HOSPITAL SELF-INSURANCE FUNDING: A MONTE CARLO APPROACH

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ABSTRACT

The common theme which appears to have evolved in the actuarial methodology for determining self-insurance funding contributions can be described in basic terms as a two-step process: (a) estimating expected retained losses for the self-insured entity and (b) estimating a safety margin or risk loading to maintain funding at a selected high level of confidence. Variations on this general theme abound. Using Hospital Professional Liability as an example, this paper sets forth a simulation technique which approximates the aggregate loss distribution and the distribution of required funding to cover losses, focusing on the interaction of several variables. Special emphasis is placed on treating the run-off of the fund's prior year losses and the prospective target year losses simultaneously in determining the required funding on a year-by-year basis.

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The establishment of self-insured trust funds has become, over the last 10-12 years, a widely accepted response by U.S. hospitals to an increasingly constricted liability and workers' compensation market. Accurate estimates relating to the total aggregate hospital funding for self-insurance may be difficult if not impossible to come by, but it seems apparent that here in the late 1980's the larger hospitals (say, 500 beds and up) who self insure a significant first layer for at least their professional liability exposure are the rule rather than the exception.

The determination of appropriate funding levels for self-insured funds calls for the careful application of a special chapter from the property-casualty actuarial repertoire. It appears from this author's perspective that, for the most part, actuarial input of one kind or another has been solicited and delivered as an integral part of the hospital self-insurance planning process. (It should be acknowledged, of course, that no small factor in the prominence and high visibility of this actuarial input was the inclusion by the HEW Department of required actuarial "certification" of self-insured funding levels in their original funding guidelines for Medicare reimbursement purposes in the mid 1970's. No attempts will be made by this author to chronicle the evolution of the Medicare guidelines. The concepts discussed in this paper are intended to be more generic, concentrating on the intrinsic risk encountered by a self-insuring entity and the funding required to retain and sustain that risk -- irrespective of government guidelines.)

Basic Principles

Any practicing actuary searching for a standard "cookbook" or "generally recognized" approach to calculating funding levels for self-insured funds will probably end up waving the white flag. It seems that there have evolved over the past decade or so several (dozens, maybe) methodologies or families of methodologies which represent variations on a general theme. Despite all the variations, it appears that the common denominator among all self-insurance funding procedures can be described in general terms as follows: An *expected* annual retained loss is estimated for the hospital, using the hospital's own loss experience to the extent deemed credible (and outside data otherwise), and, to supplement this expected level, a *safety margin* or risk loading is included in the funding, based in one way or another on some measurement of the distribution of aggregate retained losses and defining confidence intervals from that distribution. Beyond this simple theme, though, variations of all shapes and forms (which may be equally defensible) abound.

In the process of walking through the development of a self-insurance procedure, or one "variation" on the common theme, this author found that the first major building block beyond the central theme is the treatment of the funding calculation for the first year of a fund contrasted with the "renewal" funding for each year thereafter. For the initial funding calculation one is concerned only with the prospective expected retained losses for the target year and with the confidence levels around that expected level. For each year thereafter, the funding level would logically be predicated on the amount required to run off the losses from prior years as well as the amount required for the prospective target year. With these dual objectives in mind, we can set forth our first general expression for determining a self-insured funding level:

Indicated funding for year N
+ Current Assets of fund
= present value of losses from prior years paid in years N forward
+ Present value of losses incurred in year N.

When N=1, of course, the current assets = 0 and there is no runoff from prior years. For N > 1, however, the remaining unpaid losses from prior years and the projected losses for the next target year are treated simultaneously in determining what additional funding, when combined with the current assets which were generated from prior funding and the interest earned thereon, will be necessary to cover all future losses.

The two loss categories in the above general expression are, of course, treated as random variables and thus the value solved for -- the required year N funding level -- is also defined as a random variable. After the probability distribution of this random variable is approximated, a funding level is then determined corresponding to a desired confidence level. It is safe to assume that most of the actuarial effort expended over the past few years in the self-insurance field has been in the determination of this probability distribution, given all of the necessary parameters. It is also pretty safe to assume that it is in this phase of the actuarial exercise that most of the wide variations on the theme occur.

As the above basic formula implies, the annual funding amount is continually self-correcting, based on each new year's experience. Not unlike pension plan funding, the actuarial "gains" or "deficits" from prior years, represented in the formula by the present value of the runoff of prior years' losses less the current assets, are built into the formula to determine the indicated level of funding for the next year. Rather than treating the funding of each new year independently of the prior years and thereby stacking single year safety margins on top of prior single year safety margins, all years are treated collectively to determine the safety margin to cover all losses.

Expected Losses for Hospital

This paper will not dwell on the details of analyzing the loss and exposure data of a particular hospital and the loss experience from pertinent "global" sources to supplement the hospital-specific data. It would seem that the choice of which loss reserving techniques to use to analyze the data and project expected loss costs per exposure unit to a target year would depend largely on the size of the hospital, the availability of loss data, and the judgement of the actuary doing the analysis. Conceivably, for large hospitals with as many as 8-10 years of accessible loss data, one could construct historical loss development triangles, including paid and open claim counts and amounts, and determine historical development patterns based on the hospital's data itself. For middle-sized hospitals, the actual claim data might be used, but for purposes of loss development and trending, more global (e.g., statewide or countrywide) indications would probably be required. Finally, for the small hospitals, the loss experience of the entity itself would rarely, if ever, be used and the expected loss costs might be derived exclusively from the global sources.

Even for the larger hospitals, the final selection of the expected loss cost might be based to some extent on a credibility-weighted average of the hospital-specific data and the statewide average. Rather than being a slave to some dogmatic credibility standard (all together now, 682 claims = 100% credibility, etc.), it would seem that a great deal of actuarial judgement should be exercised in arriving at the final selections, particularly since, from a subjective standpoint, there may well be some unique risk characteristics for the hospital in question (types of procedures, etc.) which should be reflected irrespective of its sheer size and statistical credibility.

Given the projected expected loss cost for the hospital, the second task at hand in the procedure to determine funding levels is to approximate the probability distributions around the expected values from which confidence levels can be defined. To accomplish this task this author has developed a Monte Carlo simulation model to "sample" the experience of a fund, as defined by certain parameters, over a large number of trials (usually 1,000). Accordingly, no matter how the final weighted average expected loss cost is derived for the hospital, it will be necessary to break out this loss cost into a few key components, for purposes of generating the probability distribution. As a first step, an average claim cost (at some limit) and a total claim frequency would be determined, the product of which will equal the pure loss cost per exposure unit. The average claim cost can then be subdivided into: (a) average indemnity cost and (b) average claim expense, while frequency can be subdivided into (c) percentage of claims closed with indemnity, (d) percentage of claims closed with claim expense only, and (e) percentage of claims closed with no payment.

A quick preview of the key distributions which will need to be developed in the Monte Carlo model is as follows:

(a) Distribution of indemnity amounts
(b) Distribution of ALAE amounts
(c) Claim frequency distribution
(d) Claim reporting and claim payout distributions
(e) For renewal funding: distribution of the number of IBNR's from prior years, given the expected number of IBNR's

The key distributions used in the model will now be explored in some detail.

THE INDEMNITY SIZE OF LOSS DISTRIBUTION

The NAIC Closed Claim Studies

Perhaps the most critical component in our procedure to approximate the confidence levels of self insurance funding is the distribution of indemnity amounts (from ground up, with no limit) for one accident year. Using medical professional liability as the line of business in question, we referred to the NAIC closed claim study.[1] For this study, some 75,000 claims closed during the period 1975-78 were recorded. Among many other items of information, the accident dates, report dates, closed dates, and indemnity and ALAE amounts were included.

It has been shown by many researchers[2] that, in order for any calendar year closed claim distribution to accurately represent the claim-size distribution applicable to an accident year, some trending adjustments are necessary for both claim frequency and claim severity. For this author's model claim-size distribution, we first devised annual indices of claim severity and frequency (both accident year) from available national data covering a period of about 20 years

[1]National Association of Insurance Commissioners, **NAIC Malpractice Claims**, 1980.

[2]See, for example, Archer McWhorter, Jr., "Drawing Inferences from Medical Malpractice Closed Claim Studies", **The Journal of Risk and Insurance**, XLV, no. 1 (March, 1978) and Michael R. Lamb, "Uses of Closed Claim Data for Pricing," **Pricing Property and Casualty Insurance Products**, 1980 C.A.S. Discussion Paper Program, p. 219.

up to calendar year 1978 (the final closing year of the study). The frequency and severity indices for each year were then expressed in terms of the 1978 index equal to 1.0. Then to each detail claim record,[3] based on the accident date, we applied the reciprocal of the frequency index to the claim count (1 per record, initially) and the reciprocals of both the frequency and severity indices to the indemnity and ALAE amounts. As a result of this exercise, we produced a claim size distribution adjusted to represent the *accident year* 1978.

A printout of the trend-adjusted claim size distribution (indemnity) is shown in Appendix A, page 1. The brackets of indemnity size are set up on logarithmic (geometric) scale, with the end point of each bracket a constant factor (about 1.3335) times the end point of the previous bracket. A plot of the histogram for the non-zero members of this adjusted distribution is displayed on page 2 of Appendix A. The cumulative distribution ogive is then plotted on page 3. But the most revealing and useful plot of this accident-year adjusted distribution is shown on pages 4-5, on which we have plotted the cumulative distribution on lognormal probability graph paper, the grids of which are constructed so that the cumulative distribution ogive of a lognormal probability distribution is a straight line.

The lognormal model has been used extensively to represent claim size distributions in property and casualty lines.[4] Finger, in particular, used the lognormal model to determine implied increased limit factors for medical professional liability. It would follow, then, that the lognormal would be a good candidate to investigate for modelling self-insured losses.

On the first page of our cumulative distribution graph (claims up to $100,000), the lognormal fit -- a straight line drawn though the points strictly by sight -- clearly is good enough to represent the actual data. On the continuation of the distribution on page 5, it can be noted that for values above about $500,000 the actual data points veer out above the hand-selected lognormal line. There is a very plausible explanation for this. If the lognormal model does in fact provide a good representation of the claim size distribution *with no limit*, then the imposition of policy limits on the bigger claims in the data base itself would have had a dampening effect on the relative frequency of these claims in the higher, potentially excess, layers. It can be approximated from the graph, for example, that the extension of the

[3]In addition to referring to the hard-copy NAIC report, we also purchased the detail data tape from the association.

[4]See, for example, Charles C. Hewitt, Jr., "Credibility for Severity," PCAS, LVII (1970), p. 148; David R. Bickerstaff, "Automobile Collision Deductibles and Repair Cost Groups: the Lognormal Model," PCAS, LIX (1972), p. 68; and Robert J. Finger, "Estimating Pure Premiums by Layer -- an Approach," PCAS, LXIII (1976), p. 34.

lognormal line would indicate a frequency of claims in the $2 million plus range about 4 to 5 times greater than the actual data points would indicate. For this reason, more than any other, this author disdained any idea of walking through a rigorous, analytical curve-fitting choreography, which would have generated a "best fitting" line that understates the potential for big claims.

The selected lognormal parameters for indemnity

We estimated a mean and variance from our fitted lognormal claim size distribution by marking off the median and standard deviation directly from the graph, using the 50 percentile and +1 standard deviation marks on the vertical scale, as follows:

Observed median $= e^{\mu} = 10650$.
Observed $\sigma = \log_e(68000) - \log_e(10650) = 1.853$

Our final selected value for the mean is, then

$$\exp(\log_e(10650)+(1.853)^2/2) = 59300 .$$

The coefficient of variation (standard deviation divided by the mean) of the fitted distribution is calculated as follows:

$$\begin{aligned}(CV)^2 &= e^{\sigma^2} - 1 \\ &= 29.988 .\end{aligned}$$

Thus, for future modelling purposes, we set the CV value $= \sqrt{30}$.

Working Size of Loss Model for Indemnity

The absolute values of the 1978 NAIC closed claim distribution, even after adjusting for frequency and severity trends, are not particularly important to us - especially in 1989. The *shape* of the adjusted, fitted distribution is the key parameter, measured by the CV. We believe that it is reasonable to assume that as the average unlimited indemnity increases over time or from one territory to another, the $(CV)^2$ should remain relatively constant. This also implies that as the *average* unlimited claim increases k percent from one point in time to another, it is reasonable to expect that the entire distribution of claims moves up about k per cent. Put another way, an $800,000 claim has about the same relative niche in a distribution whose unlimited mean is $100,000 as a $400,000 claim in a distribution with half the unlimited mean.

Our working indemnity distribution can, then, be represented by a lognormal distribution whose unlimited mean is 1.0 and whose $(CV)^2$ is 30, as shown in page 6 of Appendix A. The top line represents the basic distribution of claims by size and the bottom line depicts the *first moment* distribution.[5] To illustrate how this graph is read, from the top line one can note that about 82.5% of all claims are less than or equal to the mean and about 96.5% of the claims are less than or equal to five times the mean. From the bottom line, one can further note that about 18% of the total *dollars* in the distribution come from claims which are less than or equal to the mean and about 47% of the dollars from claims below five times the mean.

Generation of random claim amounts from lognormal model

To tabulate sample claims from the lognormal distribution, our Monte Carlo model employs a random number generator which generates *normal* random numbers.[6] The sample random claim size (indemnity) is determined from the following formula:

$$X = \exp(\mu + N\sigma)$$

where μ = mean of the logs of the distribution

σ = S.D. of " " " "

N = normal random number (mean 0, var. 1) .

From the basic relationships of the lognormal distribution,

$$M = \exp(\mu + \sigma^2/2)$$

where M = mean of the distribution .

Then we have

$$\mu = \log_e(M) - \sigma^2/2$$

[5]For a discussion of moment distributions and other attributes of the lognormal distribution, see J. Aitchison and J. A. C. Brown, **The Lognormal Distribution**, (Cambridge University Press, 1969).

