Parameterizing The California Workers Compensation Experience Rating Plan: Development of Primary and Excess Credibilities & Translation into B and W Rating Values

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THE CALIFORNIA WORKERS COMPENSATION EXPERIENCE RATING PLAN

DEVELOPMENT OF PRIMARY AND EXCESS CREDIBILITIES
&
TRANSLATION INTO B AND W RATING VALUES

WARD BROOKS

Acknowledgments

The author would like to thank David Bellusci, William O'Connor and Lucia Tedesco-Fatica for their assistance in preparing this paper.

Abstract

This paper documents the methodology used to develop the primary and excess credibilities which underlie the experience rating plan of the Workers' Compensation Insurance Rating Bureau of California (the Bureau) and the translation of these credibilities into the B and W rating values used in the experience rating formula. The method is demonstrated with an analysis based on projecting experience modifications for policy year 1991. This analysis was completed in 1998 as part of the Bureau's regular maintenance of the Experience Rating Plan. The basic approach is one of multivariate regression but with the use of ridge regression to address the multicollinearity between the primary and excess components. Empirical results are smoothed by fitting logistic cumulative density functions. A process of iterative parameter refinement based on an extension of the traditional quintiles test is used and the performance of each iteration is assessed based on a measure of plan efficiency.

1. INTRODUCTION

Preliminaries

We will begin with a brief review of the experience rating formula currently used in California. The formula is:

(1) $$\text{Modification} = \frac{Ap+B+W\cdot Ae+(1-W)\cdot Ee}{E+B} \quad \text{or} \quad \frac{Ap+B+W\cdot Ae+(1-W)\cdot Ee}{Ep+B+W\cdot Ee+(1-W)\cdot Ee}$$

where	Ap	=	actual primary losses
	Ae	=	the excess of a risk's actual losses over the actual primary losses
	A	=	actual total losses (Ap + Ae)
	Ep	=	expected primary losses based on the appropriate D Ratios
	Ee	=	the excess of a risk's expected losses over expected primary losses
	E	=	expected total losses (Ep + Ee)
	B	=	a rating value relating to the credibility of primary losses
	W	=	a rating value which relates the credibility of excess losses to the credibility of primary losses

The rating values, B and W, vary by size of risk as measured by Expected Total Loss, E.[1]

Actual Primary Losses, Ap, are determined by applying the following formula to each loss:

(2) $$\text{Primary Loss} = \frac{9{,}000\times \text{Actual Total Los}}{\text{Actual Total Loss}+7{,}000}$$

This formula is known colloquially as the "split formula." All losses less than or equal to $2,000 are wholly primary.

Though not immediately obvious, it can be shown that this modification formula defines implicitly primary and excess credibilities in terms of the rating values by the following relationships:

(3) $$\text{Primary Credibility, } Zp = \frac{E}{E+B}$$

(4) $$\text{Excess Credibility, } Ze = W \times Zp = \frac{W\times E}{E+B} \qquad \text{Note that } W = \frac{Ze}{Zp}.$$

Where, primary credibility is the credibility attaching to primary losses (Ap); excess credibility, the credibility attaching to excess losses (Ae). Again, for the purposes of this analysis, we accept

[1]This paper presumes the reader is knowledgeable about workers compensation experience rating. The reader requiring additional background should consult the experience rating readings in the Casualty Actuarial Society's *Syllabus of Examinations*. In particular, see Gillam and Snader [1], Venter [2], and Gillam [3].

these credibility formulas as given. We do not consider whether other experience rating designs (such as a frequency-only plan, a frequency/severity split, or credibilities based on variables other than expected loss) might exist which are more accurate. Similarly, the split formula has not been reviewed to determine whether or not it is optimal.

Overview of the Methodology

Our goal is to determine, simultaneously, the primary and excess credibilities (Zp and Ze) appropriate for a risk of a given size. We will then translate our estimates of Zp and Ze into B and W rating values using Formulas 3 and 4. We cannot estimate Zp and Ze directly from the experience rating formula (Formula 1). However, after a little algebra, Formula 1 can be expressed as:

$$(5) \qquad \text{Modification} = 1 + Zp\,\frac{Ap-Ep}{E} + Ze\,\frac{Ae-Ee}{E}$$

where, to parameterize, we let Modification equal the *projection period empirical modification* or Actual Total Losses/Expected Total Losses for the projection period. Modification is the dependent variable in our model. The algebraic conversion of Formula 5 into Formula 1 is given in Appendix 1.

The actual and expected losses on the right hand side of the equation are for the *experience period*. We term [(Ap-Ep)/E] and [(Ae-Ee)/E] the *primary variable* and *excess variable*, respectively. The primary and excess variables are empirical values and are the independent variables in our model. Zp and Ze are the regression parameters to be estimated on these independent variables. As a practical matter, we will not estimate these parameters on an individual risk basis but rather by groupings, based on size and experience. Before continuing with the methods used to estimate Zp and Ze, we will discuss the construction of the database and the development of the groupings.

2. THE DATABASE

We will demonstrate the methodology by parameterizing the policy year 1991 at fifth report projection period. The experience period for policy year 1991 modifications is policy year 1987 at third report, 1988 at second report, and 1989 at first report, combined. For each risk, the following data was compiled:

<u>Experience Period (three policy years combined)</u>
Exposure (generally, reported subject payroll)
Expected Total Losses (based on Expected Loss Rates by class for the experience period)
Expected Primary Losses (based on empirical D Ratios, discussed below)
Expected Excess Losses (Expected Total Losses - Expected Primary Losses)
Actual Total Losses (subject to $175,000 per claim loss limit; $350,000 per catastrophe)

Actual Primary Losses (based on the split formula discussed above)
Actual Excess Losses (Actual Total Losses - Actual Primary Losses)

Projection Period (one year)
Exposure (generally, reported subject payroll)
Actual Total Losses (subject to $175,000 per claim loss limit; $350,000 per catastrophe)
Expected Total Losses (based on Expected Loss Rates by class for the projection period)

The empirical Expected Loss Rates (ELRs) are developed from the actual experience for the experience period (i.e., they are hindsight). Therefore, there is no systematic bias in the parameterization due to estimation error of the ELRs. Similarly, empirical D Ratios were determined using the policy year 1991 experience period data and the appropriate experience rating loss limit and death values. In practice, promulgated ELRs and D Ratios are estimated as all of the experience period data will not be collected until the experience modification for the last risk for a given projection period is issued. The empirical D Ratios tie to the actual experience and therefore parameter bias is again eliminated by benefit of hindsight. Because empirical ELRs and D Ratios are used, a risk's modification as calculated for this analysis is not necessarily the same as the modification actually promulgated for the policy year 1991 projection period. Appendix 2 provides the complete table of empirical ELRs and D Ratios for the policy year 1991 experience period. Appendix 3 provides a comparison of the empirical D Ratios in Appendix 2 with the D Ratios in the 1991 Experience Rating Manual for 39 "benchmark classes."

Partitioning of the Dataset and Grouping of Risks

There is a great deal of variation in the experience of individual risks. Later in this paper we will compare the performance of experience rating alternatives by looking at a measure of the proportionate reduction in total variance achieved by experience rating alternatives. To the uninitiated, the achieved reductions in variance which we will see, particularly for small risks, may seem surprisingly small. The variation explained by experience rating may be only about 1% for risks near the eligibility threshold. Yet this marginal improvement in pricing is just as important to the bottom line in insurance as the small marginal profit (typically less than 3%) of a grocery store's is to its bottom line. The variation explained for the largest risks is generally in excess of 15%.

But here we address the implications of individual risk variance to the organization of the data. Although attempts were made to avoid grouping risks, thereby retaining as much individual information as possible, there was too much variation in the individual risks' experience to obtain statistically reliable results using regression techniques.

This is not to say results could not be obtained--they were. But it was critical that we be able to statistically evaluate the results. For example, we needed reliable answers to questions such as: 'Does a shifted-logistic fit better than a regular logistic or some other curve?' and 'Is the bias in a plan, as measured by a weighted regression, statistically significant?' Because it is so large, the unexplained individual risk variation often overwhelmed the tests of statistical significance. To overcome this, risks were first partitioned into groups of similar size and then further sub-grouped based on their experience. Many partitioning and grouping schemes were explored with the mean results of each more or less the same. We decided on the following scheme which we found to be optimal for statistical significance.

First, all risks were sorted by experience period Expected Total Losses in descending order. The risk with the largest Expected Total Losses in the database is risk "number one." The risks were then partitioned into groups of 5,000. The five thousand largest risks made up group 1-5,000, or the "first group." Within each group of 5,000, risks were then sorted based on their experience period empirical modifications (experience period Actual Total Losses/Expected Total Losses) in ascending order. Claim-free risks, if any, would be among the first of each group of 5,000. When risks had the same experience period empirical modification (commonly for claim-free risks), they were sorted by experience period Expected Total Losses in descending order. Therefore, the first risk in a group of 5,000 where there was more than one risk with claim-free experience would be the largest risk with claim-free experience.

Within each group of 5,000, sorted as described above, the risks were divided into 100 sub-groups of 50 risks. The experience of each sub-group of 50 risks was combined (not averaged) to make one data record. Then, for each group of 5,000, ridge regression (discussed below) was performed on the 100 (5,000 / 50) data records.

The First Group--The Largest 5,000 Risks

The largest 5,000 risks form a more heterogeneous group in terms of size than any other group. For example, the average expected loss for the larger half of the first group, $1,633,606, is 4.2 times larger than for the smaller half, while the average expected loss for the larger half of the second group, $248,855, is 1.4 times larger than for its smaller half. Because of this, consideration was given to breaking up the largest 5,000 into five groups of a thousand. No significant improvements or meaningful differences in estimates resulted from this refinement. Further, breaking the first group into smaller groups would have necessitated the use of weighted regressions, complicating the analysis. Therefore, we chose to leave the largest risks in one group of 5,000.

We now return to directly estimating Zp and Ze, simultaneously, from Formula (5).

3. PARAMETERIZING THE PLAN

Multicollinearity and the Primary and Excess Variables

Unfortunately, we cannot apply straightforward multivariate regression because the primary and excess variables are highly correlated. This is not unexpected given the nature of the split formula. For example, for the first group of 5,000 the correlation between the primary and excess variables is 99.0% for the policy year 1991 experience period. For the sixth group, (risks 25,001 - 30,000) the correlation is 96.3%. This high degree of multicollinearity can result in unstable parameters of uncertain statistical reliability.

Is the multicollinearity present in the data severe enough to warrant an alternative estimation procedure? We will see later that it certainly is.

