that the worker's age at time of death was either 20, 25, ...., up to 60.

b. Wage

The starting point in determining the benefits to the primary dependent (usually the spouse) of a deceased worker is usually weekly wages (occasionally "spendable income" or "after tax income"). About 40% of the state have limitations in either time or amount. For the rest, the cost of the benefits are estimated by first constructing a distribution of wages in a given state. Use of the same method as outlined in Section II B 2b. (2)(a) [Permanent Total Indemnity] can be used here.

c. Percent Award

There are a variety of benefit awards depending upon whether or not there is a spouse, whether there are "school age" children and upon the existence and dependency of others, e.g. parents, siblings. The "school age" above is in quotes since the specific maximum age for a school age child varies by state except for a few states where there is actually no age limit. For example in New York the Percent of Wages is
a) Spouse Plus Children – 66 2/3,
b) Spouse Only –66 2/3,
c) One Child Only-66 2/3
while in Oklahoma the Percent of Wages is
a) Spouse Plus Children – 100%,
b) Spouse Only – 70%,
c) One Child Only – 50%

In addition there are variations such as the spouse's percentage increasing to a higher number after the children have left school. There are also lump sum payments to the spouse and/or children as well as funeral expenses and burial expenses.

Given the above it seems reasonable to select a conservative but uncomplicated approximate level of benefits. For example, in the case of Oklahoma cited above if we assume that at the time of death there is a surviving spouse and two children aged 9 and 12 then the payments are 100% for 11 years (23 maximum if in school), 85% for the next 3 years and 70% thereafter. In order to simplify the calculations, it seems reasonable to simply assume level payments at 80% for life.

d. Maximum, Minimum

Weekly fatality benefits are limited as is the case for Permanent Total. Usually the maximum and minimum can be shown to be a function of the SAWW. However benefits to children may cause some small exceptions. These limitations play a significant role when the benefits are payable for life but are not nearly as important when there are time or amount limitations. For example consider Florida where the limitation on Fatal benefits is $100,000.

The maximum weekly benefit in Florida is $522 per week. Thus the length of payments is about 3.7 years. If the weekly maximum was 50% higher the length of the payments would be about 2.5 years and if 50% lower, the length would be about 5.5 years. Thus the average point of payment would be either 1.85 years, 1.25 years or 2.75 years with the difference between any of these being no more than a year and a half. This is insignificant from the point of view of the time value of money and for excess rating purposes.

e. Offset, Limitation

(1) Offsets

Some states have Social Security offsets. Examples are Connecticut, District of Columbia, New York and Utah. The offsets for Fatal benefits are generally somewhat more complex that the offsets for Permanent Total Benefits. For example the New York law specifies "Where the death occurs on or after January 1, 1978 and the spouse is receiving benefits under the social security act for each $10 of the deceased average weekly wage in excess of $100, but in no case may the reduction exceed 50 percent of the spouse's share of the social security benefits.

- Average weekly wage over $100 up to and including $110, five percent;
- Average weekly wage over $110 up to and including $120, ten percent;

•
•
•

- Average weekly wage over $190 up to and including $190, forty five percent;
- Average weekly wage over $200 up to and including $110, fifty percent;

(2) Limitations

As noted previously about 40% of the states have some sort of aggregate limitation on the amount of Fatal benefit payments. For example California's limit on Fatal benefits is $125,000 ($160,000 if children), Florida's limit is $100,000, the Kansas limit is $200,000 and Texas limit $206,000. Other states have limits expressed in weeks. For example the Georgia limit is 400 weeks (or to age 65); the Idaho limit is 500 weeks; Illinois' limit is 20 years at TT rate whichever is greater), Virginia is 500 weeks and so forth.

It should be noted that any or all of these limitations can change in any year. Anyone employing the outlined method should consult the law or summaries of the law in specific states to determine the most current statutory limitations on benefits.

Escalation

A few states still mandate escalating benefits for fatal claim benefits. Most of these are in the Northeast e.g. Connecticut, Massachusetts and Rhode Island. It goes almost without saying that escalation is a major component costs. States with this type of benefit will exhibit the highest excess cost for workers compensation.

g. Mortality Table

As is the case with Permanent Total claims the life tables used in these calculations are the tables from the 1979-1981 U.S. experience and is derived from total population statistics. The implicit assumption made here is that men and women suffer fatalities equally in the workplace. This is probably not a precisely correct assumption and it has been speculated that perhaps the mortality rate is higher for men since men engage in inherently more hazardous work e.g. contracting, roofing, logging and fishing. However a considerable number of women drive or ride in vehicles as part of the job and many of the fatalities experienced in the course of work result from vehicle accidents. Whatever the true exposure, the unavailability of good data makes attempts to measure the mix of male and females with respect to fatal claims somewhat impractical. It should also be noted that use of an "all lives" mortality table when most of the workers compensation. fatalities are men adds a degree of conservatism. It might be noted here that in developing this methodology many similar decision points were encountered and the decision was made to make

conservative selections due to the large degree of risk taken in underwriting an excess workers comp program.

Finally it should be noted that spouse's benefits generally cease upon remarriage and that a lump sum benefit is paid at this point. In an ideal world this might reduce the costs of the benefits somewhat. However because of changing options available to survivors, availability of remunerative work and other considerations and because of the lack of availability of reliable remarriage tables it was decided to ignore this feature of the workers comp benefit laws and thus add another bit of conservatism to the estimate.

D. Major Permanent Partial

1. Medical

a. Source of Data

Data on Major Permanent Partial claims can be obtained from the NCCI, actuarial consulting firms, large primary carriers with substantial books of workers compensation or perhaps other rating bureaus such as the PCRB or the NYCIRB.

Large established casualty reinsurers usually also have substantial databases on excess workers comp losses that they usually regard as proprietary. However reinsurer databases often suffer from two problems. One is that retentions have shifted dramatically over the years with the result that it is difficult to combine data from various years. In addition, information on serious claims that only presents part of the picture can be misleading. That is, trying to estimate the distribution of all Major Permanent Partial claims from a group of claims that have pierced a particular retention is significantly more difficult than working with the totality of this type of claim. And in order to use the methodology outlined in this paper, the entire distribution is needed.

b. Range of Amounts

It was mentioned earlier that the range of the medical costs associated with this type of injury can be surprisingly large. Some databases that we were able to access displayed claims whose maximum incurred medical was not much over $500,000. But other databases presented claims in the multiple millions of dollars. Serious injuries such as damage to the spinal column, severe burns requiring extensive reconstructive surgery and electrical burns causing nerve and muscle

damage are only a few of the examples of medical catastrophes that are very costly but which may allow an individual to return to work.