[6]A full discussion of random number generation is beyond the scope of this paper. For further reference, we recommend G. S. Fishman, **Principles of Discrete Event Simulation** (New York: John Wiley & Sons, 1978), chap. 8-9.

and then the sample claim would be generated with

$$X = \exp(\log_e(M) - \sigma^2/2 + N\sigma) .$$

REPORT YEAR / CALENDAR YEAR STRATIFICATION OF ACCIDENT YEAR

In our basic funding formula, it will be recalled that we were looking for the *present value* of future losses or the distribution of the present value of losses. Furthermore, the self insured retention (SIR) limit per claim, as regards the terms with an excess carrier, may be *indexed*, i.e., the excess attachment point would be increased a specified amount (or percentage) each year based on the *calendar year* that first payment is made on the claim. Thus, we are interested not only in the distribution of claims by size but also the distribution of claims by lag time to settlement. Because of the well-recognized correlation between payment lag and payment size, we have introduced a form of stratification in the sampling of medical professional claim amounts. To accomplish this, we first set forth some basic relationships between report year and calendar year severities, within the accident year:

Let $R(i)$ = Frequency of claims reported in report year i of acc. year, relative to total accident year

$C(j)$ = Freq. of claims of one rep. year paid in cal. year j, relative to total report year

S_i = Severity of claims of report year i, relative to total accident year severity

T_j = Severity of claims of calendar year j, relative to total severity of report year

n = total report years in accident year

m = total calendar years for each report year

Then you have

$$\sum_{i=1}^{n} R(i) = 1$$

$$\sum_{j=1}^{m} C(j) = 1$$

and, by definition,

$$\sum_{i=1}^{n} S_i R(i) = 1$$

$$\sum_{j=1}^{m} T_j C(j) = 1 \ .$$

The total accident year can then be stratified into n*m report year/calendar year cells. The cell identified by the ith report year and the jth relative calendar year in that report year would have a claim frequency of R(i)*C(j) times the total accident year frequency and a severity of $S_i{}^*T_j$ relative to the total accident year severity. It also holds that the mean severity over all n*m cells is

$$\sum_{i=1}^{n} \sum_{j=1}^{m} S_i T_j C(j) R(i) = 1$$

Since the above mean = 1, the coefficient of variation squared over all n*m cells is:

$$C^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} [S_i T_j]^2 C(j) R(i) \quad - 1 \ .$$

Modified CV's for stratified sampling

We earlier developed a model indemnity size-of-loss distribution for an entire accident year, with a $(CV)^2$ of 30. But instead of simply sampling indemnity amounts from the entire accident year distribution, our Monte Carlo model will first select (randomly) a report year and then a calendar year paid for each random claim and then, based on the relative severity levels discussed above, sample from an indemnity distribution the mean of which has been adjusted to the levels corresponding to that report year and relative calendar year. Consequently, it becomes necessary to modify the CV applicable to each RY/CY stratum so that when you combine the sampled claims from the various RY/CY cells, you achieve the desired composite accident year $(CV)^2 = 30$.

To accomplish the desired approximation of the modified CV applicable to each RY/CY cell, we used a method first advanced by Hewitt.[7] He demonstrated that, if (a) a random variable Y were stratified into groups and (b) the means of the groups were lognormally distributed and (c) the variance of the logs of the means were S^2, and (d) if the variance of the logs of each group were $(\sigma_Y)^2$, a constant, then the variance of the logs of the combined distribution of all groups would be $S^2 + (\sigma_Y)^2$. The "spread parameter" S^2 over the n*m report year/calendar cells can be determined directly from the C^2, calculated above:

$$C^2 = e^{S^2} - 1$$

$$S^2 = \log(C^2 + 1)\ .$$

Thus,

$$\log(C^2 + 1) + (\sigma_Y)^2 = \text{Log}(31)$$

and

$$(\sigma_Y)^2 = \text{Log}(31) - \log(C^2 + 1)\ .$$

It should be emphasized that the above expression is an "approximation" of the modified variance (of the logs) to be used in the stratified sampling, since some of Hewitt's prerequisites are not necessarily met. Therefore, it is appropriate to perform a test of the stratified sampling, using sample values of R(i), C(j), S_i, and T_j, to determine if the overall accident year CV is achieved within an acceptable tolerance.

Testing the stratified sampling parameters

To determine appropriate values for the distributions of R(i),C(j),S_i, and T_j, we referred again to the NAIC closed claim studies. Using the detail NAIC data base, after the frequency and severity trend adjustments, we constructed a report year/calendar year matrix as shown in

[7]Hewitt, *op. cit.*, Appendix A, p. 167.

Appendix B. The entire claim data base, now adjusted to represent an accident year, was stratified into cells defined by ten report years and 16 calendar years (relative to the accident year). Each cell contains the (adjusted) claim counts, amounts, and averages. From the totals by report year, we derived the percentages of total claims by report year and the relative severity for each report year. On pages 5-6 of that same Appendix we determined relative severity values for calendar years, relative to report years. The values from this matrix will, then, be a starting point to determine the R(i),C(j),S_i, and T_j values for a specific case (it should be pointed out that the actual historical report year and calendar year patterns for a given jurisdiction and self-insured entity, to the extent that they are credible, should be given more weight than the NAIC numbers).

For this paper's case study, we have selected the report year and calendar year distributions shown in page 7 and 8 of Appendix B. We have used a total of seven report years ($n = 7$) and nine relative calendar years ($m = 9$). The relative severity factors have been selected (roughly from the NAIC matrix) and then adjusted so that the sum of the products of the frequency times the relative severities is 1.0. The $(CV)^2$ of the cell means,

$$C^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} [S_i T_j]^2 C(j) R(i) \quad - 1$$

$$= .2607 .$$

Thus,

$$(\sigma_Y)^2 = \text{Log}(31) - \log(1.2607)$$

$$= 3.20232$$

and $\sigma_Y = 1.7895$.

Thus, while the standard deviation (of the logs) of the entire accident year is $\sqrt{\log(31)} =$ 1.8531, the standard deviation applicable to each cell will be reduced to 1.7895.

The results of our test of the stratified sampling versus unstratified is summarized in Appendix C. Rather than sampling from the lognormal distribution with no limit, we sampled successively from distributions with limits of $50,000, $100,000, $500,000, $1,000,000, $10,000,000, and $25,000,000. In each case, the unlimited mean was $100,000. For each limit, we (a) calculated the mean and CV directly,[8] (b) generated a sample mean and CV from the unstratified distribution, and (c) generated a sample mean and CV using the RY/CY strata with the adjusted means and appropriately reduced variance. To make sure we covered a full spectrum of possibilities, we used three values for $(CV)^2$: 10, 20, and 30. The report year and calendar year distributions were similar, but not identical, to those in pages 7-8 of Appendix B. For each combination, 100,000 claims were sampled.

The test samples demonstrated that the composite means and CV's derived from the stratified process were a good approximation to the direct calculation, within an acceptable tolerance.

THE ALAE COMPONENT IN THE MODEL

The ALAE-Indemnity relationship

Most excess policies written over a self-insured's SIR provide that ALAE on a claim (occurrence) is recoverable "pro rata," i.e., the percentage of the ALAE in a claim which is covered by the excess policy is the same as the percentage of the gross indemnity amount which is covered. Some contracts (relatively infrequent) set forth a retention level based on the *sum* of the indemnity and ALAE for one claim. In any case, the interaction between ALAE and indemnity would be an important consideration in any self-insured risk model.

It should be emphasized that in our self insured funding model the ALAE for the sampled claim is not treated as a constant factor related to the indemnity size (like tax and gratuity), but rather the *expected* ALAE (mean value of a separate ALAE distribution) is established, given the sample observed value of the indemnity. To treat ALAE otherwise would result in an understatement in the overall variability of the aggregate loss distribution.

To determine the functional relationship (if indeed a measurable relationship exists) between ALAE size and indemnity size for medical professional liability claims, we turned again to the NAIC Closed Claim Study.[9] As shown in Appendix D, Page 1, the *average* ALAE was calculated for each of several brackets of indemnity size. After plotting the average ALAE in each bracket against the corresponding average indemnity for the bracket, using logarithmic X and Y axes (see Appendix D, page 2), it was observed that a reasonably good straight line

[8] The calculation of the moments of a lognormal distribution limited (censored) by some limit L is fairly straightforward but is not covered here.

[9] NAIC, *op. cit.*

fit was obtainable, implying that the ALAE-indemnity relationship was representable by a member of the "power" curve family, $Y=AX^B$.

The equation used to regress the ALAE means against the indemnity values (grouped into brackets) is:

$$\text{Log}_e(Y) = A + B*\text{Log}_e(X).$$

The weighted least squares best fit coefficients, using the number of claims in each indemnity bracket as weights, were

$$A = 3.66331$$

$$B = .482945$$

From the same data base which was used to develop this relationship between average ALAE and indemnity, it was also determined that the average indemnity was $53,363. Thus,

Let I = average indemnity = 53363.

Then restate the regression formula above by expressing both ALAE and indemnity as a ratio to the average indemnity over the entire distribution, as follows:

$$Y'=Y/I$$

$$X'=X/I$$

Then the restated expression becomes:

$$\text{Log}_e(I*Y') = B*\text{Log}_e(I*X') + A .$$

Simplifying, you get

$$\text{Log}_e(Y') = B*\text{Log}_e(X') + B*\text{Log}_e(I) + A - \text{Log}_e(I)$$

$$= B*\text{Log}_e(X') + (B-1)*\text{Log}_e(I) + A .$$

Then let

$$C = (B-1)*\text{Log}_e(I) + A = -1.964768 .$$

You then have

$$\text{Log}_e(Y') = B*\text{Log}_e(X') + C$$

and

$$Y' = e^C X'^B = .1401884 * X'^{.482945}$$

For future reference, we call

$$D = e^C .$$

From the above expression, it can be noted that, in approximate terms, the expected ALAE varies in proportion to the square root of the sample indemnity.

Distribution of ALAE per claim, independent of indemnity

The next step of our treatment of ALAE in the model is to examine the distribution of ALAE per claim (defendant), irrespective of indemnity amounts. To do this, we again investigated the NAIC closed claim study.[10] The distribution is graphed in Appendix D, page 3. Using lognormal probability graph paper, the near straight line plot of the cumulative distribution function suggests that, just as was the case for the distribution of indemnity values by size, the ALAE amounts also can be represented quite adequately by the lognormal model.

We determined a mean and variance for the ALAE distribution two ways: first, we calculated the mean and variance directly from the data and then we followed the same procedure used for the indemnity graph. After drawing a straight line fit for the cumulative distribution function on the lognormal probability graph paper (the plotted points from the actual data were close enough to a straight line to allow us to simply draw the fitted line free-hand), we "picked off" the median and standard deviation directly from the graph, using the 50 percentile and +1

[10]For this distribution, we chose, for the sake of conservatism, the earlier 1975 version of the NAIC study, since the plotted CV was higher than that of the 1978 release.

standard deviation marks on the vertical scale, as follows:

Observed median $= e^{\mu} = 1355$.

Observed $\sigma = \log_e(5200) - \log_e(1355) = 1.345$

Our final selected value for the mean is, then

$$\exp(\log_e(1355)+(1.345)^2/2) = 3348 .$$

Of more importance, as will become clear later, our selected value for the variance was $(1.345)^2$, or 1.809.

Parameters for conditional ALAE distribution

We established earlier that, for purposes of sampling ALAE for any Monte Carlo simulation model, the *expected* ALAE in the distribution sampled from will be dependent on the sample indemnity value, or

$$E[Y|X] = DX^B ,$$

where

Y = random variable ALAE, conditional on value of indemnity, X

D = .1401884

B = .482945

and both Y and X are expressed relative to the unlimited mean indemnity.

Aitchison and Brown[11] have shown that if the random variable X is lognormally distributed with parameters μ and σ^2, then DX^B is also lognormally distributed with parameters log(D) + $B\mu$ and $B^2\sigma^2$. The parameters are the mean and variance, respectively, of the *logs* of the random variables.

We now let

S^2 = variance of the logs of ALAE means E[Y|X], conditional on sample indemnity values

$= B^2\sigma^2$

[11]*op. cit.*, p. 11.

$= (.482956)^2(1.8531)^2$
$= .8009$

Again employing Hewitt's method of isolating the "spread parameter",[12] we can solve for the variance applicable to each ALAE "group", $(\sigma_Y)^2$, defined as the sample ALAE *given* the sample indemnity mean:

We earlier derived an approximation for the combined variance

$$S^2 + (\sigma_Y)^2 = 1.809$$

then

$$(\sigma_Y)^2 = 1.809 - .8009$$
$$= 1 \text{ (approx.)}$$

In a word summary, then, we have established that the sample ALAE (relative to the unlimited mean indemnity) would be drawn from a lognormal distribution whose mean is .1401884 $X^{.482945}$ and the variance of whose logs is 1.0, where X represents the sample indemnity, relative to the unlimited mean indemnity.

Testing the sampled ALAE values, conditional on sample indemnity

Using the parameters estimated above, a test was set up to randomly sample 100,000 claims to make sure that the resulting overall ALAE sample moments were sufficiently close to those from direct calculations. For all ALAE combined, the coefficient of variation $(CV)_a$ is determined:

$$(CV_a)^2 = e^{S^2 + \sigma^2} - 1$$
$$= 5.104$$
$$CV_a = 2.259 \; .$$

From our sample of 100,000 claims, the sample CV for ALAE was 2.24363.

THE MONTE CARLO MODEL

Having highlighted the key actuarial considerations in approximating the probability

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[12]Hewitt, *loc. cit.*

distribution of self insured losses, we are now ready to describe the Monte Carlo model in some detail. The use of Monte Carlo models shows up with increasing regularity in the actuarial literature.[13] But despite the general agreement, in risk theory circles, that Monte Carlo models are an acceptable technique for approximating these distributions, this author perceives that any number of the direct approximation methods[14] are considered superior, assuming that the mean and variance of the distribution can be calculated directly and precisely.