We explored several possible solutions to this problem and ultimately decided on ridge regression as the appropriate treatment. While ridge regression is commonly used in other disciplines, it is currently not covered in the Casualty Actuarial Society's *Syllabus of Examinations*, so many actuaries may be unfamiliar with it. Therefore, we provide here an introduction and, for the interested reader, further references. But first, we will briefly sketch the steps to follow so the reader will have context for the role of ridge regression in our overall methodology.

The ridge regression estimates are starting values in an iterative process. At each iteration we will refine *overall* credibilities using an extension of the traditional quintile tests used to evaluate experience rating plan performance and then refer back to the ridge regression results to determine appropriate *apportionments* between primary and excess credibilities. Each iteration will involve translating primary and excess credibilities into B and W rating values and recalculating modifications for each risk. This iterative process will continue until no further improvements in plan performance can be obtained by adjusting primary and excess credibilities.

Ridge Regression Overview

Ridge regression introduces a parameter, θ, into the least squares solution.[2] The vector of parameter estimates is given by the equation:

$$b_z(\theta) = (\mathbf{Z'Z} + \theta I_p)^{-1}\mathbf{Z'Y}$$

where $\mathbf{Z}$ is the vector of predictor variables, Ip is the identity matrix of dimension p, and $\mathbf{Y}$ is the vector of centered and scaled empirical modifications. When θ equals zero, the ridge regression estimates are the same as the usual least squares estimates. Exhibit 1 provides the ridge regression results for three select groups of 5,000 for the policy year 1991 projection year.

The ridge regression results, or ridge trace, on Exhibit 1 demonstrate that for ordinary least squares--that is, when θ equals zero--the estimates of primary credibility were generally greater than one, while the estimates of excess credibility were very small or even negative. For example, on Exhibit 1, multivariate regression for the fifth group gives Zp of 1.5959 and Ze of -0.0368. Clearly, these results violate our *a priori* constraints for the values of Zp and Ze--namely that Zp

[2] The following discussion of ridge regression summarizes the key points from our primary reference, Draper and Smith [4]. The reader may also find Miller and Wichern [5] and Johnson and Wichern [6] helpful.

and Ze are bounded by [0,1]. The ordinary least squares results shown in Exhibit 1 are typical for all sizes groups and partitioning schemes.

The introduction of a θ greater than zero in the equation for the parameter vector above can correct for the correlation between the variables, the cause of these unacceptable results. The parameters of the resulting equations are not least squares and are biased, but are more stable and, generally, of smaller mean square error. The stability and lower variance error should more than compensate for the bias introduced.[3]

Exhibit 2 provides a plot of each group's ridge trace, that is, a graph of θ, Zp and Ze from Exhibit 1. Determining the appropriate degree of correction--the appropriate θ--is key. As θ goes to infinity, the parameters will approach zero. The goal is to keep θ as small as possible to achieve the desired degree of correction. There are many approaches to selecting the optimal θ, which we will designate by θ^*. Draper and Smith [4] state that there is no mechanically best way to choose θ^*. We experimented with most of the methods discussed by Draper and Smith.[4] Ultimately, we developed our own method, the Maximum Excess method, which outperformed the other methods we tested.[5]

The Maximum Excess method begins by inspecting the ridge trace to locate that θ for which excess credibility is maximized, subject to the constraint that Zp and Ze are bounded by [0,1]. An examination of Exhibit 2 reveals that, for each group, there is a θ for which excess credibility is maximized. We term this θ our ***maximum excess*** θ, θ_E. We select the combination of primary and excess credibilities corresponding to θ_E for our initial credibility estimates. For example, on Exhibit 1, excess credibility is maximized when θ equals 0.27 for the fifth group. Therefore, θ_E = 0.27 and we select Zp = 0.7186 and Ze = 0.1273 as initial values for the fifth group. This process is repeated for each group. Exhibit 3 provides a summary of each group's Maximum Excess selections. The corresponding values promulgated in the 1997 Plan are also shown for comparison. Note that, because this is empirical data, the Maximum Excess credibilities are not monotonically decreasing across groups. The Fitted Credibilities on Exhibit 3 smooth out this empirical noise. We'll come back to the Fitted Credibilities shortly, but first, a few more comments on ridge regression.

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[3]Tests performed while developing the 1997 Plan parameters found that the methodology in this paper developed *overall* credibilities comparable to those obtained with the prior methodology which was last used to parameterize the 1984 Plan and which did not correct for multicollinearity. The prior methodology did not allow for direct estimation of primary and excess credibilities separately nor for the ability to directly translate these credibilities into B and W rating values.

[4]An overview of the most promising method discussed by Draper and Smith, Hoerl and Kennard's δ, is provided in Appendix 4.

[5]In prior analyses, the Maximum Excess method resulted in the best parameters, as indicated by our performance measures (discussed below), see Workers' Compensation Insurance Rating Bureau of California [7], [8], and [9]. A comparison of the relative performance of the Hoerl and Kennard's δ method with that of the Maximum Excess method is provided in the Agenda and Minutes of the July 2, 1996 Meeting of the Actuarial Committee of the Workers' Compensation Insurance Rating Bureau of California [8].

The ordinary least squares estimates of Zp and Ze routinely fall outside the [0,1] constraint thus demonstrating the need to address multicollinearity. We have selected ridge regression as the treatment. As to ridge regression's appropriateness, we note here that Draper and Smith [4] discuss two circumstances for which ridge regression is "absolutely" the correct way to proceed. The first is when we have "[a] Bayesian formulation of a regression problem with specific prior knowledge of a certain type on the parameters." The second is when we have "[a] formulation of a regression problem as one of least squares subject to a specific type of restriction on the parameters." The constraint on credibilities to be between zero and unity justify ridge regression in this situation. Indeed, it may be possible to further refine the ridge regression procedure to the *a priori* constraints (for example, the parameters could be constrained to the ellipse $0<=Ze<=Zp<=1$).

Miller and Wichern [5] discuss several ways to deal with the problems of multicollinearity, including reselection of the independent variables, discarding independent variables, alternative estimation procedures and ridge regression. Clearly, discarding a variable is not an option here. A principal components treatment would be feasible but would require altering the familiar B and W structure of the rating plan as there would be no simple, direct linkage (i.e., Formulas 3 and 4) between primary and excess credibilities and the B and W rating values.

Smoothing the Primary and Excess Credibilities

The ridge regressions have given us a series of indicated primary and excess credibilities by size of risk. We test each iteration's credibilities by calculating experience modifications for every eligible risk. The Bureau's systems are designed to accommodate Formula (1), the traditional B and W formula. To accomplish this mass re-rating requires development of a B and W table for each iteration. To develop a B and W table we first smooth the selected credibilities by fitting them to a curve.

The series of credibilities corresponding to the selected θs is smoothed by fitting the primary series and excess series separately, to a logistic cumulative density function (CDF). The logistic CDF is given by

$$F(x) = \frac{1}{1+\exp[(\alpha-X)/\beta]}$$

where X = the natural logarithm of a group's median Expected Total Losses for the experience period. Excess credibilities were fit to a translated, or shifted, logistic CDF, where

$$F(x) = \frac{1}{1+\exp[(\alpha-X)/\beta]} - \text{Shift}$$

A statistically significant shift greater than zero implies that excess credibility approaches a limit less than one (specifically, unity minus the shift). The credibilities were fit by applying the nonlinear Levenberg-Marquardt algorithm to the indicated ridge regression Zp and Ze. Exhibit 4 shows the indicated and fitted values for the initial iteration. Finally, we note that, for the B and W table to have the usual properties of B descending and W ascending with increasing Expected Total Loss, the parameter β must be less than unity for primary credibility.

Developing B & W Rating Values from the Primary and Excess Credibilities

Exhibit 5 provides the formulas used to translate the fitted primary and excess credibility curves to B and W values. First, the fitted equations for Zp and Ze are shown. We then make use of the fact that W = Ze/Zp. Using some straightforward (though unattractive) algebra, we can express W in terms of the natural logarithm of the experience period Expected Total Losses, E. With this closed form expression for W, we can determine the Expected Total Losses corresponding to any given W. (Theoretically, we could do this by inverting the equation; practically, we do this using Lotus 1-2-3's Backsolver or a bi-section algorithm.)

We construct the Table of B and W values (Exhibit 6) by first determining the Total Expected Loss ranges for each W in increments of 0.01. For example, to determine the Expected Loss range corresponding to W = 0.25, we determine (using Exhibit 5, Formula 3 and Lotus 1-2-3's Backsolver) the expected losses corresponding to W = 0.245 and W = 0.255. Next, we determine the Total Expected Losses corresponding to the midpoint of each range by averaging the endpoints ($215,673 for W = 0.25). For the midpoint Total Expected Losses we determine Zp (Exhibit 5, Formula 1). Finally, we use Formula 4 of Exhibit 5, which is a closed form expression for B in terms of E and Zp, to determine B for the midpoint of each Expected Loss Range.

Iterative Parameter Refinement

A number of tests were used to assess the performance of each set of credibilities. Each test was performed for all risks and for five groups of risks based on size (Expected Loss Quintiles).

Quintile tests were examined to assess the overall performance of parameters. A quintiles test first ranks risks by their experience modifications, then divides the population into five groups (quintiles), and then compares their relative standard and manual loss ratios. Each modification quintile has approximately 20,000 risks. Quintiles tests are a commonly accepted actuarial technique for evaluating the performance of experience rating plans [2]. The quintiles tests are shown in Exhibit 7. Ideally, we expect the standard loss ratios (the loss ratios using the modified premiums) for all groups to be the same. If a group's standard loss ratio is markedly higher or lower than the others, this indicates that the general credibility for the group is too low or too high. In particular, there should be no marked trend in the standard loss ratios and we would like the variance of the standard loss ratios to be small. Conversely, we expect the manual loss ratios to be positively correlated with the experience modifications. This indicates the experience modification does a good job of differentiating risks based on their expected future experience. If the plan did not do this, the manual loss ratios would tend to be the same.