The probabilities of this type of event are low as might be expected, but in constructing the distribution curve for medical costs on Major Permanent Partial claims consideration should be given to claims that could be in excess of $5 million. At the other end of the scale it's reasonable to assume that the medical cost of a Major Permanent Partial claim should have a minimum on the order of $15,000-$20,000.

The expected value of the average medical claim for Major Permanent Partial has been estimated to be between $80,000 and $100,000 in PCRB filings in recent years.

2. Indemnity

   a. Source of Data (not Statutory)

   For Fatal and Permanent Total Claims it was felt that direct recourse to state Statutes would generate the best available estimate of indemnity costs associated with these types of claims. However this is not true with respect to the benefits provided for Major Permanent Partial. For one thing there are an inordinate number of categories e.g. loss of index finger, thumb, eye, great toe, other than great toe, foot, arm, hand, leg and on and on and on.

   If a good current distribution of these injures by type were available (this would require a lot of injuries in each category to be credible) and the distribution could be expected to be applicable to the period for which the rates are to be effective (working environments are changing rapidly, so this is questionable) then this approach might be feasible. However we thought that the best way to estimate the distribution was to access a database of claims.

   Data on the indemnity costs associated with Major Permanent Partial claims can be obtained from some of the sources previously cited. However it should be noted that the benefits for and definition of Major Permanent Partial claims vary significantly from one state to another. As a small example of this, Illinois law specifies "The specific case of loss of both hands, both arms, or both feet, or both legs, or both eyes, or any part thereof, or the permanent and complete loss of use thereof, constitutes total and permanent disability". In other states some of these described injuries would be classified as Major Permanent Partial.

   Because of the variation from state to state the methodology adopted here has been to acquire a sample of Major PP's from a single state,

thereby obtaining, it is hoped, homogeneous data and constructing the indemnity distribution curves. When there is not recourse to additional data for all the states the curve is adjusted by reviewing the details of the Statutory PP indemnity benefits.

It should be noted that indemnity benefits can be unexpectedly large particularly in comparison with the schedule benefits listed in summaries of the Workers Compensation laws. This is the result of the fact that in a number of states Temporary Total benefits may be received for as much as 500 weeks and is not to be deemed a reduction to subsequently awarded Permanent Partial benefits.

b. Range of Amounts

Indemnity benefits for Major Permanent Partial claims seem to be relatively well contained in comparison to the benefits that might be experienced on Fatal or Permanent Total claims. Thus from the point of view the excess insurer or reinsurer indemnity benefits are not much of a threat to higher retentions. However, because Major Permanent Partial claims are serious claims it might be expected that the indemnity costs will not be trivial. In addition when these costs are combined with moderately high medical costs even relatively high retentions will be penetrated.

Since Major Permanent Partial claims are serious it might be expected that the minimum indemnity costs will be in the range of 15 thousand to 20 thousand dollars. The indemnity benefits would contemplate temporary total plus scheduled benefits. On the other end of the range it is entirely possible that the maximum indemnity benefits that might be observed would be in the interval of 500,000 to 750,000 dollars. It should be noted that in some states compensation for temporary disability is allowed in addition to scheduled benefits, in others temporary benefits are allowed with some limitations and in some the temporary benefits are deducted from the scheduled amount.

Pennsylvania rate filings show estimated indemnity benefits averaging between 140,000 and 160,000 dollars.

IV. Weighting Excess Factors

It may seem surprising but the determination of the weights by type of loss may be the weakest link in this methodology. Often the weighting must be based on data that is the summary of data on a handful of claims.

This is particularly true in states with small populations. Thus some judgement, intuition and just plain common sense must be used in selecting the weights when estimating XS rates for a given state.

A. Source of Data

Data is available from the various statistical gathering and ratemaking organizations. The National Council on Compensation Insurance is the most prominent of these and issues a widely distributed and used Statistical Bulletin each year. A facsimile of part of Exhibit X from the 1998 bulletin appears below.

Distribution of Incurred Losses
By Type By State

| State | Policy Period | Fatal % | Permanent Total % | Permanent Partial % | Temporary Total % | Medical Only % |
|---|---|---|---|---|---|---|
| AL | - | 1.8 | 5.2* | 67.3 | 21.1 | 4.6 |
| CA | - | 1.3 | 7.5 | 75.6 | 8.7 | 6.9 |
| LA | - | 2.5* | 4.3* | 54.2 | 30.8 | 8.2 |
| MA | - | 3.1 | 5.2 | 56.1 | 31.8 | 3.8 |
| NY | - | - | - | - | - | - |
| TX | - | 3.7 | 5.4 | 56.2 | 27.8 | 6.9 |

The asterisk (*) indicates that the figure is based on less than 25 cases. Given this, it might be expected that the indicated weight is not especially accurate since the sample size is small and that the range of values of individual claims is quite large.

In addition to the above cited weakness, the 1998 Edition also did not display weights for several states. Some were large states, notably Ohio and Pennsylvania.

Similar weights can be extracted from the rate filings of other rating bureaus such as PCRB, NYCIRB and WCIRBC.

B. Development

In addition to noting the problem of sparse data, it is also necessary to recognize the fact that development may not be to a truly ultimate value. The following table is taken from a recent Pennsylvania Loss Cost filing.