Given all of the interactions between the many variables discussed above -- e.g., the calendar year payout and the present value calculation and the indexed retention and the ALAE-indemnity relationship -- plus the necessity of treating the runoff of prior years' losses and the target prospective year simultaneously, this author is hard pressed to identify any direct approximation formula from any risk theory text which will yield adequate results for the defined problem. The use of a Monte Carlo model, in which all of the interactions can be adequately defined and programmed into one composite risk process, would appear to be the only satisfactory approach.

A full description of our self-insurance Monte Carlo risk model is included in Appendix E. In the first section, we have listed the miscellaneous assumptions, the input parameters, and the various distributions from which samples are made. For our selected case study (which we will call "XYZ Hospital"), the initial target year is accident year 1989. A second run, made one year later, considers the run off from the 1989 year and the 1990 prospective losses. In the second section of the outline the actual simulation process for one trial (normally, at least 1,000 trials are run for a given case study) is outlined in pseudo code. Tracking the program flow through this pseudo code will reveal how the many variables interact with each other.

Parameter variance

Over the past few years there have been welcome additions to the body of actuarial literature dealing with *parameter variance*, as it relates to simulation models to approximate aggregate loss distributions. We will not attempt in this paper to supply another textbook treatment of *parameter variance* and *process variance*. Suffice it to say that it would be hard to imagine deriving any valid results from a Monte Carlo risk model which did not incorporate some kind of parameter variance -- particularly for a line with as much uncertainty surrounding the

[13]See, for example, P. E. Heckman and G. G. Meyers, "The Calculation of Aggregate Loss Distributions from Claim Severity and Claim Count Distributions," PCAS, LXX (1983), p. 22.

[14]No attempt will be made to provide a list of these methods here.

"universe" means (frequency and severity) as medical professional liability.

The key point is that the parameter variance is the same over all size of hospital risks. The vagaries of the business -- the social, economic, and legal dynamics which dictate that we do not deal from the same 52-card deck from one year to the next -- apply equally to all sizes of risks. Thus, while the process variance may play the lead role in driving the overall aggregate loss distribution for small hospitals, the parameter variance is predominate in models of larger risks, for which the process variance, or the pure statistical sampling error, has been reduced simply by virtue of the larger volume.

Rather than mathematically rolling the parameter and process variances into one combined variance for simulation purposes, this author chose to incorporate the two variances into the model as separate routines, in step-wise fashion. For a given trial, the first step is to randomly select the "universe" frequency and severity (average unlimited indemnity) from distributions the means of which represent our best estimate of these two parameters, based on the data which is available (statewide, countrywide, the hospital itself). The standard deviations of these distributions of the frequency and severity universe means are judgmentally selected to represent the "uncertainty" surrounding these means, resulting from many forces. This author is not aware of any successful attempts to quantify these factors, if, indeed, all of them have identified.

After the universe mean frequency and severity have been selected, the second step is to select the *sample* frequency (or total claim count) and then, for each claim, the *sample* claim amount. For sampling the frequency distribution, we use a Poisson process, unless the "universe" mean, selected in the first step, is greater than 15, in which case the model uses the normal approximation. As developed earlier in some detail, the lognormal distribution is used in the sampling of the individual claim amounts.

IBNR Distribution

Treating the runoff from prior years as a random process in our model requires not only simulating the payoff of reported and unpaid claims but also determining the *expected* IBNR from those years and the distribution around that expected value. As was shown in the description of the model and the "pseudo-code", the open cases are treated separately from the IBNR's. For our model, the expected number of IBNR's is determined by selecting an *a priori* total ultimate claim count for each of the prior years, and multiplying times the reporting percentages taken from our assumed reporting distribution. The actual *sample* number of

IBNR's for a particular trial is then determined by randomly selecting an ultimate number of claims for the prior year in question and then for each of these claims randomly selecting the report year (again from the report year distribution). If the report year thus selected is prior to the current year (thus indicating the claim would have already been reported) the claim is not counted as an IBNR and the loop continues to the next claim.

DERIVATION OF THE PROBABILITY DISTRIBUTION OF REQUIRED CONTRIBUTIONS

The Simulated Loss Distribution

With the Monte Carlo model loaded up with the appropriate input parameters and distributions, we can now make the run for our selected case study. For case 1, the initial year of the fund, the resulting printout of the distribution, generated from 1,000 trials of the model, is shown in Appendix F, page 2. A printout of the input parameters is on page 1 of that appendix. The results of the 1,000 trials have been tabulated and summarized into 31 intervals of retained losses (at present value), including the number of "hits" in each bracket and also the total retained losses in each bracket.

For case 2, performed on the same hospital at the beginning of the second year of the fund, the input parameters are shown on page 3 of Appendix F. For this case, the current assets become part of the input variables, as well as the assumed expected average indemnity on unpaid claims from the prior year. The resulting distribution of required *additional* funding for year 2 is shown on page 4. It can be noted that in over half of the trials no additional funds would have been required. In other words, the assets of the fund after one year (the first year's contribution plus earned interest less the losses paid) would have carried forward sufficient safety margin to cover not only the run-off from year one but also a second year's incurred losses. However, in order to continue to maintain funding at a high level of confidence for year 2, additional funding is required.

The histogram of the simulated distribution and the cumulative distribution ogive for cases 1 and 2 are shown on pages 5 and 6, for the first and second year funding. These plots display a fairly smooth and regular contour -- so much so that, with enough effort and with an appropriate set of parameters, someone could undoubtedly uncover some exotic probability density function which would supply an acceptable "fit" to this curve. But what purpose would this serve? It would be unlikely that such a curve, or even a member of its immediate family, would adequately fit another case defined by an entirely different set of initial variables (retentions, unlimited means, report-year/calendar-year payouts, etc.). Thus, the final estimated loss and required contribution distributions in Appendix F, generated solely for this one particular situation, initial funding and second year renewal funding, are simply what they are. They need no name.

From the final simulated distributions of required funding, one needs only to make a few simple interpolations to approximate the indicated funding levels at selected confidence levels. For this example we chose to display the 90%, 95%, and 99% confidence levels. These interpolations are shown at the end of the printouts on pages 2 and 4. Thus, the indicated funding levels for the two years would be as follows:

	Confidence Level		
	90%	95%	99%
Year 1	$2,340,000	$2,734,000	$3,594,000
Year 2	1,457,000	1,968,000	2,980,000

The second year funding indication depends, of course, on which funding level was selected for year one (corresponding to a selected level of confidence) and what the assets were at the beginning of year 2. For our case study, we assumed that the assets, after the first year's contribution, one year's interest earnings on the funds, less the disbursements (paid losses) were $2,950,000. We further assumed that there were seven claims reported and unpaid from year 1 at the beginning of year 2, with an average reserve of $130,000.

SUMMARY AND CONCLUSIONS

In this paper we have developed a procedure to determine the required funding for hospitals which self insure some layer of their professional liability exposure. The method would apply equally to workers' compensation. To derive indicated funding at various confidence levels, a probability distribution is approximated which combines the runoff of losses from prior years with the prospective losses of the target year. This distribution is approximated with a Monte Carlo simulation model, incorporating the interaction of many variables. The model is designed to be run on an annual basis, and at each renewal it calculates the distribution of additional contributions required which, when combined with the current assets, will cover the present value of all losses.