We developed an extension of the quintiles test in which we regress the standard loss ratio against the experience modification. Exhibit 8 shows the standard loss ratios and number of risks by intervals of the projected experience modification for five groups based on size and for all risks combined. Again, absent noisy data, a perfect plan would produce the same loss ratio after modification for all risks. To determine what adjustments, if any, might be necessary, we look for patterns in the standard loss ratios across modification interval for risks of approximately the same size (a given Expected Loss Quintile). We quantify the pattern by performing a weighted regression. Generally, the pattern, if any, is a simple trend and we fit this with a straight line. The coefficient on the independent variable (projection modification) quantifies how much credibility should be increased or decreased. If all risks' standard loss ratios are the same, the coefficient will not be significantly different (statistically) from zero and no adjustment is indicated. If standard loss ratios are positively correlated with the proposed modifications, then credibilities are too low. If standard loss ratios are negatively correlated with the proposed modifications, then credibilities are too high. (The logic behind this adjustment is presented in Appendix 5.) The R-squared for the regression as a whole relates to the amount of variation explained and generally is expected to be small for experience rating. The statistical significance of the coefficient on the independent variable, the indicated adjustment, generally is significant at a 5% or 10% confidence level. When this coefficient is statistically insignificant, we exercise judgment in making an adjustment. The results of these regressions are provided in Exhibit 9.

The quintile test weighted regressions indicate that the appropriate adjustments to credibility vary by size. For example, from Exhibit 9 we see that the indicated adjustment for the largest risks is 0.04859 while for the smallest risks it is 0.3835. To account for this variation by size, the indicated adjustments (the coefficients on the independent variable) for each size quintile are fit to the quintiles' median risk ranks to determine a smooth transition in adjustment by size (Exhibit 10). When the pattern of adjustments is not smooth across size quintiles, linear interpolation from quintile to quintile may be used. Exhibit 11 provides a plot of the bias adjustments for the initial and subsequent iterations. As our estimates are refined, we expect the line graphed on Exhibit 11 to fall toward the x-axis with successive iterations, assuming the bias coefficients maintain their statistical significance.

From this fit of indicated adjustments to size of risk, an adjustment appropriate to each group of 5,000 can be calculated. The indicated adjustment for each group is then applied to the *overall* credibility underlying the prior iteration to determine the Overall Credibility After Adjustment (Exhibit 12).

Our new overall credibilities for the next iteration must now be split into primary and excess components. The problem for successive iterations is how to select primary and excess credibilities which are not highly multicollinear. To clarify our chosen solution to this problem, let us first consider a theoretically more idealistic solution. We propose that for each group, some combination of Zp and Ze on the ridge trace is optimal in terms of optimizing a given performance measure as well as correcting for multicollinearity. Specifically, given any performance measure, we could determine each group's optimal θ by developing a B and W table for each valid Zp/Ze combination on the ridge trace (i.e., for each θ for which Zp and Ze are bounded by [0,1]), calculate the corresponding performance measure and select the optimal combination. These results could then be smoothed out across risk sizes as discussed above.

Such a method, while theoretically appealing, is currently too computationally intensive. The Maximum Excess method, logistic smoothing, and quintile adjustments serve to get us reasonably close. Because the goal is more optimal positioning on the ridge trace for each group--not proportionate adjustment--we return to the ridge trace to find Zp and Ze combinations for which the overall credibility is closest to the new indicated credibility.

An example will clarify our procedure. For the fifth group, the overall fitted credibility before adjustment was 0.2931 (Exhibit 12). The indicated adjustment for this group from Exhibit 10 is to increase credibility 12.76%. So the desired overall credibility after adjustment is 0.3306. Returning to the ridge trace for this group, Exhibit 1, we find the Zp and Ze which provide overall credibility closest to 0.3306 at $\theta = 0.11$. Our credibility selections for the fifth group to start the first iteration become Zp = 0.8662 and Ze = 0.1155. (The initial Maximum Excess values were Iteration 0.) This procedure is followed for each group. For each iteration credibilities are then logistically smoothed before preparing the B and W table.[6]

The above process is repeated iteratively until a set of credibilities is developed for which the overall performance of the plan was maximized and no further adjustments to credibility were indicated. Generally, we determine this point by going too far. That is, adjusting until the performance deteriorates and then selecting the prior iteration.

4. EVALUATING THE PARAMETERIZATION

The Performance Measure

The selected performance measure is the efficiency of each iteration; that is, the proportionate reduction in total variance. This measure was developed by Meyers [10]. We have calculated each tested plan's efficiency on both a manual premium-weighted and risk-weighted basis and by size quintile and for all risks combined. The manual-premium basis attaches weights so as to minimize error in terms of absolute dollars. The risk-weighted basis implies the accuracy of a small 10-employee risk is of the same importance in parameter development as a large 10,000-employee risk. While generally not true, there is concern that the risks who must live with their experience modifications without recourse are smaller risks. Large risks are more likely to receive special scrutiny and have options largely unavailable to small risks, such as retrospective rating, large deductible plans, or schedule rating. Therefore, when looking at the all risks

[6]Other approaches were considered but dismissed. For example, a straightforward approach might be to increase both Zp and Ze by the indicated adjustment, allowing for special handling when the indicated primary credibility would be in excess of unity. This approach was tried in the early stages of our research but the results proved unsatisfactory and incongruous with the multicollinearity correction we sought through ridge regression. Another approach we considered was to maintain the relativity between primary and excess credibilities implied by the Maximum Excess selections. This approach's results also proved inferior.

combined efficiency, we look at both bases to ensure the best plan is not one which serves only one class of risks.

Exhibit 13 summarizes the efficiencies of each iteration. The credibilities underlying the second iteration were selected as final since no further improvements in the all risks, manual premium-weighted efficiency were achieved after this iteration. For reference, risk-weighted efficiencies are shown for the promulgated 1997 Plan and a frequency-only plan developed in 1995.[7] The promulgated 1997 Plan's credibilities were based on parameterizing the policy year 1989 projection period as well as looking at other projection periods. The frequency-only plan was developed in 1996 as an alternative to the existing experience rating formula. In the end, the frequency-only plan was not adopted. However, the efficiencies for the frequency-only plan suggest that most of the information from the current experience rating formula comes from frequency.

We note that great care must be made in comparing efficiencies across projection periods. Experience rating works best when the same dynamics extend from the experience period through the projection period. Some periods in time are more or less stable than others. In California, in particular, highly aberrant and extreme experience was observed for policy years 1989 through 1991. Generally, the Bureau tries to avoid using these years in studies such as this, but tradeoffs must be made between the availability and age of data.

We also note that our experience in California suggests parameterizing an experience rating plan is less sensitive to the maturity of the data than might be first thought.[8] This is probably true for several reasons. First, under the current formulation, frequency accounts for most of the variation explained by experience rating. Second, the severity of individual claims is limited. So, using loss limitations effective for policy year 1998 ratings, of a claim which develops from $50,000 to $500,000, only an additional $125,000 would be allowed in the experience rating. And finally, of the incremental dollars which would enter the experience rating, virtually all would be excess and subject to excess credibilities (around 33% for the largest risks and less than 10% for most risks). Indeed, the proportion of losses which are primary has grown substantially since the current split formula was last updated in 1985 (Appendix 6). The $175,000 loss limitation has also been in effect since 1985.

Impact Tests

Finally, we examine the distribution of risks by current vs. indicated modifications, separately by Expected Loss Quintile and for all risks combined. This information, for the second and final iteration, is shown in Exhibit 14, and provides an overview of the number of risks which will be impacted in any given direction and the magnitude of the impact. The shaded diagonal on Exhibit 14 marks those risks with no appreciable change in modification. The further a risk is away from

[7] Manual premium-weighted efficiencies were not available.

[8] The reader might note that the policy year 1989 parameterizations were to third report level data while the policy year 1991 parameterizations are to fifth report level data.

the diagonal, the larger the impact of the revision in credibilities. Risks above the diagonal would see their modifications go down. Risks below the diagonal would see their modifications go up.[9] While the information presented in Exhibit 14 is in 0.10 increments, the Bureau reviews the impact tests in 0.01 increments in making its final evaluation. This information, in light of this analysis and findings in prior analyses, is used in any decisions to deviate from the indicated credibilities.

Exhibit 15 provides a comparison of indicated and promulgated credibilities for the 1997 Plan and the indicated credibilities for the policy year 1991 parameterization.[10] Exhibit 16 is a graphical presentation of the information on Exhibit 15. Exhibit 17 provides a comparison of indicated and promulgated B and W values for the 1997 Plan and the indicated B and W values for the policy year 1991 parameterization. Exhibit 18 is the graphical companion to Exhibit 17.

5. DISCUSSION AND CONCLUSION

In 1998, the Bureau's Actuarial Committee reviewed the analysis presented above and decided to make no changes to credibilities at that time. Instead, the Bureau's Actuarial and Governing Committees directed further research which will follow from the following discussion. The procedures demonstrated, however, are the same as those used to develop the credibilities underlying the experience rating plan current as of this writing (namely, for policies effective in 1997 through 1999).

The credibilities developed for policy year 1991 are quite different from those developed for policy year 1989 and earlier periods. In particular, primary credibilities are much higher across all risk sizes while excess credibilities are somewhat lower (Exhibit 17). We noted earlier that the proportion of loss dollars which are primary has grown considerably since the split formula was last updated (Appendix 6). We expect this explains much of this shift in credibilities. This shift was probably evident in 1989, but that was a period characterized by many small stress claims from plant closings and fraudulent claims from 'medical mills,' for example, which masked the shift at that time. The evidence argued for a review of the split formula and it was decided this would be done before revising the Plan credibilities.

The split formula can be thought of as one point in a spectrum between a frequency-only plan, where primary losses are limited to one dollar and all excess credibilities are zero, and self-rating,

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[9]Because revising credibilities will likely change a plan's off-balance, risks with no change to their modification may actually see a modest change in standard premium. Similarly, risks with modest changes in modification may even see their standard premium change the slightly in the opposite direction.

[10]The credibilities indicated for the 1997 California Experience Rating Plan were not adopted for all sizes of risks. The Bureau's Actuarial Committee elected to phase-in indicated credibilities for smaller risks. This was accomplished by allowing no change for the smallest risks for which B and W values were published and allowing the full change for risks with experience period expected losses of $20,000 or greater. To prevent a misleading comparison between the 1997 Plan and projection year 1991, Exhibits 15 through 18 show both the indicated and promulgated values for the 1997 Plan.

where full credibility attaches to both frequency and severity.[11] We noted that frequency-only alternatives have been developed which explain nearly as much variation as the current plan. This suggests a frequency/severity split might offer even greater performance. For our future research we propose to first isolate the predictive content of frequency experience and then to examine the predictive power of layers of severity. Such an approach might obviate the need to address multicollinearity.

We continue to work on other avenues to improve our methodology. For the quintiles test extension and bias adjustments of Exhibits 9 and 10, we are exploring refinement of the adjustments to the group-of-5,000 level, perhaps even adjusting each group independently to its optimal credibilities then smoothing across size of risk.