All Policy Years

1. Experience as Reported

| | Indem. | Med. | Total | Prcnt. |
|---|---|---|---|---|
| Death | 1,413.4 | 144.4 | 1,557.8 | 1.9% |
| Perm T. | 3,636.7 | 1,891.6 | 5,528.3 | 6.7% |
| Maj. Perm Pa | 24,898.2 | 7,577.1 | 32,475.3 | 39.6% |
| Min Perm Pa | 6,825.5 | 4,946.8 | 11,772.2 | 14.3% |
| Temp Total | 12,709.9 | 12,613.8 | 25,323.7 | 30.9% |
| Med. Only | - | 5,437.8 | 5,437.8 | 6.6% |
| | | | 82,095.1 | 100.0% |

2. Developed Experience

| | Indem. | Med. | Total | Prcnt. |
|---|---|---|---|---|
| Death | 1,634.9 | 319.3 | 1,954.2 | 1.8% |
| Perm T. | 6,512.2 | 4,581.0 | 11,093.2 | 10.2% |
| Maj. Perm Pa | 36,037.2 | 19,046.9 | 55,084.1 | 50.4% |
| Min Perm Pa | 6,017.6 | 4,697.9 | 10,715.5 | 9.8% |
| Temp Total | 11,974.5 | 12,438.1 | 24,412.6 | 22.4% |
| Med. Only | - | 5,854.6 | 5,854.6 | 5.4% |
| | | | 109,114.2 | 100.0% |

Less mature data exhibits a greater change in the distribution of the type of loss as the following table shows

Latest Policy Year

1. Experience as Reported

| | Indem. | Med. | Total | Prcnt. |
|---|---|---|---|---|
| Death | 194.4 | 20.1 | 214.5 | 2.2% |
| Perm T. | 116.7 | 230.0 | 346.7 | 3.6% |
| Maj Perm Pa | 1,139.6 | 403.8 | 1,543.4 | 16.0% |
| Min Perm Pa | 1,165.0 | 798.9 | 1,963.9 | 20.3% |
| Temp Total | 2,363.8 | 2,292.9 | 4,656.7 | 48.1% |
| Med Only - | | 947.4 | 947.4 | 9.8% |
| | | | 9,672.6 | 100.0% |

2. Developed Experience

| | Indem. | Med. | Total | Prcnt. |
|---|---|---|---|---|
| Death | 267.3 | 56.5 | 323.8 | 1.7% |
| Perm T. | 1,032.7 | 805.0 | 1,837.7 | 9.7% |
| Maj Perm Pa | 6,197.3 | 3,281.6 | 9,478.9 | 50.0% |
| Min Perm Pa | 957.0 | 755.3 | 1,712.3 | 9.0% |
| Temp Total | 2,191.0 | 2,255.9 | 4,446.9 | 23.5% |
| Med Only | | 1,157.0 | 1,157.0 | 6.1% |
| | | | 18,956.6 | 100.0% |

Of particular interest in the two above tables is the development of the percentages for Permanent Total and Major Permanent Partial. The percentage of the third type of loss, Fatal, is close to 2.0% at first reporting and at its projected ultimate. However the Permanent Total percent develops substantially and the Major Permanent Partial only slightly less.

It should be noted that the above figures are taken from a primary rate filing with the development terminated after a reasonable amount of time. However, experience with Permanent Total claims would suggest that the cost of this type of claim continues to develop over a period measured in decades. Thus the distribution percentage for PT in particular is likely on the low side even at what is construed to be ultimate for the purposes of the rate filing. Thus the selection of the weights requires some judgement. For example the Permanent Total column of the above constructed facsimile shows weights between 5.2% and 7.5%. The states displaying 5.2% as the weight for PT are Alabama and Massachusetts. However Massachusetts is a much higher benefit state than Alabama with not only a higher average weekly wage but also with escalating benefits to age 65. On the other hand the fatal benefits in Texas are about the same as in Louisiana, so it is difficult to justify the difference in weights shown in he table. Thus, when selecting weights, consideration must not only be given to whatever data is available but also to the state mandated benefits.

## V. Examples

Presented below is an additional example of the method under discussion. This is considered to be a true Excess Workers Compensation example with data sources and calculations being very close to what has be previously discussed.

### A. Example #3

In the following it is assumed that the medical distribution Permanent Total Claims is as displayed in Figures 5a-5f. The indemnity is