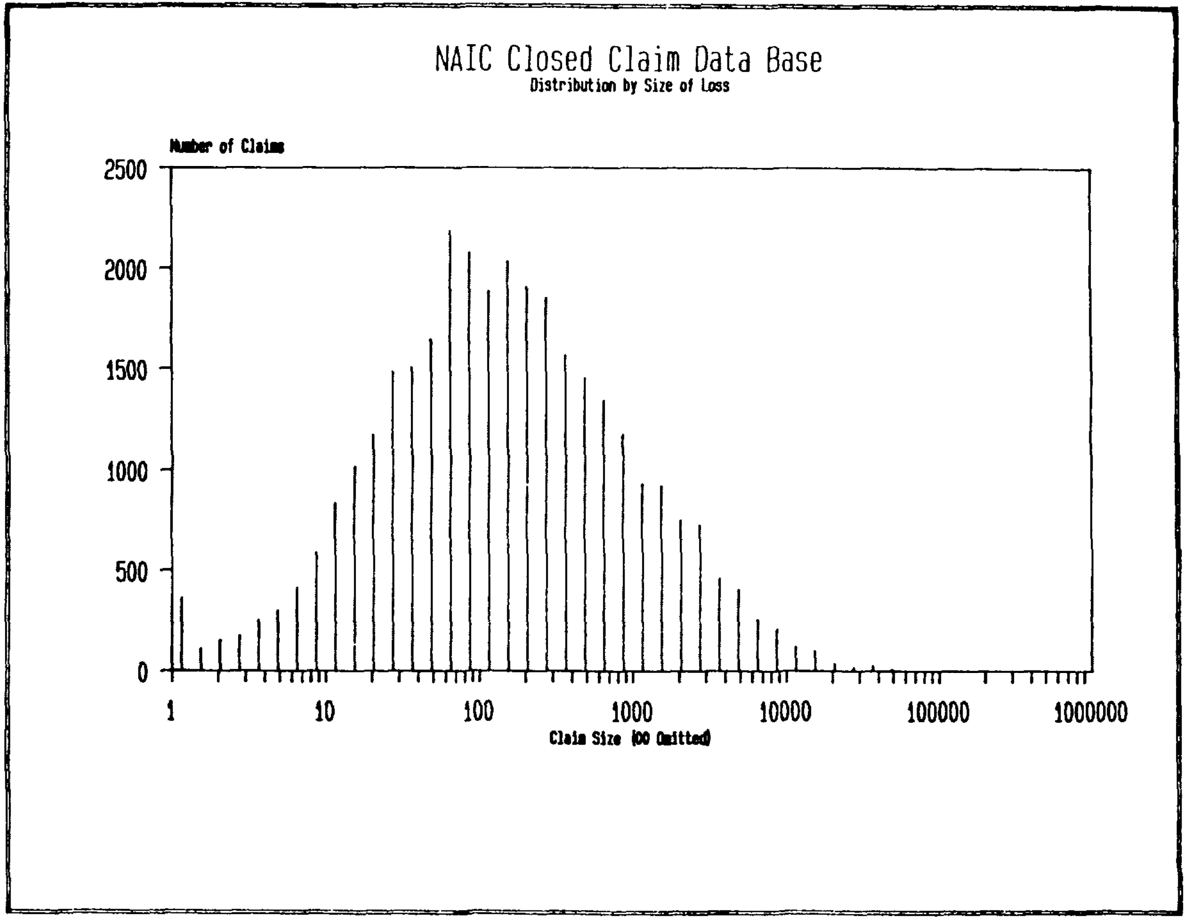
NAIC CLOSED CLAIM DATA BASE - ADJUSTED FOR FREQUENCY/SEVERITY INDICES

Distribution by Size of Loss

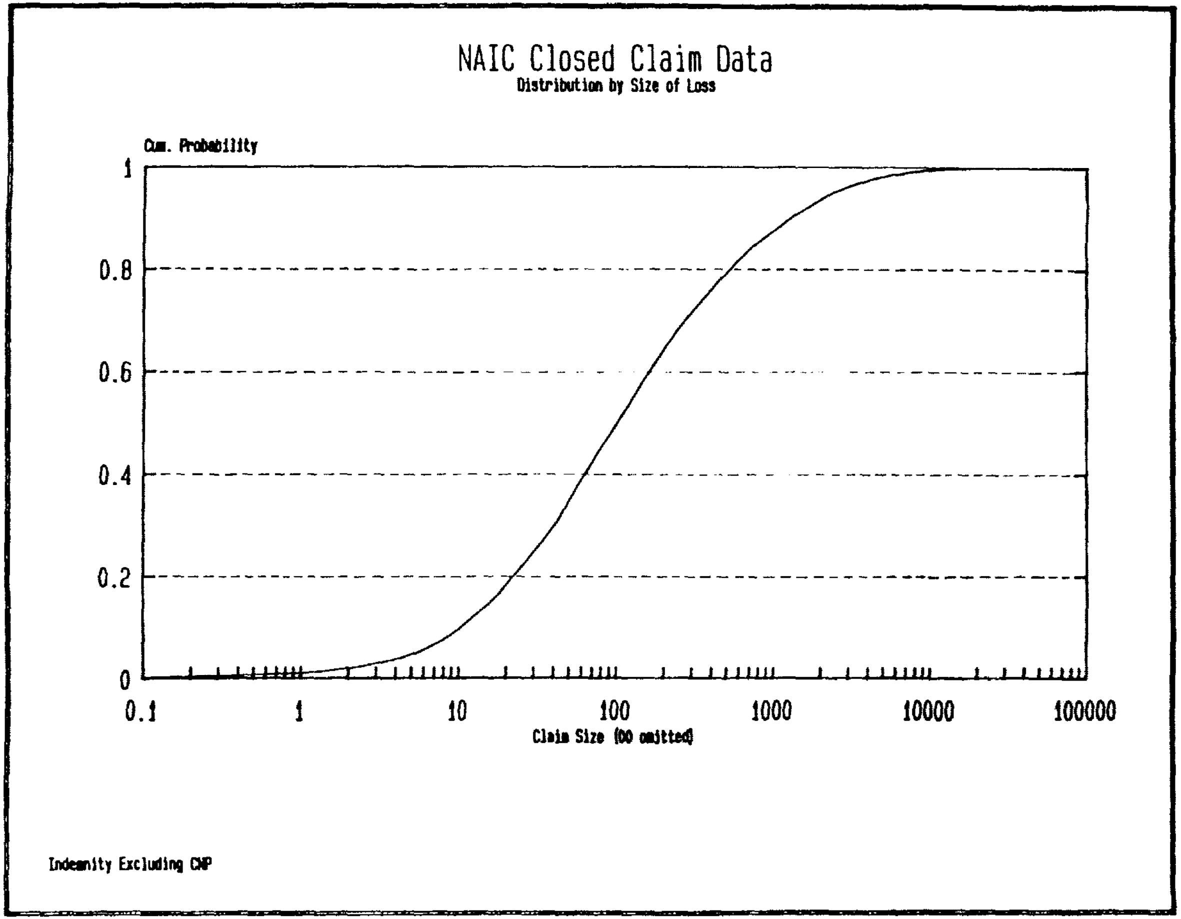
All Claims Combined

Bracket#	# Claims	Cum. # Claims	Indem. Amount	Avg. Indem.	Exp.Amount	Avg. Expense
0	51607.8	51607.8	0	0	133432000	2586
100	358.3	51966.1	18105	51	82011	229
133	103.2	52069.3	11821	115	28022	272
178	145.3	52214.6	22401	154	24138	166
237	167.7	52382.3	34386	205	65789	392
316	242.8	52625.1	67813	279	127607	526
422	292.9	52918.0	108852	372	120612	412
562	411.8	53329.8	201463	489	306647	745
750	581.2	53911.0	379945	654	409760	705
1000	828.3	54739.3	720464	870	767031	926
1334	1015.0	55754.3	1167310	1150	1408230	1387
1778	1170.2	56924.5	1831020	1565	1483850	1268
2371	1477.1	58401.6	3059210	2071	2794090	1892
3162	1499.5	59901.1	4177710	2786	2815350	1878
4217	1640.8	61541.9	6069360	3699	3594630	2191
5623	2180.2	63722.1	10755100	4933	5663140	2598
7499	2071.1	65793.2	13590200	6562	6580210	3177
10000	1884.5	67677.7	16401600	8703	5619610	2982
13335	2029.0	69706.7	23358300	11512	7190910	3544
17783	1906.4	71613.1	29460500	15453	9797740	5139
23714	1848.9	73462.0	37950200	20526	8096010	4379
31623	1564.3	75026.3	42906200	27428	8307880	5311
42170	1448.2	76474.5	53156900	36705	8734200	6031
56234	1340.3	77814.8	65590800	48937	9357350	6982
74989	1171.7	78986.5	76561700	65342	9231510	7879
100000	926.5	79913.0	79771100	86099	7090310	7653
133352	917.8	80830.8	105277000	114706	8637350	9411
177828	746.2	81577.0	114798000	153843	10081600	13511
237137	722.3	82299.3	148033000	204947	10681500	14788
316228	456.1	82755.4	124647000	273289	6077140	13324
421697	402.6	83158.0	145920000	362444	7202570	17890
562341	247.9	83405.9	120768000	487164	4983840	20104
749894	199.7	83605.6	129525000	648598	7204110	36075
1000000	112.6	83718.2	97909200	869531	2094480	18601
1333520	93.3	83811.5	106538000	1141890	2284480	24485
1778280	34.0	83845.5	50086600	1473140	1177000	34618
2371370	15.1	83860.6	30357800	2010450	434327	28763
3162280	22.4	83883.0	62135900	2773920	978374	43677
4216970	4.9	83887.9	19205700	3919530	206093	42060
5623410	0.0	83887.9	0	0	0	0
7498940	0.0	83887.9	0	0	0	0
10000000	0.0	83887.9	0	0	0	0
TOTALS		83887.9	1722570000	20534	295171000	3519
TOTAL, EXCL. CNP's		32280.1	1722570000	53363	161739000	5011

#End point of interval of indemnity amount


NAIC Closed Claim Data Base
Distribution by Size of Loss
Number of Claims
2500
2000
1500
1000
500
0
1
10
100
1000
10000
100000
1000000
Claim Size (00 Omitted)

Appendix A

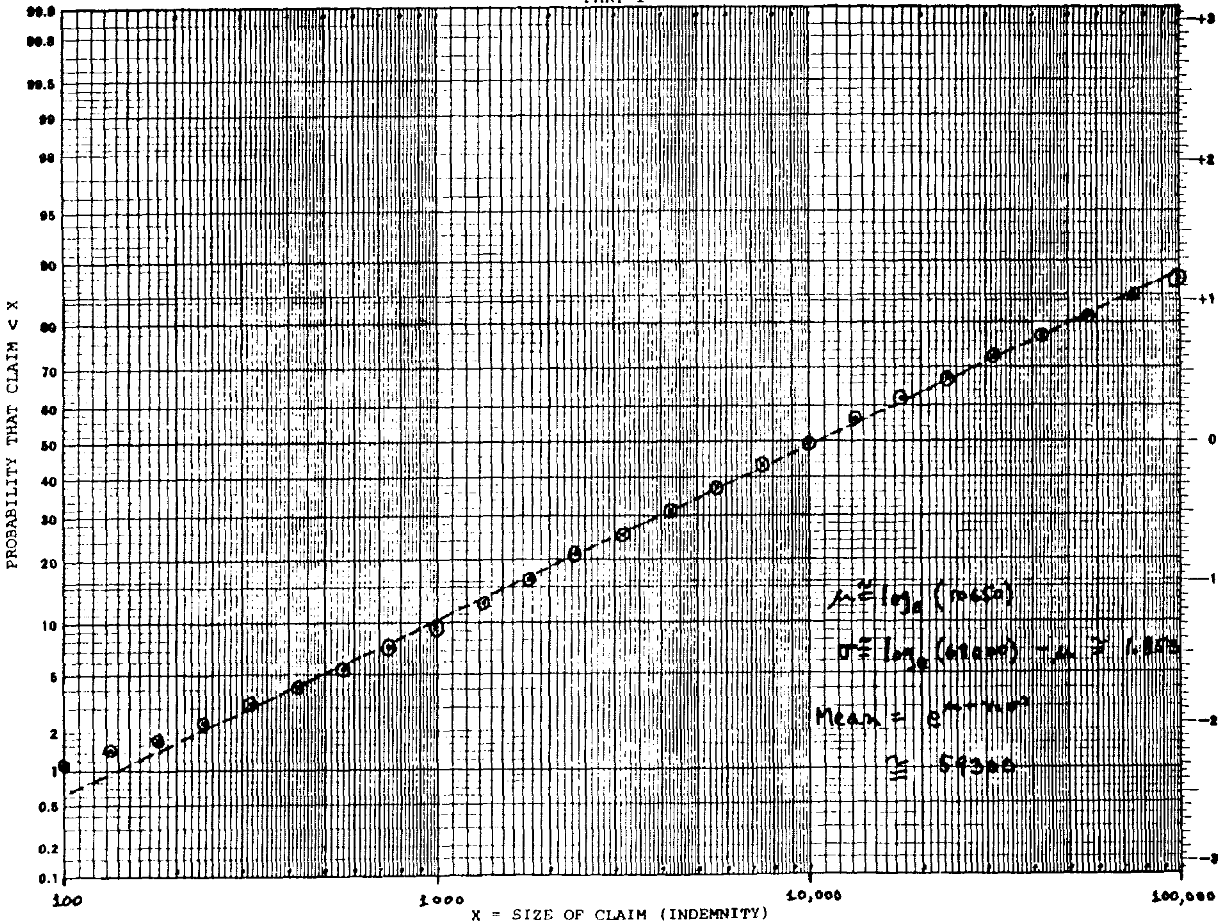

NAIC Closed Claim Data
Distribution by Size of Loss
Cum. Probability
1
0.8
0.6
0.4
0.2
0
0.1
1
10
100
1000
10000
100000
Claim Size (00 omitted)
Indemnity Excluding CNP

Appendix A

NAIC CLOSED CLAIM STUDY

CUMULATIVE DISTRIBUTION BY SIZE OF LOSS

PART 1

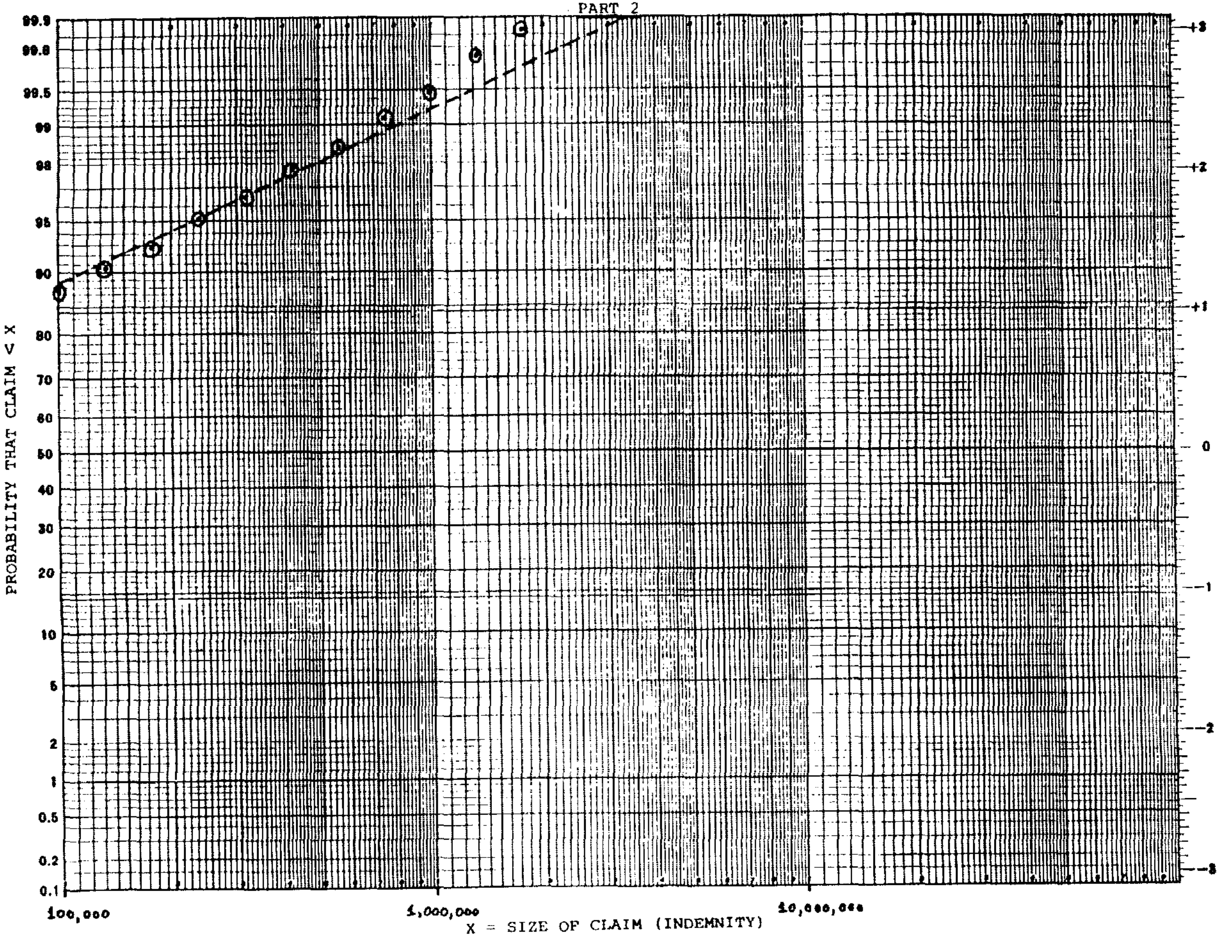


Appendix A

NAIC CLOSED CLAIM STUDY

CUMULATIVE DISTRIBUTION BY SIZE OF LOSS

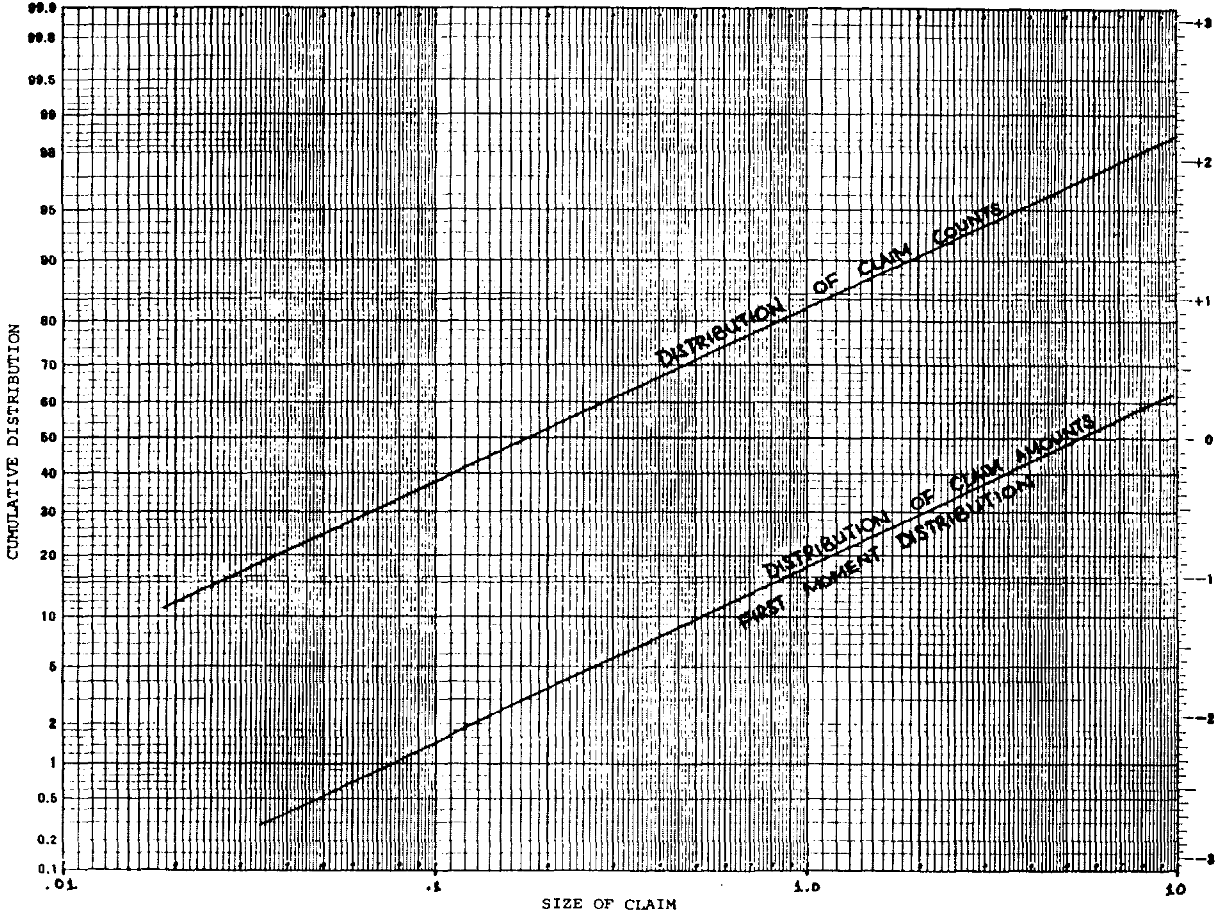
PART 2



Appendix A

MEDICAL PROFESSIONAL LIABILITY - MODEL CLAIM SIZE DISTRIBUTION

(MEAN = 1)