As with any project of this scale, of course, honing our methodology will always be a work in progress. To date, we have had neither the time nor resources to explore all the paths which might lead to further improvement. Nevertheless, this latest methodology has proved very satisfactory since its development and has offered new insights into the dynamics of experience rating.

[11] It happens that the frequency-only alternative we developed treated types of claims differently. Specifically, temporary and other indemnity claims were treated separately and medical-only frequency was not used at all. This does not detract from the proposed spectrum, but it does increase its complexity.

REFERENCES

[1] Gillam, W.R.; and Snader, R.H., "Fundamentals of Individual Risk Rating," 1992, Part I. May be borrowed from the CAS Library.

[2] Venter, G.G., "Experience Rating--Equity and Predictive Accuracy," *NCCI Digest*, April 1987, Vol. II, Issue I, p. 27. May be borrowed from the CAS Library.

[3] Gillam, W.R., "Workers' Compensation Experience Rating: What Every Actuary Should Know," *PCAS LXXIX*, 1992, Sections 1-5, pp. 215-239.

[4] Draper, Norman R., and H. Smith, *Applied Regression Analysis*, Second Edition, John Wiley & Sons, 1981, pp. 313-325.

[5] Miller, Robert B. and Dean W. Wichern, *Intermediate Business Statistics: Analysis of Variance, Regression, and Time Series*, First Edition, Holt, Rinehart and Winston, 1977, pp.. 287-291.

[6] Johnson, Richard A., and Dean W. Wichern, *Applied Multivariate Statistical Analysis*, Third Edition, Prentice Hall, 1992, pp.. 313-314.

[7] Workers' Compensation Insurance Rating Bureau of California, "Agenda and Minutes of the Actuarial Committee Meeting Held on May 30, 1996 in the San Francisco Office of the Bureau."

[8] Workers' Compensation Insurance Rating Bureau of California, "Agenda and Minutes of the Actuarial Committee Meeting Held on July 2, 1996 in the San Francisco Office of the Bureau."

[9] Workers' Compensation Insurance Rating Bureau of California, "January 1, 1997 Pure Premium Rate Filing."

[10] Meyers, G., "An Analysis of Experience Rating," PCAS LXXII, 1985, p287.

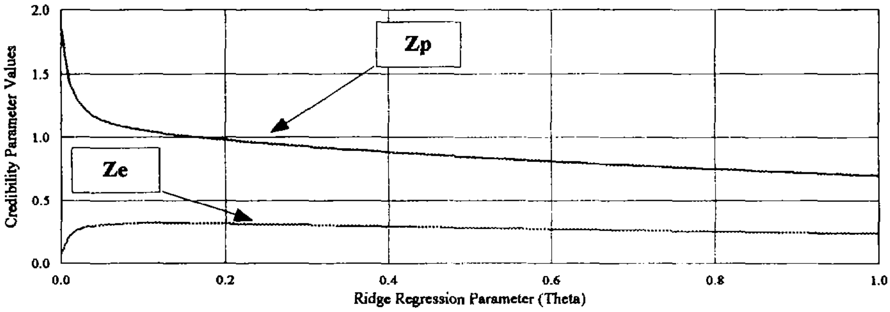
CALIFORNIA EXPERIENCE RATING PLAN **Exhibit 1**
RIDGE REGRESSION RESULTS
Projection Year 1991 5th Report

θ	Risks 1 - 5,000 (1st Group)			Risks 20,001 - 25,000 (5th Group)			Risks 45,001 - 50,000 (10th Group)		
	Zp	Ze	Overall	Zp	Ze	Overall	Zp	Ze	Overall
0.00	1.8494	0.0790	0.6388	1.5959	-0.0368	0.4330	1.1171	-0.0131	0.3079
0.01	1.4293	0.2210	0.6030	1.3700	0.0142	0.4043	1.0467	0.0009	0.2979
0.02	1.2901	0.2657	0.5896	1.2340	0.0442	0.3865	0.9902	0.0119	0.2898
0.03	1.2188	0.2869	0.5815	1.1426	0.0638	0.3742	0.9439	0.0207	0.2829
0.04	1.1743	0.2988	0.5756	1.0765	0.0776	0.3650	0.9050	0.0279	0.2770
0.05	1.1431	0.3062	0.5708	1.0263	0.0877	0.3577	0.8719	0.0339	0.2719
0.06	1.1195	0.3109	0.5666	0.9865	0.0953	0.3517	0.8432	0.0390	0.2674
0.07	1.1006	0.3141	0.5628	0.9540	0.1013	0.3466	0.8181	0.0433	0.2634
0.08	1.0849	0.3162	0.5592	0.9269	0.1060	0.3422	0.7959	0.0469	0.2597
0.09	1.0714	0.3175	0.5559	0.9038	0.1099	0.3383	0.7761	0.0501	0.2563
0.10	1.0596	0.3183	0.5527	0.8838	0.1130	0.3348	0.7583	0.0529	0.2532
0.11	1.0489	0.3187	0.5496	0.8662	0.1155	0.3315	0.7421	0.0553	0.2504
0.12	1.0393	0.3188	0.5466	0.8506	0.1177	0.3285	0.7273	0.0574	0.2477
0.13	1.0304	0.3187	0.5437	0.8365	0.1194	0.3258	0.7138	0.0593	0.2452
0.14	1.0221	0.3184	0.5409	0.8237	0.1209	0.3231	0.7013	0.0610	0.2428
0.15	1.0143	0.3180	0.5381	0.8121	0.1222	0.3207	0.6897	0.0624	0.2406
0.16	1.0070	0.3174	0.5354	0.8014	0.1232	0.3183	0.6789	0.0637	0.2385
0.17	**1.0000**	**0.3167**	**0.5328**	0.7914	0.1241	0.3161	0.6689	0.0649	0.2365
0.18	0.9933	0.3160	0.5302	0.7822	0.1248	0.3139	0.6594	0.0659	0.2345
0.19	0.9869	0.3152	0.5276	0.7735	0.1254	0.3119	0.6505	0.0669	0.2327
0.20	0.9807	0.3143	0.5250	0.7653	0.1259	0.3099	0.6421	0.0677	0.2309
0.21	0.9747	0.3134	0.5225	0.7576	0.1263	0.3079	0.6342	0.0685	0.2291
0.22	0.9690	0.3125	0.5201	0.7504	0.1266	0.3061	0.6266	0.0691	0.2275
0.23	0.9633	0.3115	0.5176	0.7434	0.1268	0.3042	0.6194	0.0697	0.2259
0.24	0.9579	0.3105	0.5152	0.7368	0.1270	0.3025	0.6126	0.0703	0.2243
0.25	0.9525	0.3095	0.5128	0.7305	0.1271	0.3007	0.6061	0.0707	0.2228
0.26	0.9473	0.3085	0.5105	0.7245	0.1272	0.2991	0.5998	0.0712	0.2213
0.27	0.9422	0.3074	0.5081	**0.7186**	**0.1273**	**0.2974**	0.5938	0.0715	0.2199
0.28	0.9373	0.3063	0.5058	0.7130	0.1272	0.2958	0.5881	0.0719	0.2185
0.29	0.9324	0.3053	0.5036	0.7076	0.1272	0.2942	0.5825	0.0722	0.2171
0.30	0.9276	0.3042	0.5013	0.7024	0.1271	0.2927	0.5772	0.0724	0.2158
0.31	0.9229	0.3031	0.4991	0.6974	0.1270	0.2911	0.5720	0.0727	0.2145
0.32	0.9183	0.3020	0.4969	0.6925	0.1269	0.2896	0.5670	0.0729	0.2132
0.33	0.9137	0.3009	0.4947	0.6878	0.1268	0.2882	0.5622	0.0730	0.2120
0.34	0.9092	0.2998	0.4925	0.6831	0.1266	0.2867	0.5575	0.0732	0.2108
0.35	0.9048	0.2987	0.4904	0.6787	0.1264	0.2853	0.5530	0.0733	0.2096
0.36	0.9005	0.2976	0.4882	0.6743	0.1262	0.2839	0.5486	0.0734	0.2084
0.37	0.8962	0.2965	0.4861	0.6700	0.1260	0.2825	0.5444	0.0735	0.2072
0.38	0.8920	0.2954	0.4840	0.6659	0.1258	0.2812	0.5402	0.0735	0.2061
0.39	0.8878	0.2943	0.4820	0.6618	0.1255	0.2798	0.5362	0.0736	0.2050
0.40	0.8837	0.2932	0.4799	0.6579	0.1253	0.2785	0.5323	0.0736	0.2039
0.41	0.8797	0.2921	0.4779	0.6540	0.1250	0.2772	0.5284	0.0736	0.2028
0.42	0.8757	0.2910	0.4759	0.6502	0.1247	0.2759	**0.5247**	**0.0736**	**0.2018**
0.43	0.8717	0.2899	0.4739	0.6465	0.1244	0.2746	0.5211	0.0736	0.2007
0.44	0.8678	0.2889	0.4719	0.6428	0.1241	0.2734	0.5175	0.0736	0.1997
0.45	0.8640	0.2878	0.4700	0.6392	0.1238	0.2721	0.5140	0.0736	0.1987
0.46	0.8601	0.2867	0.4680	0.6357	0.1235	0.2709	0.5106	0.0735	0.1977
0.47	0.8564	0.2856	0.4661	0.6323	0.1232	0.2697	0.5073	0.0735	0.1967
0.48	0.8526	0.2846	0.4642	0.6289	0.1229	0.2685	0.5041	0.0734	0.1957
0.49	0.8489	0.2835	0.4623	0.6256	0.1226	0.2673	0.5009	0.0734	0.1948

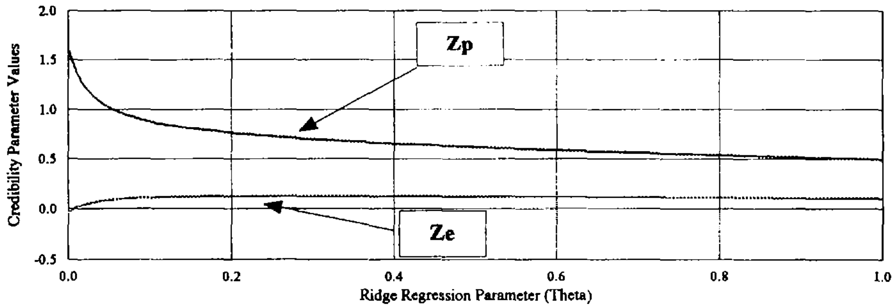
Notes: Overall Crediblity = (D x Zp) + ((1 - D) x Ze), where D is the empirical D-ratio for the group.
Valid combinations of Zp and Ze are those for which Zp and Ze are bounded by [0,1].