Figure 5a

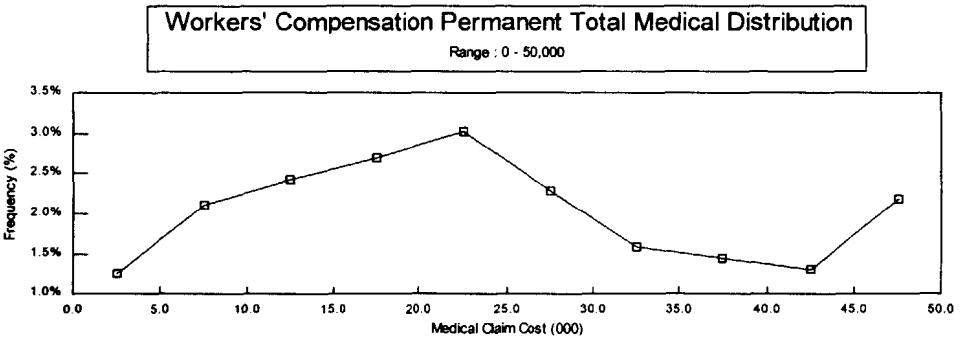



Figure 5b

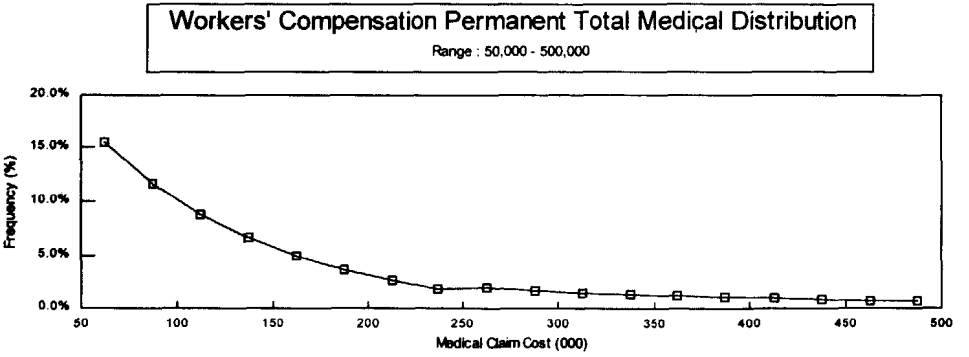


Figure 5c

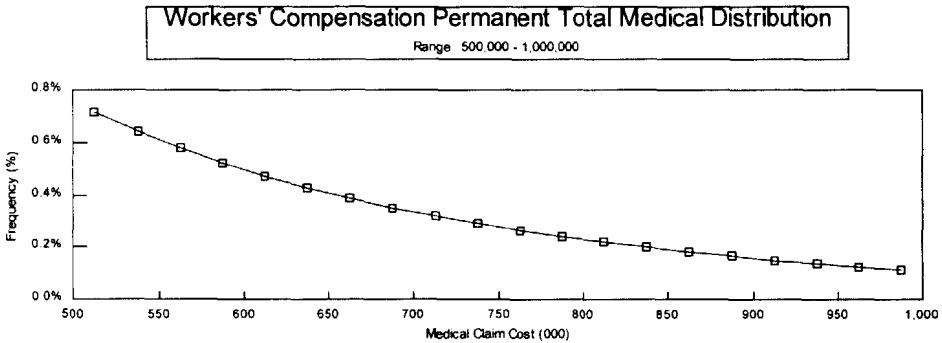





Figure 5d

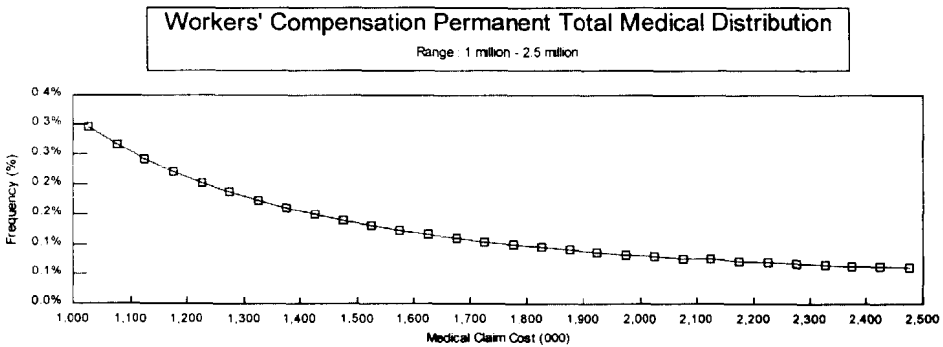


Figure 5e

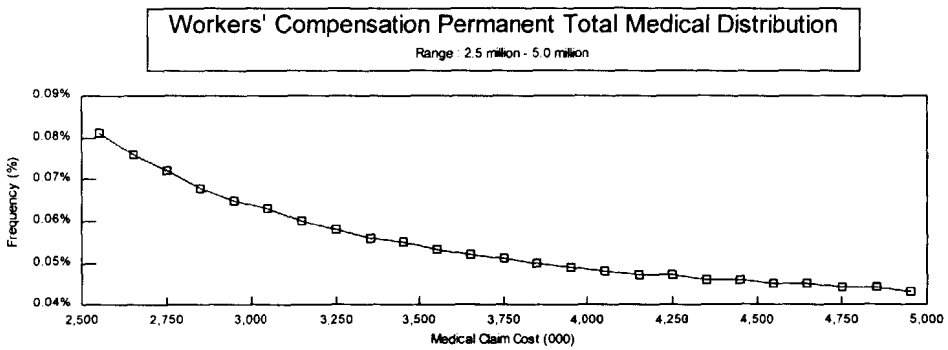
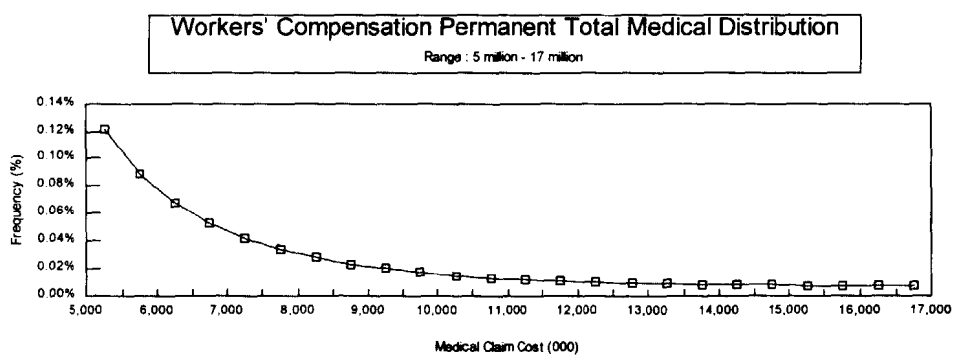





Figure 5f



generated by assuming a wage distribution similar to that produced by NCCI in the past and assuming a given level of SAWW and benefits. The SAWW is assumed to be $600 in this example.

The percent indemnity benefit is assumed to be 66 2/3% of wage at time of injury for Permanent Total claims. The maximum is 100% of the SAWW and the minimum is 20%. The self-insured retention (SIR) is $500,000. Given the above information the excess cost is found to be 55.8%.

For Fatal claims the medical distribution is as shown in the following table

Fatal
Medical Distribution

| Amount | Probability |
|---|---|
| 0 | 25.0% |
| 8,000 | 67.5% |
| 75,000 | 4.0% |
| 300,000 | 3.0% |
| 1,750,000 | 0.5% |

Again the SAWW is assumed to be $600. The percent indemnity is assumed to be 50% for Fatal claims. The maximum and minimum percents are 100% and 20% respectively. The SIR's $500,000. The above assumptions result in an excess percentage of 34.1%.

Finally data with respect to Major Permanent Partials is displayed in Figures 6 and 7 following. Figures 6a, 6b and 6c display the medical costs. Figures 7a and 7b display the indemnity costs. The percent of costs excess $500,000 is 11.5%.

Next assume that the weights are as given in the following table.

Weights by
Type of Loss

| Type of Loss | Weights |
|---|---|
| Fatal | 2.0% |
| Perm. Total | 11.5% |
| Maj. Perm. Pa. | 55.0% |