NAIC CLOSED MEDICAL LIABILITY CLAIMS - ADJUSTED FOR FREQUENCY/SEVERITY TRENDS

REPORT YEAR/CALENDAR YEAR MATRIX FOR LOSSES OF ONE ACCIDENT YEAR

	Report Year										
Cal.Year	1	2	3	4	5	6	7	8	9	10+	Total CY
1:											
#CWI	4218.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4218.5
INDEM	32999300	0	0	0	0	0	0	0	0	0	32999300
#CWI/CWE	2822.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2822.5
ALAE	1985220	0	0	0	0	0	0	0	0	0	1985220
#CNP	11648.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11648.7
AVG.INDEM	7823	0	0	0	0	0	0	0	0	0	7823
AVG.ALAE	703	0	0	0	0	0	0	0	0	0	703
2:											
#CWI	3400.8	998.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4399.5
INDEM	97259700	15218500	0	0	0	0	0	0	0	0	112478000
#CWI/CWE	4685.5	1305.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5990.8
ALAE	11119700	2209980	0	0	0	0	0	0	0	0	13329700
#CNP	6591.1	2076.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8667.3
AVG.INDEM	28599	15238	0	0	0	0	0	0	0	0	25566
AVG.ALAE	2373	1693	0	0	0	0	0	0	0	0	2225
3:											
#CWI	2771.4	2013.0	659.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5443.8
INDEM	114001000	63847100	11433500	0	0	0	0	0	0	0	189282000
#CWI/CWE	4473.3	4075.9	1418.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9967.7
ALAE	18193800	10811900	2336750	0	0	0	0	0	0	0	31342400
#CNP	1754.2	2141.0	966.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4862.1
AVG.INDEM	41135	31717	17339	0	0	0	0	0	0	0	34770
AVG.ALAE	4067	2653	1647	0	0	0	0	0	0	0	3144
4:											
#CWI	2059.9	2065.8	1183.4	196.7	0.0	0.0	0.0	0.0	0.0	0.0	5505.8
INDEM	119169000	97840500	37162100	5590990	0	0	0	0	0	0	259762000
#CWI/CWE	3439.6	3882.1	2687.6	425.0	0.0	0.0	0.0	0.0	0.0	0.0	10434.3
ALAE	22287000	22019200	9143340	750406	0	0	0	0	0	0	54200000
#CNP	512.5	700.7	945.5	367.6	0.0	0.0	0.0	0.0	0.0	0.0	2526.3
AVG.INDEM	57852	47362	31403	28424	0	0	0	0	0	0	47180
AVG.ALAE	6480	5672	3402	1766	0	0	0	0	0	0	5194
5:											
#CWI	1287.5	1494.5	1353.5	365.7	100.6	0.0	0.0	0.0	0.0	0.0	4601.8
INDEM	90294500	99669400	60844300	19196000	4988230	0	0	0	0	0	274992000
#CWI/CWE	2012.5	2716.1	2502.3	852.4	165.1	0.0	0.0	0.0	0.0	0.0	8248.4
ALAE	15079500	18122900	12210800	2898220	360409	0	0	0	0	0	48671900
#CNP	221.8	359.9	411.7	357.0	175.5	0.0	0.0	0.0	0.0	0.0	1525.9
AVG.INDEM	70132	66691	44953	52491	49585	0	0	0	0	0	59758
AVG.ALAE	7493	6672	4880	3400	2183	0	0	0	0	0	5901

NAIC CLOSED MEDICAL LIABILITY CLAIMS - ADJUSTED FOR FREQUENCY/SEVERITY TRENDS

REPORT YEAR/CALENDAR YEAR MATRIX FOR LOSSES OF ONE ACCIDENT YEAR

Cal.Year	Report Year 1	2	3	4	5	6	7	8	9	10+	Total CY
6:											
#CWI	637.0	954.0	936.5	448.5	175.6	40.5	0.0	0.0	0.0	0.0	3192.1
INDEM	62810500	68229600	51776400	29412800	7451200	2176270	0	0	0	0	221857000
#CWI/CWE	1047.0	1611.6	1645.2	822.7	354.8	72.2	0.0	0.0	0.0	0.0	5553.5
ALAE	8918380	15749100	11532300	5062490	1394870	124000	0	0	0	0	42781100
#CNP	114.7	234.5	257.7	144.7	186.3	89.3	0.0	0.0	0.0	0.0	1027.2
AVG.INDEM	98604	71520	55287	65580	42433	53735	0	0	0	0	69502
AVG.ALAE	8518	9772	7010	6154	3931	1717	0	0	0	0	7703
7:											
#CWI	312.0	457.1	501.4	288.3	159.3	91.9	35.5	0.0	0.0	0.0	1845.5
INDEM	25695300	43347500	36378300	28472600	7354830	7186140	1840770	0	0	0	150276000
#CWI/CWE	519.9	842.0	850.2	588.1	311.2	186.9	64.2	0.0	0.0	0.0	3362.5
ALAE	5202720	7814970	7501700	5747590	1468480	847159	119039	0	0	0	28701700
#CNP	63.4	118.7	161.5	64.2	72.1	118.8	76.6	0.0	0.0	0.0	675.3
AVG.INDEM	82357	94832	72553	98760	46170	78195	51853	0	0	0	81428
AVG.ALAE	10007	9281	8823	9773	4719	4533	1854	0	0	0	8576
8:											
#CWI	166.6	169.9	246.1	154.4	107.2	86.1	69.5	48.6	0.0	0.0	1048.4
INDEM	22553100	20196800	24585500	23101900	14556600	8527560	15314600	3321850	0	0	132158000
#CWI/CWE	261.4	343.5	508.7	319.7	174.7	138.9	138.0	52.6	0.0	0.0	1937.5
ALAE	2390770	3691680	5584570	2777160	1436690	1067770	561138	106096	0	0	17615900
#CNP	53.6	57.0	60.5	24.4	33.7	32.2	78.4	56.9	0.0	0.0	396.7
AVG.INDEM	135373	118875	99900	149624	135789	99043	220354	68351	0	0	126057
AVG.ALAE	9146	10747	10978	8687	8224	7687	4066	2017	0	0	9092
9:											
#CWI	91.9	125.3	138.1	87.3	55.5	76.6	56.4	45.1	12.6	0.0	688.8
INDEM	16032600	16306000	28059500	18619100	4322220	16250000	3333660	6686580	553704	0	110163000
#CWI/CWE	178.4	208.7	264.1	197.0	108.4	104.9	95.6	99.4	17.8	0.0	1274.3
ALAE	2408700	2365090	4652560	2499220	1299700	798795	524145	559968	17809	0	15126000
#CNP	17.6	27.6	46.9	22.8	16.0	21.9	50.8	61.2	31.2	0.0	296.0
AVG.INDEM	174457	130136	203182	213277	77878	212141	59107	148261	43945	0	159935
AVG.ALAE	13502	11332	17617	12686	11990	7615	5483	5633	1001	0	11870
10:											
#CWI	38.2	59.6	102.1	64.4	30.8	33.5	33.0	46.3	40.9	9.4	458.2
INDEM	6153010	10470000	25091200	11632900	7919250	9263940	6371450	7106910	6234870	550632	90794100
#CWI/CWE	77.4	99.1	153.7	100.6	70.3	59.8	61.3	70.1	72.5	21.1	785.9
ALAE	767007	1593940	2390640	1606360	1013300	495524	477845	302084	354016	791526	9792240
#CNP	7.0	12.2	30.3	19.0	2.2	0.0	9.8	7.4	30.5	7.1	125.5
AVG.INDEM	161074	175671	245751	180635	257119	276536	193074	153497	152442	58578	198154
AVG.ALAE	9910	16084	15554	15968	14414	8286	7795	4309	4883	37513	12460

NAIC CLOSED MEDICAL LIABILITY CLAIMS - ADJUSTED FOR FREQUENCY/SEVERITY TRENDS

REPORT YEAR/CALENDAR YEAR MATRIX FOR LOSSES OF ONE ACCIDENT YEAR

	Report Year										
Cal.Year	1	2	3	4	5	6	7	8	9	10+	Total CY
11:											
#CWI	32.4	28.4	50.5	27.5	10.6	12.8	40.6	20.3	30.8	49.0	302.9
INDEM	4386450	4233490	5834620	5565890	1339760	765109	3187830	3816980	1481460	4948140	35559700
#CWI/CWE	47.1	55.4	80.9	50.7	23.5	14.9	67.9	56.2	59.2	54.5	510.3
ALAE	747815	842896	1031990	859194	329762	109646	626445	510024	462201	185338	5705310
#CNP	10.5	12.1	10.4	4.8	0.0	7.6	5.3	2.6	17.6	46.0	116.9
AVG.INDEM	135384	149067	115537	202396	126393	59774	78518	188029	48099	100982	117398
AVG.ALAE	15877	15215	12756	16947	14032	7359	9226	9075	7807	3401	11180
12:											
#CWI	8.3	24.1	24.2	16.0	12.8	16.5	13.4	26.0	28.1	57.6	227.0
INDEM	1117480	6275840	4763150	2770500	2870580	4038150	1583540	2216640	5530560	6412130	37578600
#CWI/CWE	32.7	51.7	37.0	19.0	18.1	19.3	29.8	28.3	44.1	109.9	389.9
ALAE	545520	764081	426788	214047	146696	109696	443067	434754	1042200	13770900	17897800
#CNP	8.0	0.0	10.8	10.7	5.2	0.0	0.0	2.7	0.0	47.1	84.5
AVG.INDEM	134636	260408	196824	173156	224264	244736	118175	85255	196817	111322	165544
AVG.ALAE	16683	14779	11535	11266	8105	5684	14868	15362	23633	125304	45904
13:											
#CWI	5.4	5.3	22.4	2.8	5.3	2.8	5.2	8.9	24.8	57.5	140.4
INDEM	1103330	1078500	6978730	137336	560984	610383	1687220	10049400	5933220	6842250	34981300
#CWI/CWE	8.2	16.5	30.6	5.4	13.9	2.7	13.6	8.9	24.8	98.2	222.8
ALAE	117986	235890	551016	97325	50023	29515	212639	367939	349327	571351	2583010
#CNP	2.8	2.6	2.7	0.0	0.0	2.8	2.6	8.5	13.6	24.8	60.4
AVG.INDEM	204320	203491	311550	49049	105846	217994	324464	1129140	239243	118996	249155
AVG.ALAE	14389	14296	18007	18023	3599	10931	15635	41341	14086	5818	11593
14:											
#CWI	8.8	5.8	14.4	0.0	0.0	5.5	0.0	2.8	5.7	66.7	109.7
INDEM	162381	519054	1590490	0	0	615932	0	2136340	385388	14013500	19423100
#CWI/CWE	9.0	8.8	23.0	5.7	0.0	5.5	0.0	2.8	14.3	89.6	158.7
ALAE	27520	178291	246741	26013	0	60947	0	1896	525605	805173	1872190
#CNP	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	23.6
AVG.INDEM	18452	89492	110451	0	0	111988	0	762979	67612	210098	177056
AVG.ALAE	3058	20260	10728	4564	0	11081	0	677	36756	8986	11797
15:											
#CWI	5.7	3.1	0.0	0.0	0.0	0.0	0.0	3.1	0.0	14.8	26.7
INDEM	1076180	274815	0	0	0	0	0	1544170	0	1588750	4483920
#CWI/CWE	14.5	3.1	0.0	3.0	0.0	0.0	0.0	3.1	3.0	43.9	70.6
ALAE	221683	99595	0	80071	0	0	0	609400	29850	473084	1513680
#CNP	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	5.8	8.8
AVG.INDEM	188804	88650	0	0	0	0	0	498121	0	107348	167937
AVG.ALAE	15288	32127	0	26690	0	0	0	196581	9950	10776	21440

NAIC CLOSED MEDICAL LIABILITY CLAIMS - ADJUSTED FOR FREQUENCY/SEVERITY TRENDS

REPORT YEAR/CALENDAR YEAR MATRIX FOR LOSSES OF ONE ACCIDENT YEAR

page 4 of 4

	Report Year										
Cal.Year	1	2	3	4	5	6	7	8	9	10+	Total CY
16:											
#CWI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.4	70.4
INDEM	0	0	0	0	0	0	0	0	0	15784300	15784300
#CWI/CWE	0.0	0.0	0.0	3.1	0.0	3.1	0.0	0.0	0.0	80.3	86.5
ALAE	0	0	0	16284	0	65949	0	0	0	1951080	2033320
#CWP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4	21.4
AVG.INDEM	0	0	0	0	0	0	0	0	0	224209	224209
AVG.ALAE	0	0	0	5253	0	21274	0	0	0	24297	23507
Total Rep.Year											
#CWI	15044.4	8404.6	5232.0	1651.6	657.7	366.2	253.6	201.1	142.9	325.4	32279.5
INDEM	594814000	447507000	294498000	144500000	51363700	49433500	33319100	36878800	20119200	50139700	1722570000
#CWI/CWE	19629.0	15219.8	10201.8	3392.4	1240.0	608.2	470.4	321.4	235.7	497.5	51816.2
ALAE	90013400	86499500	57609200	22634400	7499930	3709000	2964320	2892160	2781010	18548500	295151000
#CWP	21011.7	5742.5	2904.9	1015.2	491.0	272.6	226.5	139.3	92.9	170.0	32066.6
AVG.INDEM	39537	53246	56288	87491	78096	134990	131384	183386	140792	154086	53364
AVG.ALAE	4586	5683	5647	6672	6048	6098	6302	8999	11799	37283	5696
Ratio, avg. indemnity to total acc.yr.	.74	1.00	1.05	1.64	1.46	2.53	2.46	3.44	2.64	2.89	
"Smoothed" avg. indem. ratio	.74	1.00	1.20	1.40	1.60	2.00	2.35	2.70	2.845	3.00	
Ratio, total # claims to total acc.yr.	.484	.250	.156	.053	.021	.011	.008	.005	.004	.008	

Source: NAIC Malpractice Claims: Medical Malpractice Closed Claims, 1975-78, National Association of Insurance Commissioners. 1980.
Adjustments for frequency/severity trends performed by the author on the detail data tape purchased from NAIC. Accordingly, the conclusions drawn from the adjusted data are those of the author and not necessarily those of the NAIC.