CALIFORNIA EXPERIENCE RATING PLAN Exhibit 2
RIDGE REGRESSION RESULTS
Projection Year 1991 5th Report

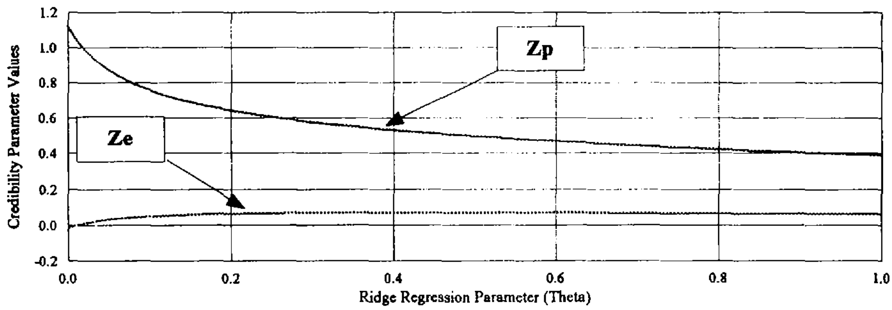
Risks 1 - 5,000



Risks 20,001 - 25,000



Risks 45,001 - 50,000



CALIFORNIA EXPERIENCE RATING PLAN Exhibit 3

MAXIMUM EXCESS RIDGE REGRESSION CREDIBILITIES

Projection Year 1991 at 5th Report - Iteration 0

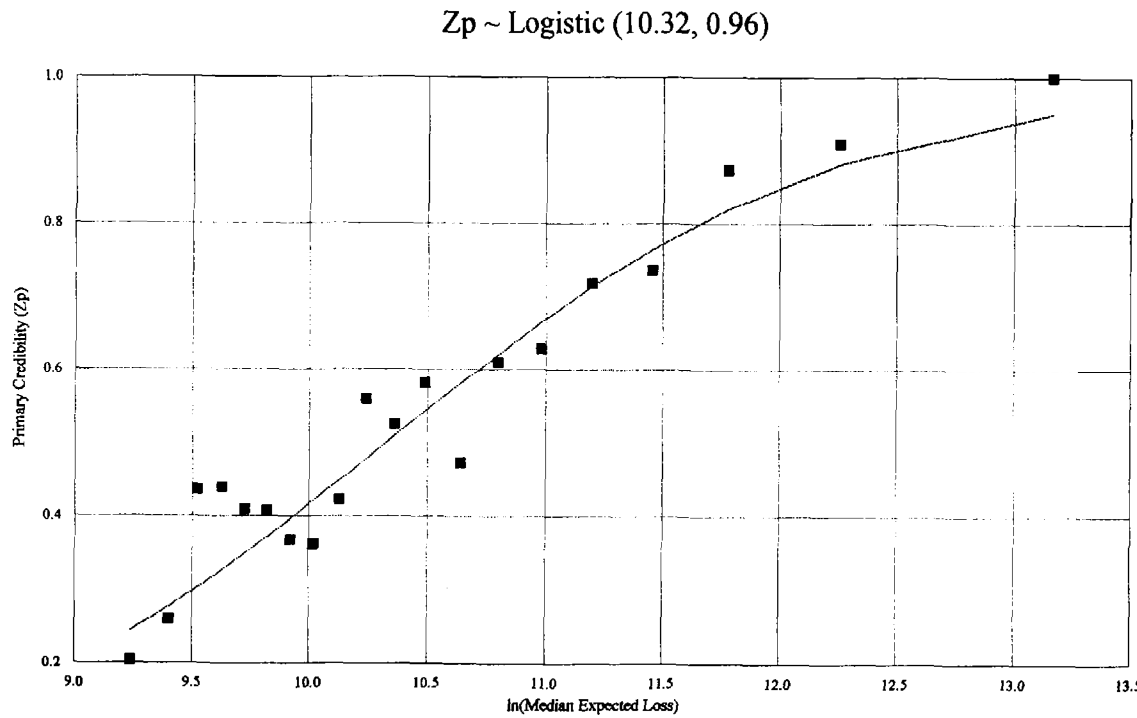
Risks	Median Exper. Period Expected Loss	1997 Experience Rating Plan Zp	1997 Experience Rating Plan Ze	Exp Period Empirical D Ratio	Maximum Excess Ridge Regression Values* θ	Maximum Excess Ridge Regression Values* Zp	Maximum Excess Ridge Regression Values* Ze	Maximum Excess Ridge Regression Values* Overall	Fitted Values Zp	Fitted Values Ze	
1 - 5k	520,196	0.98381	0.37463	0.31619	0.17	0.99999	0.31674	0.53277	0.95084	0.32174	
5k - 10k	209,397	0.95602	0.23796	0.29807	0.22	0.90989	0.21842	0.42453	0.88214	0.21834	
10k - 15k	130,614	0.92729	0.17917	0.29403	0.16	0.87377	0.19318	0.39329	0.82059	0.17218	
15k - 20k	94,331	0.89826	0.14421	0.29252	0.25	0.73658	0.14503	0.31807	0.76510	0.14369	
20k - 25k	73,038	0.86864	0.11991	0.28773	0.27	0.71864	0.12725	0.29741	0.71380	0.12322	
25k - 30k	58,775	0.83801	0.10137	0.29156	0.58	0.62907	0.09186	0.24849	0.66535	0.10714	
30k - 35k	48,710	0.80709	0.08684	0.28371	0.30	0.61032	0.09719	0.24277	0.62040	0.09419	
35k - 40k	41,539	0.77752	0.07555	0.28733	0.78	0.47275	0.05385	0.17421	0.58056	0.08388	
40k - 45k	35,917	0.74781	0.06602	0.28722	0.52	0.58135	0.07679	0.22171	0.54323	0.07498	
45k - 50k	31,528	0.71903	0.05807	0.28404	0.42	0.52471	0.07364	0.20177	0.50934	0.06742	
50k - 55k	27,940	0.69065	0.05120	0.28807	0.65	0.55995	0.06828	0.20992	0.47785	0.06074	
55k - 60k	24,984	0.66303	0.04523	0.28579	0.56	0.42228	0.05234	0.15806	0.44884	0.05485	
60k - 65k	22,444	0.63545	0.03984	0.28890	0.82	0.36133	0.03880	0.13198	0.42136	0.04943	
65k - 70k	20,297	0.60875	0.03508	0.28551	0.61	0.36762	0.04313	0.13577	0.39601	0.04457	
70k - 75k	18,366	0.58154	0.03061	0.28546	0.42	0.40716	0.05187	0.15329	0.37135	0.03993	
75k - 80k	16,696	0.55512	0.02657	0.28212	0.69	0.40919	0.04364	0.14677	0.34845	0.03568	
80k - 85k	15,175	0.52833	0.02275	0.28821	0.33	0.43899	0.06078	0.16978	0.32617	0.03160	**
85k - 90k	13,641	0.49826	0.01874	0.28056	0.38	0.43581	0.05543	0.16215	0.30222	0.02723	**
90k - 95k	12,083	0.46406	0.01447	0.27956	0.75	0.25916	0.02758	0.09232	0.27622	0.02250	**
95k - 100k	10,278	0.41901	0.00923	0.26503	1.03	0.20355	0.01676	0.06626	0.24378	0.01656	**

*Values along the ridge trace where excess credibility is maximized, with primary and excess credibilities bounded by [0,1].

**Data not used in credibility smoothing. Adjusted R^2 of fits: 0.93, Zp; 0.97, Ze.

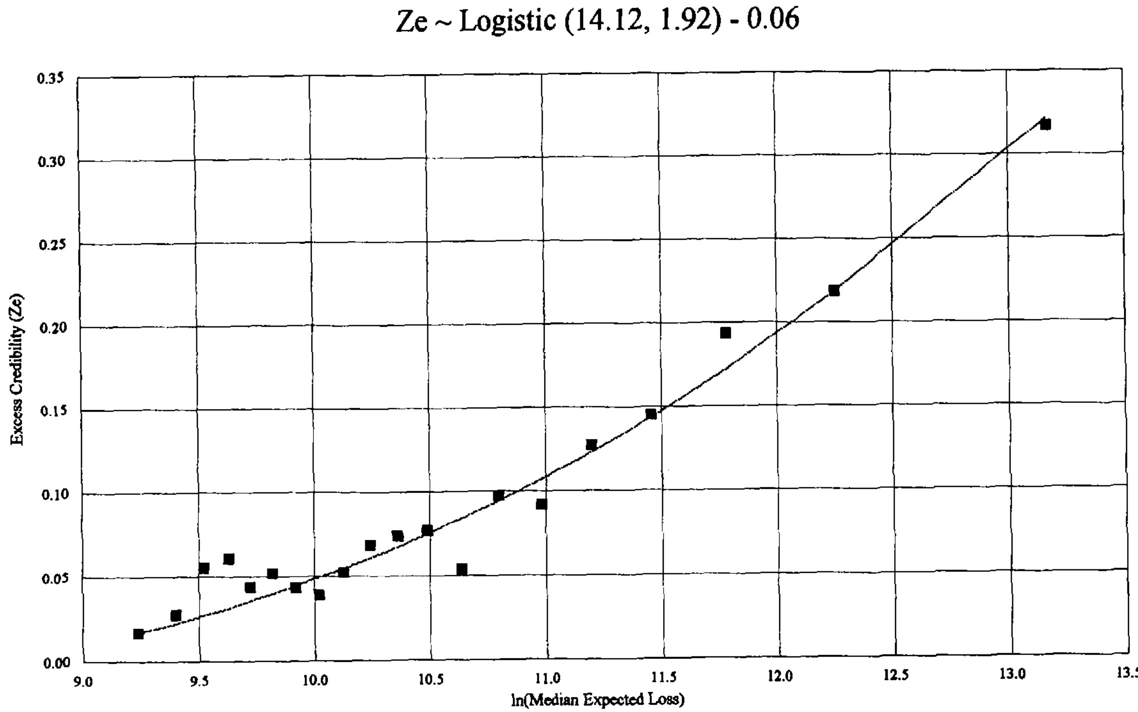
CALIFORNIA EXPERIENCE RATING PLAN
DEVELOPMENT OF RATING VALUES / 1991 5th Report - Iteration 0
Primary Credibility / Zp = 1/(1 + exp[(10.3228 -X) / 0.958451)