Figure 6a

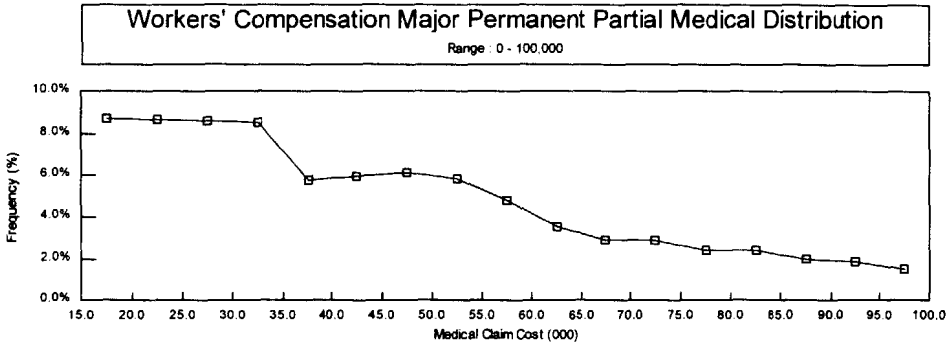





Figure 6b

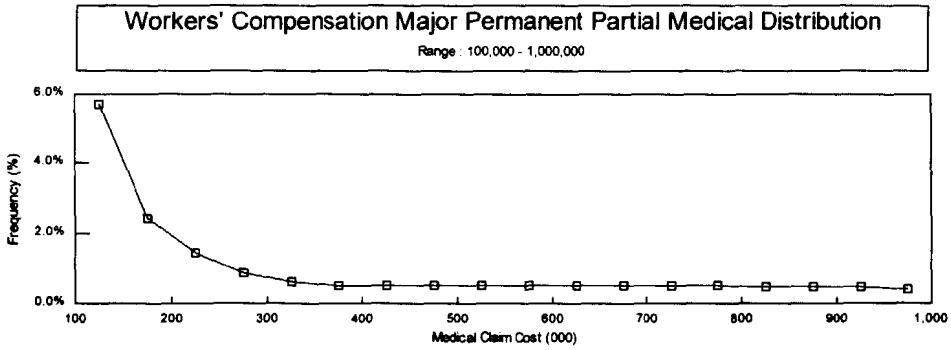


Figure 6c

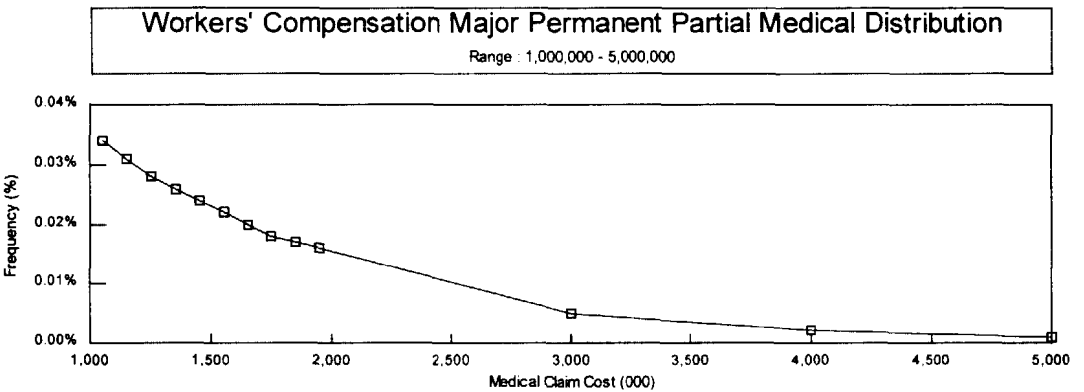

Workers' Compensation Major Permanent Partial Medical Distribution
Range : 1,000,000 - 5,000,000
0.04%
0.03%
0.02%
0.01%
0.00%
Frequency (%)
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Medical Claim Cost (000)

Figure 7a

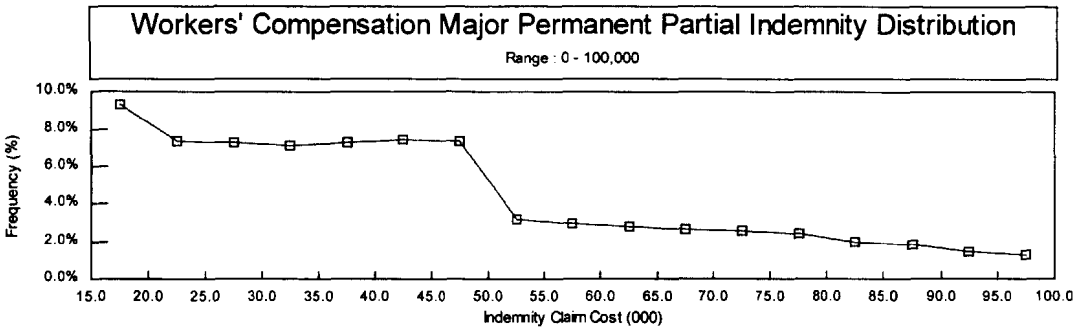
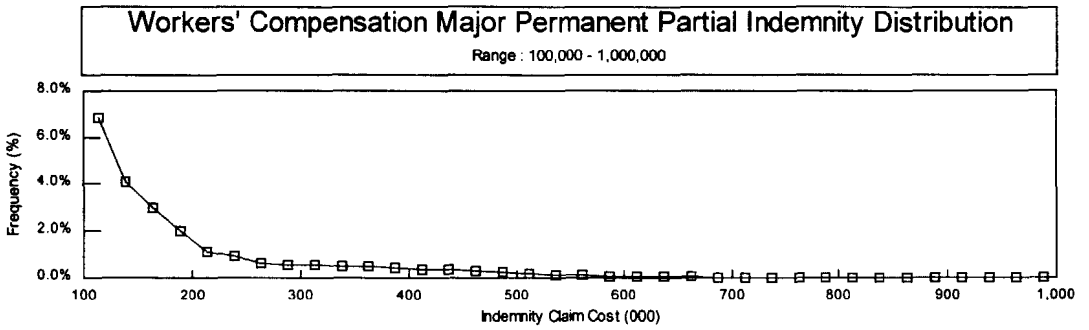





Figure 7b



These weights combine with the previously estimated excess factors to produce an excess factor of 13.45%, i.e.
(2.0%)(34.1%)+(11.5%)(55.8%)+(55.0%)(11.5%) = 13.4%.

B. Example #4

In Appendix D, the reader will find a complete set of excess factors for Pennsylvania. These were developed using the described methodology.

VI. Miscellaneous

1. Change of Benefits

Over the past decade workers compensation laws have been revised often with varying levels of impact emanating from given changes. Many of the changes have been focused on benefits. In an effort to bring the benefits accruing to an injured worker to a level equal to economic benefits accruing from other events, the benefits have generally been reduced and/or the administration of the law modified. For example, Maine at one time mandated escalating benefits for workers that had been killed or had been permanently and totally disabled. The benefits plus the rate regulation grew so onerous that eventually the insurance industry stopped underwriting workers compensation exposures in that state. The resulting problems that this caused businesses that operated in Maine were partially remedied by reducing the statutory benefits. Currently instead of escalating lifetime benefits fatal claims receive level benefits for 500 weeks. Permanent Total claim now receive level lifetime benefits but these are now offset to an extent by Social Security benefits and other benefits such as employer funded benefits.