MAIC CLOSED MEDICAL LIABILITY CLAIMS - ADJUSTED FOR FREQUENCY/SEVERITY TRENDS

REPORT YEAR/CALENDAR YEAR MATRIX FOR LOSSES OF ONE ACCIDENT YEAR

Average Indemnity by Calendar Year Components of Report Year
Page 1 of 2

Cal. Year	Report Year 1	2	3	4	5	6	7	8	9	10+	
1:	7823 0.198	<----------- Average indemnity <----------- Ratio, avg. indemnity to avg.ind.,total report year									
2:	28599 0.723	15238 0.286									
3:	41135 1.040	31717 0.596	17339 0.308								
4:	57852 1.463	47362 0.890	31403 0.558	28424 0.325							
5:	70132 1.774	66691 1.253	44953 0.799	52491 0.600	49585 0.635						
6:	98604 2.494	71520 1.343	55287 0.982	65580 0.750	42433 0.543	53735 0.398					
7:	82357 2.083	94832 1.781	72553 1.289	98760 1.129	46170 0.591	78195 0.579	51853 0.395				
8:	135373 3.424	118875 2.233	99900 1.775	149624 1.710	135789 1.739	99043 0.734	220354 1.677	68351 0.373			
9:	174457 4.412	130136 2.444	203182 3.610	213277 2.438	77878 0.997	212141 1.572	59107 0.450	148261 0.808	43945 0.312		
10:	161074 4.074	175671 3.299	245751 4.366	180635 2.065	257119 3.292	276536 2.049	193074 1.470	153497 0.837	152442 1.083	58578 0.380	Rel. CY 1
11:	135384 3.424	149067 2.800	115537 2.053	202396 2.313	126392 1.618	59774 0.443	78518 0.598	188029 1.025	48099 0.342	100982 0.655	Rel. CY 2
12:	134636 3.405	260408 4.891	196824 3.497	173156 1.979	224264 2.872	244736 1.813	118175 0.899	85255 0.465	196817 1.398	111322 0.722	Rel. CY 3
13:	204320 5.168	203491 3.822	311550 5.535	49049 0.561	105846 1.355	217994 1.615	324465 2.470	1129150 6.157	239243 1.699	118996 0.772	etc.
14:	18452 0.467	89492 1.681	110451 1.962	0 0.000	0 0.000	111988 0.830	0 0.000	762979 4.161	67612 0.480	210097 1.364	
15:	188804 4.775	88650 1.665	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	498119 2.716	0 0.000	107348 0.697	
16:	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	224209 1.455	
Total rep.yr	39537 1.000	53246 1.000	56288 1.000	87491 1.000	78096 1.000	134990 1.000	131384 1.000	183386 1.000	140792 1.000	154086 1.000	

NAIC CLOSED MEDICAL LIABILITY CLAIMS - ADJUSTED FOR FREQUENCY/SEVERITY TRENDS

REPORT YEAR/CALENDAR YEAR MATRIX FOR LOSSES OF ONE ACCIDENT YEAR

Average Indemnity by Calendar Year Components of Report Year
Page 2 of 2

Composite Average Indemnity by Relative Calendar Year Cells

		Smoothed
relative cal. year 1 avg. =	0.233	.25
relative cal. year 2 avg. =	0.669	.67
relative cal. year 3 avg. =	0.891	.89
relative cal. year 4 avg. =	1.295	1.30
relative cal. year 5 avg. =	1.531	1.53
relative cal. year 6 avg. =	2.125	2.13
relative cal. year 7 avg. =	2.623	2.60
relative cal. year 8 avg. =	3.173	2.80
relative cal. year 9 avg. =	2.972	3.00

XYZ HOSPITAL

Assumed Distribution of Claims by Report Year

For Claims Incurred in One Accident Year

	Report Year	(1) Ratio, Number of Claims Reported to Total Accident Year Claims	(2) Ratio, Average Indemnity to Average for Entire Accident Year	(3) Ratio, Amount of Indemnity to Total Accident Year = (1) x (2)
	1	.387	.73873	.28589
	2	.300	.98498	.29549
	3	.201	1.18197	.23758
	4	.066	1.37897	.09101
	5	.025	1.67446	.04186
	6	.012	2.16695	.02600
	7	.009	2.46245	.02216
Total		1.0000		1.000

XYZ HOSPITAL

Assumed Distribution of Claims by Calendar Year of Payment

For Claims Incurred in One Report Year

Calendar Year	(1) Ratio, Number of Claims Paid to Total Report Year	(2) Ratio, Average Indemnity to Average for Entire Report Year	(3)* Ratio, Amount of Indemnity to Total Report Year = (1) x (2)
1	.25742	.26416	.068
2	.18505	.70794	.131
3	.25840	.94040	.243
4	.13104	1.37362	.180
5	.07175	1.61664	.116
6	.03110	2.25062	.070
7	.02403	2.74724	.066
8	.02197	2.95857	.065
9	.01924	3.16989	.061
Total	1.0000		1.000

* Column (1) x Column (2)

Note: Distribution includes *all* claims from ground up

MEDICAL PROFESSIONAL LIABILITY CLAIM SIZE DISTRIBUTION

TEST OF SAMPLED MEANS AND CV'S, STRATIFIED AND UNSTRATIFIED COMPARED TO DIRECT CALCULATIONS, WITH VARIOUS POLICY LIMITS

Lognormal distribution with Unlimited mean = 100,000

Each sample = 100,000 random trials

	Unlim. CV^2=10		Unlim. CV^2=20		Unlim. CV^2=30	
	Limited Mean	Limited CV	Limited Mean	Limited CV	Limited Mean	Limited CV
Limit=50,000						
Direct Calc.	29686	0.6361	26076	0.7511	24185	0.8173
Sample, unstrat.	29716	0.6352	26119	0.7502	24231	0.8164
Sample, strat.	29242	0.6525	25717	0.7655	23861	0.8309
Limit=100,000						
Direct Calc.	43878	0.8464	38297	0.9696	35416	1.0413
Sample, unstrat.	43960	0.8453	38370	0.9681	35476	1.0395
Sample, strat.	43245	0.8614	37723	0.9831	34868	1.0544
Limit=500,000						
Direct Calc.	77888	1.4981	70163	1.6635	65847	1.7595
Sample, unstrat.	77742	1.4948	69996	1.6605	65667	1.7566
Sample, strat.	77020	1.5166	69251	1.6829	64935	1.7796
Limit=1,000,000						
Direct Calc.	88071	1.8412	81451	2.0531	77437	2.1725
Sample, unstrat.	87797	1.8374	81158	2.0508	77136	2.1711
Sample, strat.	87386	1.8657	80648	2.0786	76594	2.1988
Limit=10,000,000						
Direct Calc.	99499	2.8548	98364	3.5134	97273	3.8728
Sample, unstrat.	98367	2.7628	96964	3.4215	95784	3.7946
Sample, strat.	99335	2.9231	98250	3.5966	97164	3.9585
Limit=25,000,000						
Direct Calc.	99916	3.0473	99582	3.9620	99169	4.4987
Sample, unstrat.	98575	2.8535	97794	3.7435	97141	4.2810
Sample, strat.	99619	3.0336	99436	3.9946	99192	4.5895

Notes:

The objective of this test is to establish the reliability of the Monte Carlo simulation process in sampling indemnity amounts, both stratified and unstratified. The stratified process samples from distributions for assigned report year/calendar year subsets of an accident year. Prior to each RY/CY sampling, the report year and calendar year are selected randomly from RY/CY distributions. For the selected subset, the mean has been adjusted by report year and calendar year severity relativity factors and the variance has been adjusted downward from the variance for the entire accident year, so that the total sample variance for all subsets combined will approximate that of the overall accident year. The unstratified sampling bypasses the partitioning of the accident year into report year/calendar cells and simply samples from the total accident year distribution, using the accident year mean and overall variance.

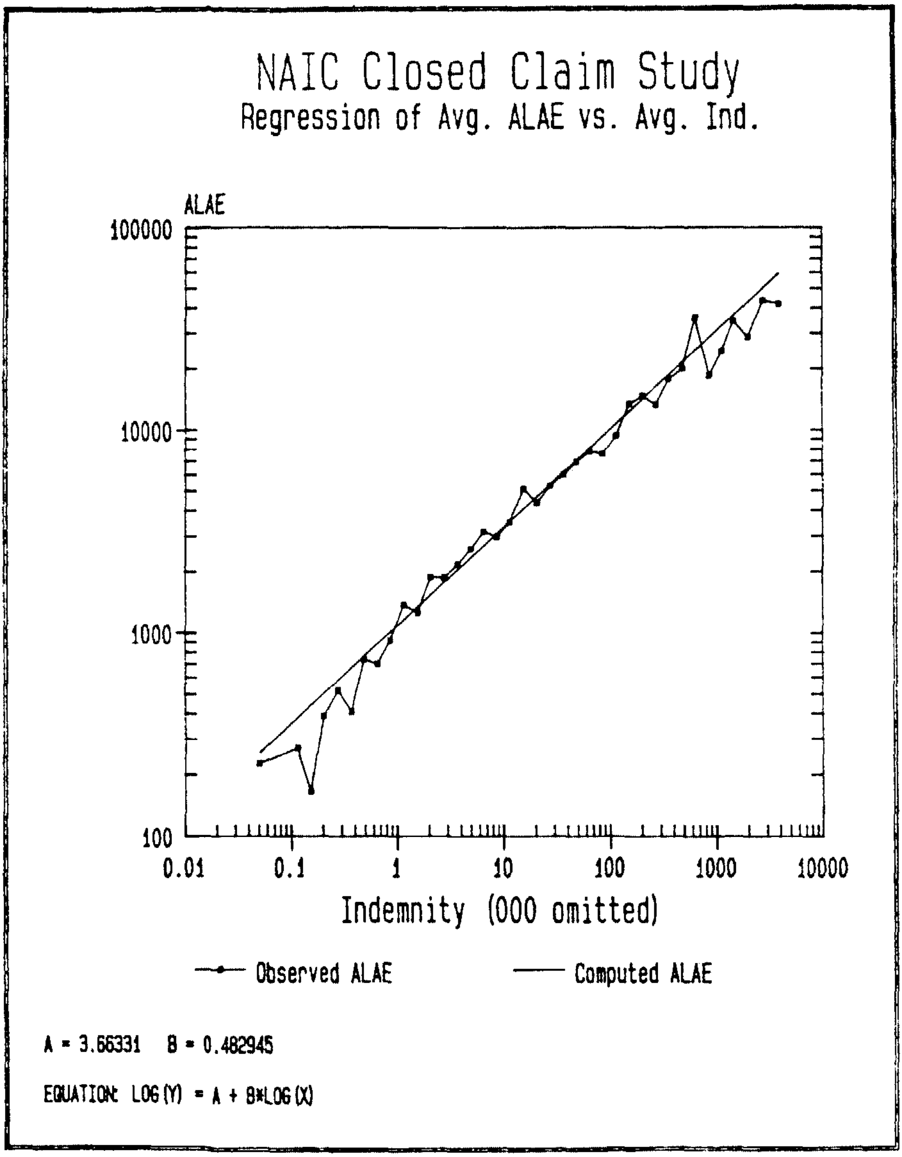
NAIC CLOSED CLAIM STUDY

Regression of Avg. Expense Versus Avg. Indemnity

X = Average Indemnity Bracket	Y = Average ALAE In Bracket	Weight (Number of Claims)	Computed Y
51	229	358.3	259.2
115	272	103.2	384.9
154	166	145.3	444.3
205	392	167.7	509.9
279	526	242.8	591.9
372	412	292.9	679.5
489	745	411.8	776.0
654	705	581.2	892.6
870	926	828.3	1024.6
1150	1387	1015.0	1172.5
1565	1268	1170.2	1360.5
2071	1892	1477.1	1557.7
2786	1878	1499.5	1797.6
3699	2191	1640.8	2061.3
4933	2598	2180.2	2368.8
6562	3177	2071.1	2718.7
8703	2982	1884.5	3116.1
11512	3544	2029.0	3566.7
15453	5139	1906.4	4111.7
20526	4379	1848.9	4715.8
27428	5311	1564.3	5424.5
36706	6031	1448.2	6244.1
48937	6982	1340.3	7174.5
65342	7879	1171.7	8249.5
86099	7653	926.5	9425.2
114706	9411	917.8	10825.7
153844	13511	746.2	12474.7
204947	14788	722.3	14328.0
273289	13324	456.1	16464.3
362444	17890	402.6	18869.6
487164	20104	247.9	21766.5
648598	36075	199.7	24993.1
869532	18601	112.6	28794.1
1141890	24485	93.3	32843.9
1473140	34618	34.0	37143.0
2010450	28763	15.1	43161.8
2773930	43677	22.4	50421.5
3919530	42060	4.9	59583.4