Exhibit 4
Part 1



CALIFORNIA EXPERIENCE RATING PLAN
DEVELOPMENT OF RATING VALUES / 1991 5th Report - Iteration 0
Excess Credibility / Ze = [1/(1 + exp[(14.1151 -X) / 1.92436)] - 0.0569084

Exhibit 4
Part 2



DERIVATION OF B AND W VALUES FROM PRIMARY AND EXCESS CREDIBILITIES

Projection Year: 1991 5th Report - Iteration 0

1. $$Zp = \left(\frac{1}{1+\exp[(10.3228 - \ln(E))/0.9584]} \right) \sim \text{Logistic}(10.3228, 0.9584)$$

2. $$Ze = \left(\frac{1}{1+\exp[(14.1151 - \ln(E))/1.9244]} - 0.0569 \right) \sim \text{Logistic}(14.1151, 1.9244) - 0.0569$$

3. $$W = \frac{Ze}{Zp} \longrightarrow$$

$$W = \left(\frac{\frac{1}{1+\exp[(14.1151 - \ln(E))/1.9244]} - 0.0569}{\frac{1}{1+\exp[(10.3228 - \ln(E))/0.9584]}} \right)$$

$$W = \left(\frac{\frac{1}{1+\exp[(14.1151 - \ln(E))/1.9244]}}{\frac{1}{1+\exp[(10.3228 - \ln(E))/0.9584]}} - \frac{0.0569}{\frac{1}{1+\exp[(10.3228 - \ln(E))/0.9584]}} \right)$$

$$W = \frac{1+\exp[(10.3228 - \ln(E))/0.9584]}{1+\exp[(14.1151 - \ln(E))/1.9244]} - 0.0569 \times (1+\exp[(10.3228 - \ln(E))/0.9584])$$

4. $$Zp = \frac{E}{E+B}$$

Where E is the expected loss for the midpoint of the range and Zp is the primary credibility associated with E.

$$\longrightarrow \quad B = \frac{E(1 - Zp)}{Zp}$$

CALIFORNIA EXPERIENCE RATING PLAN
TABLE OF B AND W VALUES
Projection Year: 1991 at 5th Report - Iteration 0

Expected Losses		W	B	Expected Losses		W	B
8,750 -	9,019	0.05	32,124	1,915,987 -	2,077,363	0.50	25,373
9,020 -	9,958	0.06	31,994	2,077,364 -	2,252,832	0.51	25,284
9,959 -	11,143	0.07	31,847	2,252,833 -	2,443,862	0.52	25,195
11,144 -	12,677	0.08	31,680	2,443,863 -	2,652,114	0.53	25,106
12,678 -	14,720	0.09	31,489	2,652,115 -	2,879,464	0.54	25,017
14,721 -	17,508	0.10	31,268	2,879,465 -	3,128,044	0.55	24,927
17,509 -	21,361	0.11	31,015	3,128,045 -	3,400,278	0.56	24,838
21,362 -	26,619	0.12	30,733	3,400,279 -	3,698,937	0.57	24,748
26,620 -	33,502	0.13	30,434	3,698,938 -	4,027,195	0.58	24,657
33,503 -	42,022	0.14	30,134	4,027,196 -	4,388,699	0.59	24,566
42,023 -	52,053	0.15	29,849	4,388,700 -	4,787,661	0.60	24,474
52,054 -	63,464	0.16	29,584	4,787,662 -	5,228,959	0.61	24,381
63,465 -	76,178	0.17	29,342	5,228,960 -	5,718,269	0.62	24,287
76,179 -	90,172	0.18	29,120	5,718,270 -	6,262,224	0.63	24,193
90,173 -	105,460	0.19	28,916	6,262,225 -	6,868,610	0.64	24,097
105,461 -	122,087	0.20	28,728	6,868,611 -	7,546,617	0.65	23,999
122,088 -	140,115	0.21	28,552	7,546,618 -	8,307,147	0.66	23,901
140,116 -	159,619	0.22	28,387	8,307,148 -	9,163,208	0.67	23,800
159,620 -	180,688	0.23	28,231	9,163,209 -	10,130,416	0.68	23,698
180,689 -	203,420	0.24	28,083	10,130,417 -	11,227,642	0.69	23,594
203,421 -	227,925	0.25	27,942	11,227,643 -	12,477,859	0.70	23,487
227,926 -	254,321	0.26	27,807	12,477,860 -	13,909,243	0.71	23,378
254,322 -	282,740	0.27	27,678	13,909,244 -	15,556,644	0.72	23,267
282,741 -	313,323	0.28	27,553	15,556,645 -	17,463,567	0.73	23,152
313,324 -	346,226	0.29	27,433	17,463,568 -	19,684,858	0.74	23,034
346,227 -	381,615	0.30	27,316	19,684,859 -	22,290,427	0.75	22,913
381,616 -	419,674	0.31	27,202	22,290,428 -	25,370,463	0.76	22,787
419,675 -	460,603	0.32	27,091	25,370,464 -	29,042,880	0.77	22,656
460,604 -	504,618	0.33	26,983	29,042,881 -	33,464,157	0.78	22,521
504,619 -	551,956	0.34	26,878	33,464,158 -	38,845,437	0.79	22,379
551,957 -	602,876	0.35	26,774	38,845,438 -	45,477,054	0.80	22,230
602,877 -	657,660	0.36	26,673	45,477,055 -	53,766,874	0.81	22,074
657,661 -	716,618	0.37	26,573	53,766,875 -	64,302,165	0.82	21,908
716,619 -	780,090	0.38	26,475	64,302,166 -	77,953,021	0.83	21,732
780,091 -	848,447	0.39	26,378	77,953,022 -	96,052,589	0.84	21,543
848,448 -	922,099	0.40	26,283	96,052,590 -	120,726,940	0.85	21,339
922,100 -	1,001,497	0.41	26,189	120,726,941 -	155,535,462	0.86	21,116
1,001,498 -	1,087,138	0.42	26,096	155,535,463 -	206,807,256	0.87	20,869
1,087,139 -	1,179,571	0.43	26,003	206,807,257 -	286,695,068	0.88	20,591
1,179,572 -	1,279,404	0.44	25,912	286,695,069 -	421,029,234	0.89	20,272
1,279,405 -	1,387,312	0.45	25,821	421,029,235 -	673,045,311	0.90	19,893
1,387,313 -	1,504,041	0.46	25,730	673,045,312 -	1,234,122,861	0.91	19,419
1,504,042 -	1,630,426	0.47	25,640	1,234,122,862 -	2,936,427,591	0.92	18,772
1,630,427 -	1,767,395	0.48	25,551				
1,767,396 -	1,915,986	0.49	25,462				

Exhibit 7

CALIFORNIA EXPERIENCE RATING PLAN
QUINTILES TESTS
Projection Year: 1991 5th Report

Iteration 0

Standard Loss Ratio

Indicated Modification Quintile	Expected Loss Quintiles					All Risks
	Largest	Large	Middle	Small	Smallest	
Lowest	0.572	0.491	0.487	0.491	0.542	0.571
Low	0.625	0.550	0.528	0.491	0.633	0.603
Middle	0.629	0.589	0.567	0.593	0.633	0.621
High	0.638	0.641	0.618	0.630	0.628	0.642
Highest	0.622	0.639	0.657	0.633	0.743	0.627
All Risks	0.620	0.592	0.582	0.575	0.640	0.613

Manual Loss Ratio

Indicated Modification Quintile	Expected Loss Quintiles					All Risks
	Largest	Large	Middle	Small	Smallest	
Lowest	0.394	0.373	0.401	0.427	0.486	0.426
Low	0.513	0.457	0.446	0.427	0.596	0.515
Middle	0.577	0.538	0.511	0.540	0.596	0.588
High	0.677	0.671	0.632	0.634	0.629	0.663
Highest	0.865	0.879	0.873	0.820	0.935	0.840
All Risks	0.598	0.583	0.574	0.571	0.644	0.595

Iteration 1

Standard Loss Ratio

Indicated Mod Quintile	Expected Loss Quintile					All Risks
	Largest	Large	Middle	Small	Smallest	
Lowest	0.587	0.524	0.489	0.534	0.561	0.575
Low	0.632	0.550	0.547	0.534	0.587	0.621
Middle	0.634	0.597	0.599	0.589	0.687	0.628
High	0.635	0.626	0.609	0.629	0.636	0.635
Highest	0.614	0.628	0.631	0.602	0.701	0.618
All Risks	0.622	0.594	0.585	0.577	0.639	0.615

Manual Loss Ratio

Indicated Mod Quintile	Expected Loss Quintile					All Risks
	Largest	Large	Middle	Small	Smallest	
Lowest	0.394	0.382	0.376	0.452	0.490	0.411
Low	0.513	0.439	0.444	0.452	0.520	0.530
Middle	0.578	0.541	0.533	0.516	0.648	0.577
High	0.677	0.661	0.633	0.645	0.646	0.663
Highest	0.866	0.892	0.877	0.828	0.938	0.851
All Risks	0.598	0.583	0.574	0.571	0.644	0.595

Iteration 2

Standard Loss Ratio

Indicated Modification Quintile	Expected Loss Quintiles					All Risks
	Largest	Large	Middle	Small	Smallest	
Lowest	0.595	0.531	0.514	0.500	0.575	0.579
Low	0.632	0.558	0.544	0.568	0.592	0.623
Middle	0.635	0.599	0.611	0.601	0.667	0.629
High	0.635	0.626	0.601	0.618	0.633	0.633
Highest	0.613	0.620	0.621	0.583	0.710	0.615
All Risks	0.622	0.595	0.586	0.578	0.640	0.616

Manual Loss Ratio

Indicated Modification Quintile	Expected Loss Quintiles					All Risks
	Largest	Large	Middle	Small	Smallest	
Lowest	0.395	0.375	0.383	0.389	0.493	0.403
Low	0.513	0.440	0.420	0.473	0.522	0.520
Middle	0.579	0.541	0.544	0.523	0.636	0.576
High	0.676	0.663	0.629	0.642	0.648	0.664
Highest	0.866	0.893	0.886	0.825	0.940	0.854
All Risks	0.598	0.583	0.574	0.571	0.644	0.595

CALIFORNIA EXPERIENCE RATING PLAN
ITERATIVE PARAMETER REFINEMENT
Projection Year: 1991 5th Report - Iteration 0