Pennsylvania and Louisiana are two other states which have revised the statutorily mandated benefits in the last decade.

Changes such as these will naturally generate changes in excess costs, usually lowering them as a result of decreasing statutory benefits. Reliance on existing data to estimate the revised excess costs only makes sense if the particulars of previously incurred permanent total and fatal claims are known and present the possibility of estimating the costs under the new benefit system. Even when available this is tedious and expensive with the adjusted values being subject to some degree of error.

It is suggested that the methodology presented in this paper is superior in that an estimate of the excess factors that would be expected under the new law can be produced in a very short time. This not only saves expense which is usually somewhat important but it also saves time

which is often more critical. In addition to the above, the view presented here is that the estimate generated using the described methodology is, at any rate, more accurate since it does not depend on a small sample of claims.

2. Uncertainty and Sensitivity Testing

   Even if all the steps described above are executed in a reasonably effective manner, there may still be a good deal of uncertainty in the final rates that are produced. One of the reasons for this is the data problem that has been discussed above a number of times. If there is one true statement that can be made about developing Excess Rates for Workers Compensation it's that there is never enough data available and that the ultimates on individual claims will never be known with sufficient accuracy to provide a great deal of comfort.

   Another of the reasons is that the law governing Statutory Benefits made not be entirely clear and/or interpretations of the law may be somewhat flawed. Finally, those administering the law may not be applying the law as intended.

   As a result of the uncertainty it is advisable to examine the rates that have been produced and to evaluate the contribution of each component. Once this is done the person charged with producing the final rates should test the sensitivity of the rates to changes in a given component or simultaneous changes in a number of components. This should provide a guide to which elements produce the greatest change in the rate for a given amount of error. Additional resources can then be brought to bear on the re-estimation for critical components.

3. Pricing of Layers

   The methodology presented here is designed to provide the cost of statutory benefits excess of a given retention. The cost is expressed as a percent of the pure premium. For example in Appendix D it can be seen that the cost excess $500,000 is 9.88%. However many specific excess treaties are written for layers such as $500,000 excess $500,000 (usually referred to as 500 xs 500). The excess pricing should be able to accommodate this. In Appendix D the price of the excess $1,000,000 layer is found to be 2.50%. Thus the cost of the layer 500 xs 500 is 7.38%.

   After constructing a table of excess factors a test of the results can be generated by examining the costs of consecutive layers such as 250 xs 250, 250 xs 500, 250 xs 750 etc. There of course should be no reversals and the costs should be decreasing uniformly. While this test

does not guarantee that the results are accurate it is a simple task to perform and may identify missteps in calculations.

4. Cost Determination for "Compromise and Release" States

   Occasionally a question is raised with respect to whether the proposed method needs to be modified for use in states where serious claims can be settled essentially through paying lump sum to the injured party.

   The position adopted here is that it is necessary in constructing rates to provide for the costs of all claims regardless of how they are ultimately disposed. The first step is to estimate the nominal costs of all claims that will occur and estimate the cost of the various retention levels. The next step in converting these cost estimates into prices, is to estimate the impact of investment income. This leads to a price that is charged for the risk. In the event that a claim occurs, the funds plus future interest should be enough to pay for the claims or to pay the claims immediately on a present value basis. Thus those charging the calculated price in exchange for assuming the risk should be indifferent as to whether the claims are settled early or not.

5. Adjusting Statewide Indications to Reflect Individual Risk

   The methodology presented in this paper was designed to produce statewide rates. Thus the rates will be adequate but not excessive for a risk whose profile is exactly the same as the state as a whole. However the vast majority of risks presented to an underwriter will generate risk which is either greater or less.

   It has been suggested that adjusting the rates to reflect the Hazard Group profile might produce the appropriate rates. However it should be noted that somewhat over 90% of all risks fall into either Hazard Group II or Hazard Group III. Thus adjusting the statewide rates by Hazard Group may produce some improvement in matching the rates to the risk but it would seem that the progress would be minimal.

   It would seem that a better approach would be develop a profile of the risk by classification code with debits or credits assessed by code. The process of developing debits or credits by classification code is a major undertaking and is beyond the intended scope of this paper. However thinking along these lines will likely reproduce rates that more closely match the risk than recourse to Hazard Group.

   Statistics to begin the above suggested process are available from the various ratemaking bureaus.

6. Allocated Loss Adjustment Expense Considerations

The methodology and the examples presented in this paper did not consider the impact of allocated loss adjustment expense. However it is felt that this methodology can be extended to include allocated loss adjustment expense costs. It would seem that this would add an additional layer of complexity. Evidence available to the author of this paper suggests that ALAE is not a direct add-on. That is, it would be inappropriate to load each claim value by say 10%. For example, a claim whose size is $15,000,000 would not carry an associated ALAE cost of $1,500,000.

On the other hand, whereas the medical and indemnity costs seem to be independent, it would appear that the ALAE amount is, in some way, related to the size of the claim cost excluding ALAE. However incurred ALAE as a percent of incurred losses seems to be negatively correlated to the size of loss.

7. Payout Rates

There may be an initial temptation to model the payout of the incurred claim costs evenly over a lifetime. This is generally incorrect. For limited benefit fatal claims, Major Permanent Partial and Employer's Liability the average date of payment is actually within three to seven years of the accident date.

Permanent Total claims present something of a paradox especially in comparison to, say, General Liability. As a rule of thumb, the larger G.L. claims are paid later and hence it might be expected that additional investment income might be generated to offset the cost of the ultimate settlement (This is not an inviolate rule.) However, larger Permanent Total Claims are, all things being equal, caused by larger medical costs. Claims like these generally, (not always), demonstrate extremely large medical payments in the earlier years to counteract the effect of the serious injuries. Thus, generally, the larger the Permanent Total claim, the faster the payments. On PT claims where the incurred medical in very high (excess of 2-5 million) a retention of 500,000 can be pierced in a year or two.

8. Closing Remarks

The method outlined in this paper was developed in response to a specific problem. The problem - generation of reasonably accurate estimates of excess workers compensation costs- is sufficiently important and of wide enough interest to justify the cost in some circumstances.