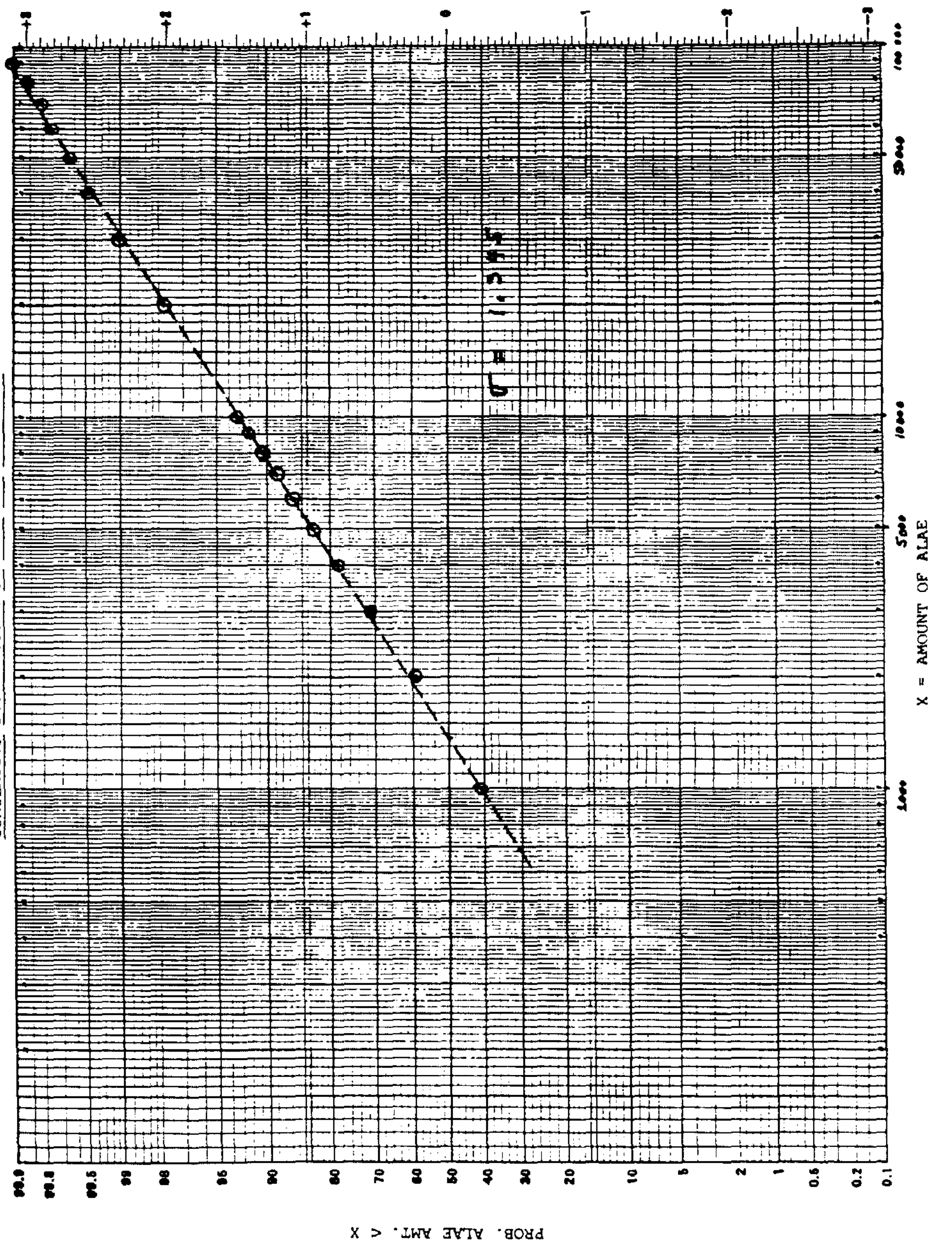
B = 0.48294500 A= 3.66331000

EQUATION: Log (Y) = A+B*LOG(X)


NAIC Closed Claim Study
Regression of Avg. ALAE vs. Avg. Ind.
ALAE
100000
10000
1000
100
0.01
0.1
1
10
100
1000
10000
Indemnity (000 omitted)
Observed ALAE
Computed ALAE
A = 3.66331 B = 0.482945
EQUATION: LOG(Y) = A + B*LOG(X)

NAIC CLOSED CLAIM STUDY

CUMULATIVE DISTRIBUTION OF ALAE PER DEFENDANT



DESCRIPTION OF MONTE CARLO MODEL TO GENERATE PROBABILITY DISTRIBUTION OF REQUIRED SELF INSURANCE CONTRIBUTION

I. Miscellaneous Assumptions, Input parameters, and Distributions

(a) Report year distribution of accident year losses, with relative severity factors by report year - see Appendix B, page 7.

(b) Calendar year distribution of report year losses, with relative severity factors by calendar year - see Appendix B, page 8.

(c) Distribution of claims (indemnity) by size - see Appendix A, page 6.

Note: the basic distribution applies to all claims of one accident year, using the overall mean value for the entire year. The model stratifies the claims first in 63 report year/calendar year cells, each with a modified mean value from (a) and (b) above. Accordingly the variance applicable to each cell has been reduced from the overall variance for random selection purposes, such that the combined sample variance over all 63 cells will approximate the entire accident year distribution.

(d) Average unlimited indemnity by year - used as the parameter in the size of loss distribution for each accident year:

year 1: $200,000
year 2: $225,000

(e) Average claim expense by year. Based on the functional relationship derived between expected average ALAE and the sample indemnity value (see Appendix D), the sample ALAE is SELECTED from a distribution the *mean* of which is determined as a function of the sample indemnity. The starting values for the average ALAE for the entire accident year, over all indemnity values, are:

year 1: $12,000
year 2: $13,000

(f) Total *expected* number of claims by accident year, including claims closed with indemnity (CWI) and claims closed with expense only (CWE):

year 1: 20

year 2: 21

(claims closed with no payment are excluded)

(g) Percentages for claims disposed, all years:

CWI: 60%

CWE: 40%

(h) Self insured retention, all years:

per claim: $1,000,000

annual aggregate: $5,000,000

(i) Parameter variance (uncertainty factor). These values are expressed in relation to the expected population frequency and severity, which are input. In this case study we are assuming a "standard error" of .15 for frequency and .18 for severity, both expressed relative to the expected values.

II. The Monte Carlo Simulation Process (in Pseudo Code)

Accumulators set up:

(1) Aggregate retained loss brackets (31) for all trials combined (probability distribution), less current assets. One accumulator for counts (number of trials falling into bracket) and another for total loss dollars.

(2) Total retained by policy year. To be compared with aggregate SIR. Reinitialized for each trial.

Input:

(1) Uncertainty factors for population mean frequency and severity (parameter variance).

(2) Retentions by policy year and index amount (if applicable). Per claim and aggregate

(3) Current assets

(4) Number of claims open for all prior years and assumed average indemnity for these open claims by year.

(5) Assumed average unlimited indemnity, claim frequency, and average ALAE for next (target) year.

(6) Assumed rate of return for present value discounting

(7) Number of trials to sample

(8) Present (target) year of coverage [Y1]. For initial funding Y1=1.

(9) Percentage of claims closed with expense only (CWE). Note: claims closed with no payment ignored.

** Main trial loop

For each trial

If Y1= 1 then skip to Routine for current year

For each prior year 1 to Y1-1

If Number of claims open for year = 0 then skip to [next year]

For each open claim for year

(1) Determine year reported (from actual, if available, else by randomizing from report year distr.)

(2) Establish mean indemnity for year from input values for open claims for that year.

(3) SELECT calendar year paid, relative to report year, and modify mean indemnity by calendar year severity factor

(4) Establish retention per claim applicable to calendar year, including index, if applicable.

(5) SELECT mode of closure (CWI or CWE). If CWE, SELECT ALAE amount only and then skip to next claim.

(6) SELECT gross (unlimited) indemnity from size of loss distribution, the mean of which was adjusted by calendar year severity factors from (3).

(7) Limit indemnity to per-claim retention for that year, as necessary.

(8) If claim burns through remaining annual aggregate SIR, then limit claim accordingly.

(9) Based on indemnity amount, adjust *expected* ALAE, and SELECT sample gross ALAE from distribution.

(10) Add retained indemnity and pro-rata retained ALAE to retained accumulator for calendar year of payment selected in (3).

(11) Add retained indemnity to the aggregate losses for that year.

Next claim

Next year

** Now do loop for prior year's IBNR's and/or current year's losses

For each year 1 to Y1

SELECT "universe" mean frequency and severity, drawing from expected and using the parameter variances (input).

SELECT sample number of claims for year, drawing from "universe". If expected number < 15, use Poisson, else use normal distribution.

For each claim

(1) Determine year reported (from report year distr.). If claim already reported (report year < Y1), then branch to next claim. Thus, IBNR claims from prior years are included.

(2) Establish mean indemnity from input value for that year and modify with report year severity factor.

(3) SELECT calendar year paid, relative to report year, and further modify mean indemnity by calendar year severity factor.

(4) Establish retention per claim applicable to calendar year, including index, if applicable.

(5) SELECT mode of closure (CWI or CWE). If CWE, SELECT ALAE amount only and then skip to next claim.

(6) SELECT gross (unlimited) indemnity from size of loss distribution, the mean of which was adjusted by report year and calendar year severity factors from (2) and (3).

(7) Limit indemnity to per-claim retention for that year, as necessary.

(8) If claim burns through remaining annual aggregate SIR, then limit claim accordingly.

(9) Based on indemnity amount, adjust *expected* ALAE, and SELECT sample gross ALAE from distribution.

(10) Add retained indemnity and pro-rata retained ALAE to retained accumulator for the calendar year of payment from (3).

(11) Add retained indemnity to the aggregate losses for that year.

Next claim

Next year

** Tally section for this trial

Determine present value of all retained losses from accumulator by calendar year and deduct current assets to get required funding for this trial (if < 0 then make it 0).

Determine which one of the 31 brackets of aggregate retained losses this trial falls in and bump the corresponding accumulators for counts (1) and total retained dollars.

Reinitialize all accumulators, except aggregate loss brackets.

Next trial

Print out probability distribution

NOTE: Each time the word "SELECT" is used in the above process, the program randomly samples from the appropriate distribution described in Part I, using a random number generator.

```
RUN
SELFRISB      SUN, FEB 26 1989          13:23:56

Report year distribution:
RY  Cum.     Rel.
    counts   Sev.
-- ------- -------
1   .38700   .73873
2   .68700   .98498
3   .88800  1.18197
4   .95400  1.37897
5   .97900  1.67446
6   .99100  2.16695
7  1.00000  2.46245

Cal. Year distribution:
CY  Cum.      Rel.
   Counts     Sev.
-- ------  -------
1  .25742    .26416
2  .44247    .70794
3  .70087    .94040
4  .83191   1.37362
5  .90366   1.61664
6  .93476   2.25062
7  .95879   2.74724
8  .98076   2.95857
9 1.00000   3.16989

INPUT RATE OF RETURN (X.XX) ?1.07
S1=.9999999999998            [mean of ry*cy severities]
S2=1.632776340059            [second moment of ry*cy severities]
NET S2=.4902818419985        [log(S2)]
ADJUSTED S=1.715722985358    [  sqrt[log(31) - log(S2)]   ]
INPUT NO. TRIALS ? 10000
INPUT PERCENT CLAIMS CLOSED EXPENSE ONLY ?.4
INPUT UNLIMITED SEVERITY TREND (X.XX) ?1.12
INPUT ALAE TREND (x.xx) ?1.08
INPUT FREQUENCY TREND (X.XX) ?1.04
INPUT CLIENT NAME
?XYZ HOSPITAL
INPUT PRESENT YEAR OF COVERAGE
?1
INPUT LIMIT PER CLAIM FOR THIS YEAR FORWARD
?1000000
INPUT AGGREGATE LIMIT FOR THIS YEAR FORWARD
?5000000
INPUT AVERAGE INDEMNITY WITH NO LIMIT FOR THIS YEAR
?200000
AVERAGE ALLOCATED CLAIMS EXPENSE FIRST YEAR 12000
ALAE ADJ. FACTOR =.65711657248
INPUT EXPECTED TOTAL CLAIM COUNT FOR THIS YEAR
?20
INPUT NET EXPECTED RETAINED LOSSES FOR THIS YEAR
?1000000
UNCERTAINTY FACTORS FOR POPULATION MEAN FREQUENCY AND SEVERITY (.XX,.XX)?.15,.18
STARTING
```