Exhibit 8

Expected Loss Quintiles

Projected Mod	Quintile #1		Quintile #2		Quintile #3		Quintile #4		Quintile #5		All Risks	
	Number of Risks	Std Loss Ratio	Number of Risks	Std Loss Ratio	Number of Risks	Std Loss Ratio	Number of Risks	Std Loss Ratio	Number of Risks	Std Loss Ratio	Number of Risks	Std Loss Ratio
0.0												
0.1												
0.2												
0.3												
0.4	2	1.013									2	1.013
0.5	11	0.339									11	0.339
0.6	167	0.496									167	0.496
0.7	1,703	0.573	165	0.385							1,868	0.569
0.8	3,666	0.583	4,840	0.497	1,453	0.423					9,959	0.561
0.9	3,782	0.643	4,567	0.566	8,470	0.528	9,835	0.491	4,507	0.530	31,161	0.603
1.0	3,249	0.623	3,366	0.602	3,433	0.597	3,894	0.672	13,247	0.633	27,189	0.622
1.1	2,485	0.658	2,335	0.655	2,507	0.627	2,460	0.602	3,010	0.624	12,797	0.652
1.2	1,646	0.594	1,681	0.642	1,568	0.640	1,556	0.625	2,232	0.724	8,683	0.610
1.3	1,086	0.594	1,078	0.657	936	0.671	904	0.651	1,104	0.749	5,108	0.613
1.4	763	0.615	700	0.600	611	0.616	535	0.601	628	0.713	3,237	0.615
1.5	512	0.658	462	0.640	368	0.649	323	0.644	330	0.827	1,995	0.658
1.6	296	0.608	269	0.618	239	0.632	189	0.528	185	0.932	1,178	0.616
1.7	212	0.757	167	0.617	141	0.740	125	0.547	111	0.925	756	0.731
1.8	134	0.689	130	0.708	93	0.649	63	0.931	51	0.678	471	0.695
1.9	75	0.603	82	0.620	48	0.878	40	0.904	41	0.603	286	0.631
2.0	61	0.548	44	0.682	34	0.752	24	0.569	22	0.839	185	0.575
2.1	41	0.625	29	0.596	32	0.790	19	0.441	9	0.833	130	0.630
2.2	23	0.703	24	0.698	21	0.892	11	1.318	8	0.262	87	0.717
2.3	18	0.694	14	0.383	16	0.530	6	1.118	7	1.174	61	0.657
2.4	13	0.487	16	0.760	9	0.203	3	2.489	4	0.663	45	0.516
2.5	15	0.657	10	0.896	6	1.807	5	0.220			36	0.695
2.6	6	0.725	5	0.888			1	0.154	1	0.000	13	0.714
2.7	4	0.977	4	0.139	4	0.789					12	0.657
2.8	3	1.146	2	0.856	2	0.699	1	0.635	3	2.743	11	1.188
2.9	7	0.629	2	0.425	1	0.050			2	0.432	12	0.589
3.0	2	0.841			1	0.000					3	0.832
>3.0	18	0.562	8	1.306	7	0.995	6	1.287	1	0.000	40	0.644
Total	20,000	0.620	20,000	0.592	20,000	0.582	20,000	0.575	25,503	0.640	105,503	0.613

Notes:
1. The Indicated Modification shown is the upper bound for the row. Therefore, the expected Indicated Mod for the 1.0 row is 0.95.

CALIFORNIA EXPERIENCE RATING PLAN
ITERATIVE PARAMETER REFINEMENT
Risk-Weighted Regression Output
Projection Year: 1991 5th Report - Iteration 0

Exhibit 9

Quintile 1

Weighted Regression Analysis

Dependent variable: Std_LR

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.568885	0.025802	22.048	0.0000
PROJ_MOD - 0.05	0.0485909	0.0253898	1.9138	0.0687

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	3.68357	1	3.68357	3.66	0.0687
Residual	22.1258	22	1.00572		
Total (Corr.)	25.8093	23			

R-squared = 14.2722 percent
R-squared (adjusted for d.f.) = 10.3755 percent
Standard Error of Est. = 1.00285
Mean absolute error = 0.0283059
Durbin-Watson statistic = 1.70045

Quintile 2

Weighted Regression Analysis

Dependent variable: Std_LR

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.395065	0.0394384	10.0173	0.0000
PROJ_MOD - 0.05	0.190755	0.0390622	4.88336	0.0001

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	44.7696	1	44.7696	23.85	0.0001
Residual	35.6697	19	1.87735		
Total (Corr.)	80.4394	20			

R-squared = 55.6564 percent
R-squared (adjusted for d.f.) = 53.3225 percent
Standard Error of Est. = 1.37017
Mean absolute error = 0.0340373
Durbin-Watson statistic = 0.869006

Quintile 3

Weighted Regression Analysis

Dependent variable: Std_LR

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.312573	0.0496612	6.29412	0.0000
PROJ_MOD - 0.05	0.262768	0.0493486	5.32473	0.0001

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	65.3039	1	65.3039	28.35	0.0001
Residual	39.1555	17	2.30326		
Total (Corr.)	104.459	18			

R-squared = 62.5161 percent
R-squared (adjusted for d.f.) = 60.3111 percent
Standard Error of Est. = 1.51765
Mean absolute error = 0.0292991
Durbin-Watson statistic = 1.43271

Quintile 4

Weighted Regression Analysis

Dependent variable: Std_LR

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.320195	0.0909611	3.52013	0.0031
PROJ_MOD - 0.05	0.251596	0.0910402	2.76357	0.0145

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	47.9631	1	47.9631	7.64	0.0145
Residual	94.2013	15	6.28009		
Total (Corr.)	142.164	16			

R-squared = 33.7378 percent
R-squared (adjusted for d.f.) = 29.3203 percent
Standard Error of Est. = 2.50601
Mean absolute error = 0.0543409
Durbin-Watson statistic = 2.20498

Quintile 5

Weighted Regression Analysis

Dependent variable: Std_LR

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.250208	0.0694848	3.60089	0.0032
PROJ_MOD - 0.05	0.383455	0.0684319	5.60346	0.0001

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	90.7514	1	90.7514	31.40	0.0001
Residual	37.5737	13	2.89029		
Total (Corr.)	128.325	14			

R-squared = 70.7199 percent
R-squared (adjusted for d.f.) = 68.4676 percent
Standard Error of Est. = 1.70008
Mean absolute error = 0.0288783
Durbin-Watson statistic = 2.03497

All Risks

Weighted Regression Analysis

Dependent variable: Std_LR

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	0.540786	0.0209312	25.8363	0.0000
PROJ_MOD - 0.05	0.0735404	0.0207073	3.55142	0.0016

Analysis of Variance

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	28.3259	1	28.3259	12.61	0.0016
Residual	53.9003	24	2.24585		
Total (Corr.)	82.2262	25			

R-squared = 34.4488 percent
R-squared (adjusted for d.f.) = 31.7175 percent
Standard Error of Est. = 1.49861
Mean absolute error = 0.0158363
Durbin-Watson statistic = 1.6168

CALIFORNIA EXPERIENCE RATING PLAN Exhibit 10

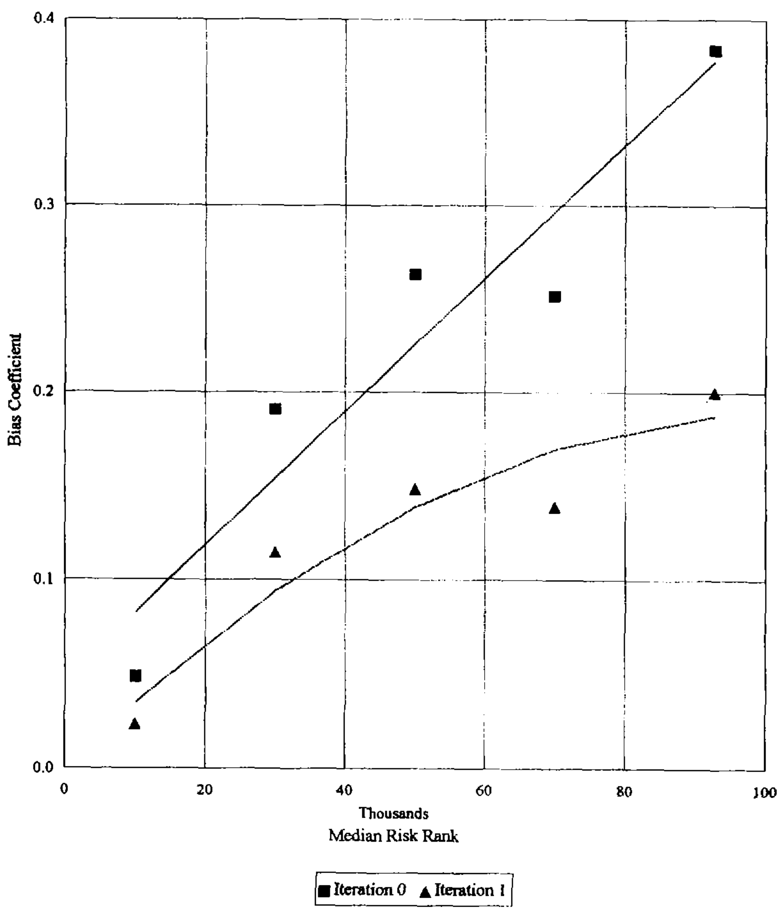
ITERATIVE PARAMETER REFINEMENT

Projection Year: 1991 5th Report - Iteration 0

Expected Loss Quintile	Median Risk Rank	Bias Coefficient
Quintile # 1	10,000	0.048591
Quintile # 2	30,000	0.190755
Quintile # 3	50,000	0.262768
Quintile # 4	70,000	0.251596
Quintile # 5	92,752	0.383455
All Risks		0.073540

Regression Output:	
Constant	0.047528
Std Err of Y Est	0.044633
R Squared	0.899567
No. of Observations	5
Degrees of Freedom	3
X Coefficient(s)	3.55892E-06
Std Err of Coef.	6.86560E-07