The effort, cost, and acceptance of the methodology do not guarantee, of course, that the rates are as accurate as they might be. This is due in part to the difficulties previously discussed. It is also due to assumptions that have been untested but where at least a degree of testing may be possible. Thus work must continue to refine the methodology.

## Pennsylvania – Compensation Benefits
## Summary of Salient Items

Death Benefits

Dependents: In the case of death, compensation will be computed on the following basis, and distributed to the following persons, provided that in no case will the wages of the deceased be taken to be less than 50 percent of the SAWW.

Children, no spouse: If there is no surviving spouse entitle to compensation, compensation will be paid to the guardian of the child or children, if there is no guardian, then to such other persons as may be designated by the board as follows

- If there is one child, 32 percent of wages of deceased, but not in excess of the SAWW
- If there are two children, 42 percent of wages of deceased, but not in excess of the SAWW
- If there are three children, 52 percent of wages of deceased, but not in excess of the SAWW
- If there are four children, 62 percent of wages of deceased, but not in excess of the SAWW
- If there are five children, 64 percent of wages of deceased, but not in excess of the SAWW
- If there are six children, 66 2/3 percent of wages of deceased, but not in excess of the SAWW

Spouse and children: To the widow or widower, if there is one child, 60 percent of wages, but not in excess of the SAWW. To the widow or widower, if there are two children, 66 2/3 percent of wages but not in excess of the SAWW. To the widow or widower, if there are three or more children 66 2/3 per cent of wages, but not in excess of the SAWW.

Parents: If there are neither widow, widower, nor children entitled to compensation, then to the father or mother, if dependent to any extent upon the employee at the time of the injury, 32 percent of wages but not in excess of the SAWW. (Additional wording omitted)

Siblings: If there are neither widow, widower, children, nor dependent parent, entitled to compensation, then to the brothers and sisters, if actually dependent on the employee for support at the time of death, 22 percent of wages for one brother or sister, and an additional five percent for each additional brother

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or sister, with a maximum of 32 percent of the wages of the employee, not to exceed the SAWW.

Generally, compensation is payable to or on account of any child, brother, or sister, only if and while the child, brother, or sister, is under the age of 18. If the child, brother, or sister is dependent because of disability, then compensation will be paid during the disability of a child, brother, or sister over 18 years of age. Furthermore, if the child is enrolled as a full-time student in any accredited educational institution, then compensation will continue until the student turns 23. (Additional wording omitted)

Spouse Only: To a surviving spouse if there are no children, 59 percent of wages not to exceed the SAWW

Miscellaneous Benefits:

Funeral Expenses Whether or not there are dependents, the reasonable expense of burial, not exceeding $3,000 will be paid by the employer or insurer directly to the undertaker (without deduction of any amounts already paid for compensation or for medical expenses).

Permanent Disability Compensation

Permanent Total Disability: For total disability, 66 2/3 percent of the wages of the injured employee beginning after the seventh day of total disability, and payable for the duration of total disability. However, compensation cannot be more than the maximum compensation payable. If the benefit is less than 50 percent of the SAWW, the benefit payable will be the lower of 50 percent of the SAWW or 90 percent of the employee's average weekly wage. (Additional wording omitted)

Permanent Partial Disability: For partial disability, 66 2/3 percent of the difference between the wages of the injured employee before the injury and the earning power of the employee thereafter; but compensation cannot be more than the maximum compensation payable. (Additional wording omitted)

Schedule of Permanent Injuries. For all disability resulting from permanent injuries of the following classes, 66 2/3 percent of wages is exclusively paid for the following number of weeks

- loss of hand 335 weeks
- loss of forearm 370 weeks

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- loss of an arm 410 weeks
- loss of a foot 250 weeks
- loss of a lower leg 350 weeks
- loss of a leg 410 weeks
- loss of an eye 275 weeks
- loss of a thumb 100 weeks
- loss of a first or index finger 50 weeks
- loss of a second finger 40 weeks
- loss of a third finger 30 weeks
- loss of a fourth or little finger 28 weeks
- loss of a great toe 40 weeks
- loss of any other toe 16 weeks

(Additional wording omitted – including lengthy section on Hearing Loss)

Healing period compensation: In addition to the payments provided for permanent injuries of the classes specified, any period of disability necessary and required as a healing period is compensated in accordance with the provisions of this subsection. The healing period ends when the claimant returns to employment without impairment in earnings, or on the last day of the period specified in the following table, whichever is the earlier.

- For the loss of hand 20 weeks
- For the loss of forearm 20 weeks
- For the loss of an arm 20 weeks
- For the loss of a foot 25 weeks
- For the loss of a lower leg 25 weeks
- For the loss of a leg 25 weeks
- For the loss of an eye 10 weeks
- For the loss of a thumb or part thereof 10 weeks
- For the loss of a any finger or part thereof 6 weeks
- For the loss of a great toe or part thereof 12 weeks
- For the loss of a any other toe or part thereof six weeks

(Additional wording omitted)

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## 79-81 U.S.Standard Life Table