XYZ HOSPITAL

ANNUAL BREAKEVEN CONTRIBUTION FOR SELF-INSURANCE TRUST

INTERVAL END POINT	NUMBER OF TRIALS	CUMULATIVE NUMBER TRIALS	TOTAL AMOUNT	CUMULATIVE TOTAL AMOUNT
0	0	0	0	0
100000	20	20	1567150	1567150
117210	9	29	988079	2555229
137382	23	52	2979852	5535081
161026	31	83	4660393	10195474
188739	39	122	6842149	17037623
221222	71	193	14544679	31582303
259294	98	291	23550079	55132382
303920	128	419	36079809	91212191
356225	202	621	66547061	157759252
417532	237	858	91816354	249575605
489390	324	1182	146497576	396073181
573615	384	1566	204715603	600788784
672336	512	2078	318352411	919141195
788046	647	2725	473392789	1392533984
923671	770	3495	659660990	2052194975
1082637	941	4436	943185973	2995380948
1268961	965	5401	1131134839	4126515787
1487352	1048	6449	1441612233	5568128020
1743329	1004	7453	1614047558	7182175578
2043360	957	8410	1806550499	8988726077
2395027	691	9101	1529247998	10517974074
2807216	479	9580	1238595136	11756569210
3290345	246	9826	737560999	12494130209
3856621	133	9959	465756993	12959887202
4520354	40	9999	162642492	13122529694
5298317	1	10000	4539766	13127069460
6210170	0	10000	0	13127069460
7278954	0	10000	0	13127069460
8531679	0	10000	0	13127069460
10000000	0	10000	0	13127069460

Interpolated values for selected confidence levels:
(geometric interpolation)

2340077	9000
2733743	9500
3594291	9900

```
>RUN
SELFRIS8     SUN, FEB 26 1989          15:26:11

Report year distribution.
RY  Cum.     Rel.
    counts   Sev.
-- -------  -------
1  .38700   .73873
2  .68700   .98498
3  .88800  1.18197
4  .95400  1.37897
5  .97900  1.67446
6  .99100  2.16695
7 1.00000  2.46245

Cal. Year distribution:
CY  Cum.      Rel.
   Counts    Sev.
-- ------   -------
1  .25742   .26416
2  .44247   .70794
3  .70087   .94040
4  .83191  1.37362
5  .90366  1.61664
6  .93476  2.25062
7  .95879  2.74724
8  .98076  2.95857
9 1.00000  3.16989

INPUT RATE OF RETURN (X.XX) ?1.07
S1=.9999999999998          [mean of ry*cy severities]
S2=1.632776340059          [second moment of ry*cy severities]
NET S2=.4902818419985      [log(S2)]
ADJUSTED S=1.715722985358   [  sqrt(log(31) - log(S2))   ]
INPUT NO. TRIALS ? 10000
INPUT PERCENT CLAIMS CLOSED EXPENSE ONLY ?.4
INPUT UNLIMITED SEVERITY TREND (X.XX) ?1.12
INPUT ALAE TREND (x.xx) ?1.08
INPUT FREQUENCY TREND (X.XX) ?1.04
INPUT CLIENT NAME
?XYZ HOSPITAL
INPUT PRESENT YEAR OF COVERAGE
?2
INPUT PRESENT FUND ASSETS
?2950000
INPUT NUMBER CLAIMS OUTSTANDING FOR EACH OF THE FIRST 1 YEARS OF COVERAGE
YEAR 1
?7
INPUT ULTIMATE AVERAGE (UNLIMITED) INDEMNITY RESERVE FOR OPEN CLAIM FOR EACH OF
THE FIRST 1 YEARS OF COVERAGE
YEAR 1
?130000
INPUT LIMIT PER CLAIM FOR EACH OF THE FIRST 1 YEARS OF COVERAGE
YEAR 1
?1000000
INPUT TARGET AGGREGATE EACH OF THE FIRST 1YEARS OF COVERAGE
YEAR 1
?4960000
INPUT LIMIT PER CLAIM FOR THIS YEAR FORWARD
?1000000
INPUT AGGREGATE LIMIT FOR THIS YEAR FORWARD
?5000000
INPUT AVERAGE INDEMNITY WITH NO LIMIT FOR THIS YEAR
?225000
AVERAGE ALLOCATED CLAIMS EXPENSE FIRST YEAR 13000
ALAE ADJ. FACTOR =.6327789216474
INPUT EXPECTED TOTAL CLAIM COUNT FOR THIS YEAR
?21
INPUT NET EXPECTED RETAINED LOSSES FOR THIS YEAR
?1200000
UNCERTAINTY FACTORS FOR POPULATION MEAN FREQUENCY AND SEVERITY (.XX,.XX)?.15,.18
STARTING
```

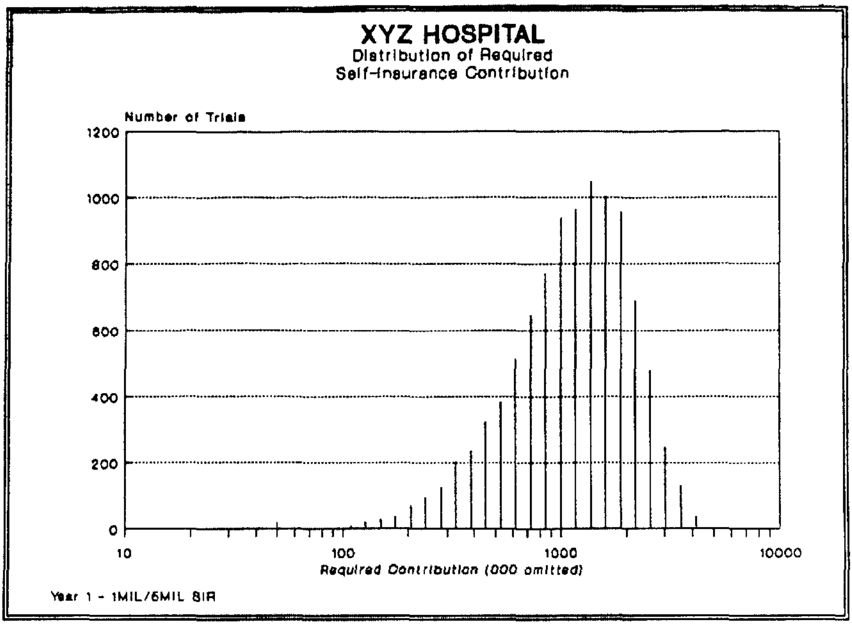
XYZ HOSPITAL

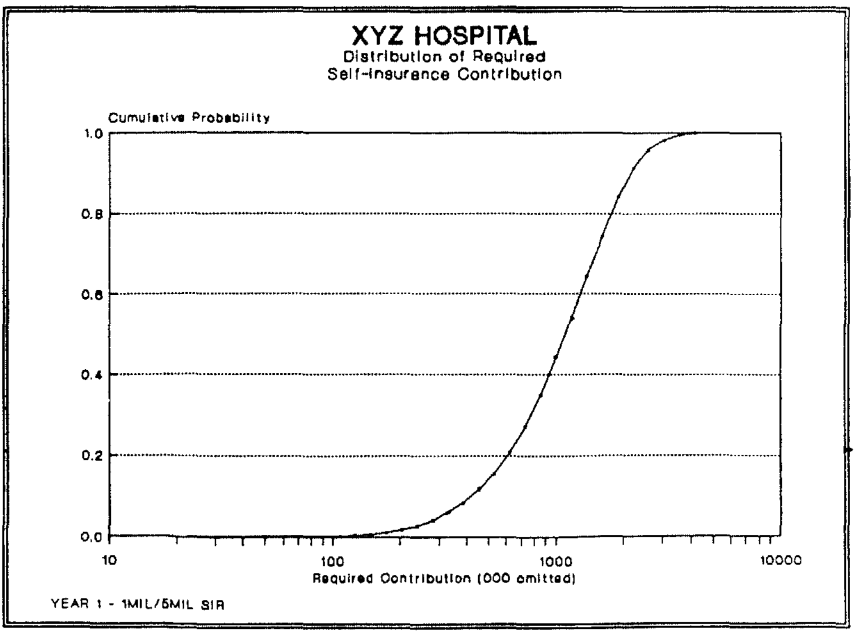
ANNUAL BREAKEVEN CONTRIBUTION FOR SELF-INSURANCE TRUST

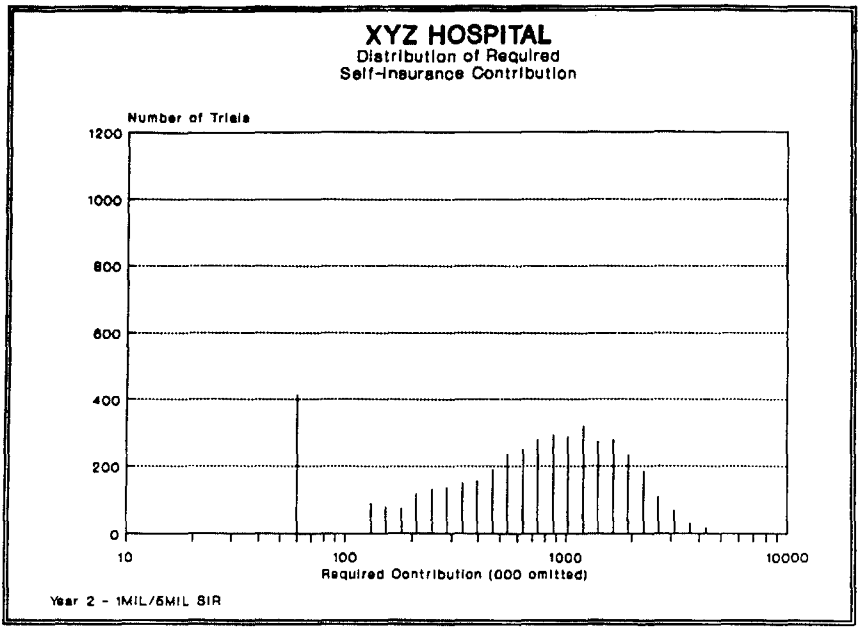
INTERVAL END POINT	NUMBER OF TRIALS	CUMULATIVE NUMBER TRIALS	TOTAL AMOUNT	CUMULATIVE TOTAL AMOUNT
0	5583	5583	0	0
120000	414	5997	24648222	24648222
140652	91	6088	11830798	36479020
164859	81	6169	12307073	48786092
193231	76	6245	13571310	62357402
226487	118	6363	24706476	87063878
265466	133	6496	32901574	119965452
311153	138	6634	39861648	159827100
364703	151	6785	50702085	210529184
427470	158	6943	62734682	273263867
501038	189	7132	88302392	361566259
587268	235	7367	127689223	489255482
688338	251	7618	159438697	648694178
806803	281	7899	209627406	858321584
945656	293	8192	257166219	1115487803
1108405	289	8481	296198263	1411686066
1299164	321	8802	386577962	1798264028
1522753	274	9076	384974193	2183238221
1784823	281	9357	462473361	2645711581
2091995	233	9590	449359285	3095070867
2452032	185	9775	418087611	3513158478
2874032	109	9884	286821719	3799980197
3368660	70	9954	215857101	4015837298
3948414	30	9984	107482615	4123319913
4627945	16	10000	68141691	4191461605
5424425	0	10000	0	4191461605
6357980	0	10000	0	4191461605
7452203	0	10000	0	4191461605
8734745	0	10000	0	4191461605
10238015	0	10000	0	4191461605
12000000	0	10000	0	4191461605

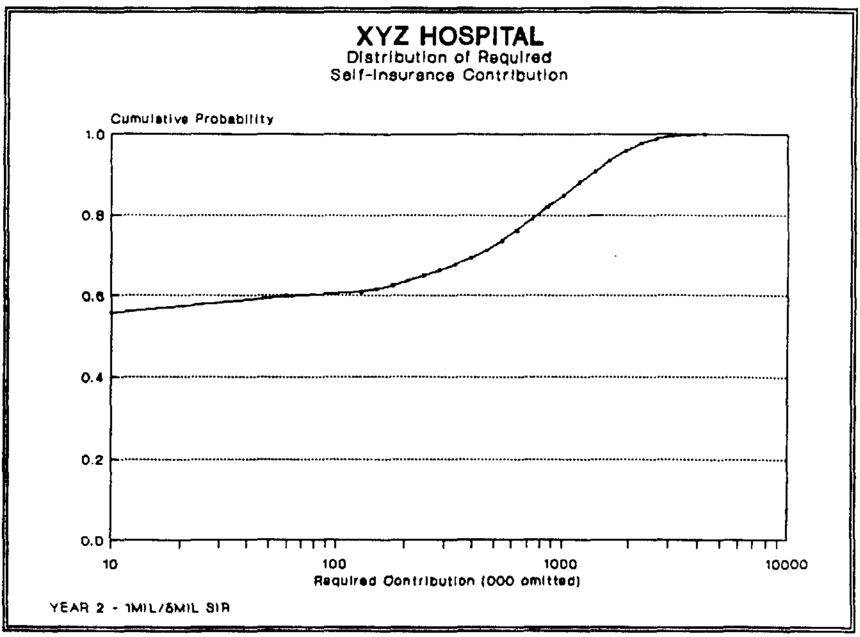
Interpolated values for selected confidence levels:
(geometric interpolation)

1457137	9000
1967531	9500
2980267	9900


XYZ HOSPITAL
Distribution of Required
Self-Insurance Contribution
Number of Trials
1200
1000
800
600
400
200
0
10
100
1000
10000
Required Contribution (000 omitted)
Year 1 - 1MIL/5MIL SIR


XYZ HOSPITAL
Distribution of Required
Self-Insurance Contribution
Cumulative Probability
1.0
0.8
0.6
0.4
0.2
0.0
10
100
1000
10000
Required Contribution (000 omitted)
YEAR 1 - 1MIL/5MIL SIR


XYZ HOSPITAL
Distribution of Required
Self-Insurance Contribution
Number of Trials
1200
1000
800
600
400
200
0
10
100
1000
10000
Required Contribution (000 omitted)
Year 2 - 1MIL/5MIL SIR


XYZ HOSPITAL
Distribution of Required
Self-Insurance Contribution
Cumulative Probability
1.0
0.8
0.6
0.4
0.2
0.0
10
100
1000
10000
Required Contribution (000 omitted)
YEAR 2 - 1MIL/5MIL SIR