| Age | Number of lives | Age | Number of lives |
|---|---|---|---|
| 0 | 100,000 | 56 | 87,551 |
| 1 | 98,740 | 57 | 86,695 |
| 2 | 98,648 | 58 | 85,776 |
| 3 | 98,584 | 59 | 84,789 |
| 4 | 98,535 | 60 | 83,726 |
| 5 | 98,495 | 61 | 82,581 |
| 6 | 98,459 | 62 | 81,348 |
| 7 | 98,426 | 63 | 80,024 |
| 8 | 98,396 | 64 | 78,609 |
| 9 | 98,370 | 65 | 77,107 |
| 10 | 98,347 | 66 | 75,520 |
| 11 | 98,328 | 67 | 73,846 |
| 12 | 98,309 | 68 | 72,082 |
| 13 | 98,285 | 69 | 70,218 |
| 14 | 98,248 | 70 | 68,248 |
| 15 | 98,196 | 71 | 66,165 |
| 16 | 98,129 | 72 | 63,972 |
| 17 | 98,047 | 73 | 61,673 |
| 18 | 97,953 | 74 | 59,279 |
| 19 | 97,851 | 75 | 56,799 |
| 20 | 97,741 | 76 | 54,239 |
| 21 | 97,623 | 77 | 51,599 |
| 22 | 97,499 | 78 | 48,878 |
| 23 | 97,370 | 79 | 46,071 |
| 24 | 97,240 | 80 | 43,180 |
| 25 | 97,110 | 81 | 40,208 |
| 26 | 96,982 | 82 | 37,172 |
| 27 | 96,856 | 83 | 34,095 |
| 28 | 96,730 | 84 | 31,012 |
| 29 | 96,604 | 85 | 27,960 |
| 30 | 96,477 | 86 | 24,961 |
| 31 | 96,350 | 87 | 22,038 |
| 32 | 96,220 | 88 | 19,235 |
| 33 | 96,088 | 89 | 16,598 |
| 34 | 95,951 | 90 | 14,154 |
| 35 | 95,808 | 91 | 11,908 |
| 36 | 95,655 | 92 | 9,863 |
| 37 | 95,492 | 93 | 8,032 |
| 38 | 95,317 | 94 | 6,424 |
| 39 | 95,129 | 95 | 5,043 |
| 40 | 94,926 | 96 | 3,884 |
| 41 | 94,706 | 97 | 2,939 |
| 42 | 94,465 | 98 | 2,185 |
| 43 | 94,201 | 99 | 1,598 |
| 44 | 93,913 | 100 | 1,150 |
| 45 | 93,599 | 101 | 815 |
| 46 | 93,256 | 102 | 570 |
| 47 | 92,882 | 103 | 393 |
| 48 | 92,472 | 104 | 267 |
| 49 | 92,021 | 105 | 179 |
| 50 | 91,526 | 106 | 119 |
| 51 | 90,986 | 107 | 78 |
| 52 | 90,402 | 108 | 51 |
| 53 | 89,771 | 109 | 33 |
| 54 | 89,087 | 110 | 21 |
| 55 | 88,348 | 111 | 0 |

Indemnity & Medical Age : 20-60

| Group | Probability | Amount | Group | Probability | Amount |
|---|---|---|---|---|---|
| G1 | 3.392298% | 58,942.96 | G1 | 3.426564% | 58,942.96 |
| G2 | 5.809995% | 155,860.20 | G2 | 5.842723% | 155,846.50 |
| G3 | 7.702869% | 255,115.73 | G3 | 7.736413% | 255,111.55 |
| G4 | 9.049774% | 354,567.58 | G4 | 9.082577% | 354,564.07 |
| G5 | 9.333479% | 455,459.36 | G5 | 9.358949% | 455,465.94 |
| G6 | 8.461007% | 553,659.39 | G6 | 8.475570% | 553,644.28 |
| G7 | 8.817601% | 649,715.82 | G7 | 8.842459% | 649,687.29 |
| G8 | 8.254022% | 749,451.97 | G8 | 8.270407% | 749,450.07 |
| G9 | 7.031388% | 850,871.57 | G9 | 7.039757% | 850,884.23 |
| G10 | 5.844955% | 953,687.72 | G10 | 5.850663% | 953,713.27 |
| G11 | 4.316986% | 1,052,420.61 | G11 | 4.307616% | 1,052,394.21 |
| G12 | 4.333955% | 1,146,177.19 | G12 | 4.330345% | 1,146,097.40 |
| G13 | 3.974101% | 1,247,102.48 | G13 | 3.961901% | 1,247,071.31 |
| G14 | 3.206946% | 1,346,987.28 | G14 | 3.186389% | 1,346,931.95 |
| G15 | 2.891444% | 1,449,632.62 | G15 | 2.872877% | 1,449,607.32 |
| G16 | 1.716948% | 1,551,120.97 | G16 | 1.691124% | 1,551,108.52 |
| G17 | 1.479908% | 1,645,467.42 | G17 | 1.459716% | 1,645,353.36 |
| G18 | 1.136829% | 1,748,418.39 | G18 | 1.116369% | 1,748,429.45 |
| G19 | 0.849223% | 1,843,873.16 | G19 | 0.831567% | 1,843,676.94 |
| G20 | 0.907306% | 1,948,071.59 | G20 | 0.895396% | 1,948,009.42 |
| G21 | 0.525709% | 2,055,019.66 | G21 | 0.513358% | 2,055,167.92 |
| G22 | 0.401405% | 2,148,343.07 | G22 | 0.390635% | 2,148,337.99 |
| G23 | 0.251621% | 2,243,637.95 | G23 | 0.241198% | 2,243,437.87 |
| G24 | 0.157137% | 2,336,717.51 | G24 | 0.148850% | 2,336,082.85 |
| G25 | 0.097350% | 2,440,360.63 | G25 | 0.089951% | 2,439,668.49 |
| G26 | 0.029220% | 2,550,790.86 | G26 | 0.024563% | 2,551,044.20 |
| G27 | 0.012159% | 2,644,844.76 | G27 | 0.008410% | 2,644,484.67 |
| G28 | 0.005467% | 2,743,043.15 | G28 | 0.002640% | 2,737,255.81 |
| G29 | 0.003101% | 2,838,520.33 | G29 | 0.001013% | 2,827,854.55 |
| G30 | 0.002246% | 2,947,941.25 | | | |
| G31 | 0.001283% | 3,055,167.92 | Total : | 100.000000% | 750,197.87 |
| G32 | 0.000977% | 3,148,337.99 | | | |
| G33 | 0.000603% | 3,243,437.87 | | | |
| G34 | 0.000372% | 3,336,082.85 | | | |
| G35 | 0.000225% | 3,439,668.49 | | | |
| G36 | 0.000061% | 3,551,044.20 | | | |
| G37 | 0.000021% | 3,644,484.67 | | | |
| G38 | 0.000007% | 3,737,255.81 | | | |
| G39 | 0.000003% | 3,827,854.55 | | | |
| | 100.000000% | 753,447.87 | | | |

**Appendix D**

Sample rates constructed using described methodology

State: Pennsylvania
Effective Year: 1999

| Excess of | Excess Factor |
|---|---|
| 100,000 | 37.67% |
| 150,000 | 30.51% |
| 200,000 | 25.32% |
| 250,000 | 21.44% |
| 300,000 | 18.31% |
| 350,000 | 15.68% |
| 400,000 | 13.43% |
| 450,000 | 11.51% |
| 500,000 | 9.88% |
| 750,000 | 4.97% |
| 1,000,000 | 2.50% |
| 1,250,000 | 1.55% |
| 1,500,000 | 1.07% |
| 2,000,000 | 0.66% |