Plot of Bias Coefficients



CALIFORNIA EXPERIENCE RATING PLAN Exhibit 12

ADJUSTMENT OF MAXIMUM EXCESS CREDIBILITIES

Projection Year 1991 at 5th Report - Iteration 1

	Iteration 0 Cred. Before Adjustment		D Ratio Based on Actual Losses	Overall Crediblity Before Adj.	Indicated* Credibility Adjustments	Overall Credibility After Adj.**	Credibilities After Adjustment***				Fitted Values	
Risks	Zp	Ze					Θ	Zp	Ze	Overall	Zp	Ze
1 - 5k	0.95084	0.32174	0.31619	0.52065	0.05643	0.55003	0.17	0.99999	0.31674	0.53277	0.99180	0.32759
5k - 10k	0.88214	0.21834	0.29807	0.41620	0.07422	0.44709	0.13	0.99840	0.21305	0.44714	0.97129	0.20602
10k - 15k	0.82059	0.17218	0.29403	0.36284	0.09201	0.39622	0.15	0.88164	0.19310	0.39555	0.94588	0.15591
15k - 20k	0.76510	0.14369	0.29252	0.32546	0.10981	0.36120	0.08	0.92664	0.12449	0.35914	0.91725	0.12664
20k - 25k	0.71380	0.12322	0.28773	0.29314	0.12760	0.33055	0.11	0.86620	0.11554	0.33152	0.88570	0.10650
25k - 30k	0.66535	0.10714	0.29156	0.26989	0.14540	0.30914	0.22	0.88408	0.07091	0.30800	0.85113	0.09125
30k - 35k	0.62040	0.09419	0.28371	0.24348	0.16319	0.28322	0.09	0.78779	0.08215	0.28235	0.81467	0.07935
35k - 40k	0.58056	0.08388	0.28733	0.22659	0.18099	0.26760	0.14	0.93206	0.00205	0.26928	0.77864	0.07013
40k - 45k	0.54323	0.07498	0.28722	0.20947	0.19878	0.25111	0.30	0.69411	0.07244	0.25100	0.74160	0.06237
45k - 50k	0.50934	0.06742	0.28404	0.19294	0.21658	0.23473	0.18	0.65941	0.06595	0.23451	0.70514	0.05592
50k - 55k	0.47785	0.06074	0.28807	0.18090	0.23437	0.22330	0.52	0.60997	0.06752	0.22378	0.66882	0.05034
55k - 60k	0.44884	0.05485	0.28579	0.16745	0.25217	0.20967	0.14	0.65065	0.03292	0.20946	0.63329	0.04550
60k - 65k	0.42136	0.04943	0.28890	0.15688	0.26996	0.19923	0.17	0.66953	0.00908	0.19988	0.59780	0.04115
65k - 70k	0.39601	0.04457	0.28551	0.14491	0.28776	0.18661	0.14	0.59118	0.02374	0.18575	0.56356	0.03729
70k - 75k	0.37135	0.03993	0.28546	0.13454	0.30555	0.17565	0.20	0.49474	0.04821	0.17568	0.52890	0.03368
75k - 80k	0.34845	0.03568	0.28212	0.12392	0.32334	0.16399	0.47	0.47507	0.04205	0.16422	0.49558	0.03042
80k - 85k	0.32617	0.03160	0.28821	0.11650	0.34114	0.15624	0.49	0.39471	0.05975	0.15629	0.46223	0.02734
85k - 90k	0.30222	0.02723	0.28056	0.10438	0.35893	0.14185	0.65	0.36987	0.05334	0.14215	0.42544	0.02409
90k - 95k	0.27622	0.02250	0.27956	0.09343	0.37673	0.12863	0.20	0.42198	0.01504	0.12881	0.38456	0.02064
95k - 100k	0.24378	0.01656	0.26503	0.07678	0.39452	0.10707	0.20	0.40402	0.00043	0.10739	0.33256	0.01641

* Credibility Adjustment = 0.047528 + (Rank of median risk) x (3.55892E-06). See Exhibit 10.

** Overall Credibility After Adjustment = Overall Credibility Before Adjustment x [1 + Indicated Credibility Adjustment].

*** Credibilities along the ridge trace with overall credibility closest to the "Overall Credibility After Adjustment" and with Primary and Excess Credibility values bounded by [0,1].

CALIFORNIA EXPERIENCE RATING PLAN

SUMMARY OF PLAN EFFICIENCIES BY EXPECTED LOSS QUINTILES

Projection Year: 1991 5th Report

Exhibit 13

Manual Premium Weighted		Expected Loss Quintiles: Largest 20%	2nd Largest 20%	Middle 20%	2nd Smallest 20%	Smallest 20%	All Risks
Parameterized B & W Plan -1989 3rd		NA	NA	NA	NA	NA	NA
Frequency Only -1989 3rd		NA	NA	NA	NA	NA	NA
Promulgated Rating Values (based on 1989 3rd)		0.128994	0.042998	0.029201	0.020843	0.013164	0.068523
Parameterized B & W Plan (based on 1991 5th)	Starting Values	0.129106	0.039685	0.024801	0.017089	0.010145	0.066184
	Iteration 1	0.129792	0.042418	0.028301	0.019253	0.012138	0.068038
	Iteration 2	**0.130107**	**0.043756**	**0.029928**	**0.019647**	**0.011545**	**0.068829**
	Iteration 3	0.129575	0.044131	0.030589	0.020583	0.010485	0.068709

Risk Weighted		Expected Loss Quintiles: Largest 20%	2nd Largest 20%	Middle 20%	2nd Smallest 20%	Smallest 20%	All Risks
Parameterized B & W Plan -1989 3rd		0.074752	0.024968	0.010343	0.010181	0.007118	0.020767
Frequency Only -1989 3rd		0.081791	0.028444	0.015099	0.013181	0.008131	0.024437
Promulgated Rating Values (based on 1989 3rd)		0.067791	0.033602	0.025104	0.017707	0.009833	0.024833
Parameterized B & W Plan (based on 1991 5th)	Starting Values	0.067418	0.031215	0.021153	0.014610	0.007803	0.023358
	Iteration 1	0.068274	0.033614	0.024102	0.015783	0.009420	0.024758
	Iteration 2	**0.069529**	**0.034387**	**0.025760**	**0.017029**	**0.009400**	**0.025815**
	Iteration 3	0.069166	0.034830	0.026186	0.017744	0.008103	0.025577

NOTES:

Efficiency is measured as the proportionate reduction in total variance using the following formula:

$$\text{Efficiency} = \frac{E[(u-M)^2 - (u-F)^2]}{E[(u-M)^2]}$$

Where E[x] is the expected value function over all risks, u is the Empirical Modification (actual loss / expected loss), M is the Average Empirical Modification for all risks, and F is the Modification under the Plan. This measure of efficiency is discussed by Glenn Meyers in "An Analysis of Experience Rating," PCAS LXXII, 1985, p287. Larger values of efficiency indicate better reproduction of empirical experience.

CALIFORNIA EXPERIENCE RATING PLAN
INDICATED MODIFICATION VS CURRENT MODIFICATION
Projection Year: 1991 5th Report - Iteration 2
Number of Risks - All Risks

Exhibit 14
Part 1

Indicated	Current Modification																															
Mod	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	>3.0	Total
0.0																																	
0.1																																	
0.2																																	
0.3				1	1																												2
0.4					1																												1
0.5						27	1																										28
0.6						6	300	5																									311
0.7							127	3,956	1,016																								5,099
0.8								461	15,627	3,258																							19,346
0.9									525	24,001	862																						25,388
1.0										4,399	13,836	673																					18,908
1.1											349	9,596	983	188	137	2																	11,255
1.2												669	6,770	903	120	140	76	30	4	1													8,713
1.3												1	813	3,900	584	43		7	31	27	27	6	1		1								5,441
1.4													33	649	2,295	470	59	11			2	5	13	6	4								3,547
1.5														8	544	1,452	355	51	16						5	5	3	3					2,442
1.6															20	436	832	232	25	18	3							1		2	1	3	1,573
1.7															1	29	319	526	160	14	7	5										2	1,063
1.8																1	27	272	316	107	17	5	7	1								4	757
1.9																		14	141	200	78	15		4	4							1	457
2.0																		3	26	119	110	44	13	1	1	1	2						320
2.1																			3	24	89	71	36	11		1	2						237
2.2																			1		16	43	44	21	9	2		1					137
2.3																					4	15	42	32	16	1	4					1	115
2.4																				1	1	2	7	27	27	12	6	1				2	86
2.5																							2	6	17	16	12	4	5			1	63
2.6																							1	1	9	20	13	7	3	1			55
2.7																									5	10	6	9	7	2		1	40
2.8																										1	4	3	3	4	1	1	17
2.9																										1	1	4	4	2	1	1	14
3.0																											1	1	4	3	1	6	16
>3.0																													2	7	2	61	72
Total				1	2	33	428	4,422	17,168	31,658	15,047	10,939	8,599	5,648	3,701	2,573	1,668	1,146	723	511	354	211	166	110	98	70	54	34	28	21	6	84	105,503

CALIFORNIA EXPERIENCE RATING PLAN
INDICATED MODIFICATION VS CURRENT MODIFICATION
Projection Year: 1991 5th Report - Iteration 2
Number of Risks - Quintile #1

Exhibit 14
Part 2

Indicated	Current Modification																															
Mod	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	>3.0	Total
0.0																																	
0.1																																	
0.2																																	
0.3				1	1																												2
0.4					1																												1
0.5						27	1																										28
0.6						6	299	3																									308
0.7							127	2,029	3																								2,159
0.8								412	2,997	18																							3,427
0.9									350	3,158	54																						3,562
1.0										223	2,750	123																					3,096
1.1											101	2,123	141																				2,365
1.2												49	1,443	141																			1,633
1.3													29	927	132																		1,088
1.4														13	596	137																	746
1.5															13	436	110																559
1.6																8	216	79	2														305
1.7																	3	166	69	1													239
1.8																		1	103	44	1												149
1.9																				54	32	3											89
2.0																				1	36	28											65
2.1																					2	26	18										46
2.2																							19	12	1								32
2.3																								12	9	1							22
2.4																									7	8							15
2.5																										4	10	1					15
2.6																											1	6	2				9
2.7																												3	4				7
2.8																													2	2	1		5
2.9																															1	1	2
3.0																															1	4	5
>3.0																																21	21
Total				1	2	33	427	2,444	3,350	3,399	2,905	2,295	1,613	1,081	741	581	329	246	174	100	71	57	37	24	17	13	11	10	8	2	3	26	20,000

CALIFORNIA EXPERIENCE RATING PLAN
INDICATED MODIFICATION VS CURRENT MODIFICATION
Projection Year: 1991 5th Report - Iteration 2
Number of Risks - Quintile #2

Exhibit 14
Part 3

Indicated	Current Modification																																
Mod	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	>3.0	Total
0.0																																	
0.1																																	
0.2																																	
0.3																																	
0.4																																	
0.5																																	
0.6							1	2																									3
0.7								1,825	474																								2,299
0.8								49	4,139	108																							4,296
0.9									124	3,169	94																						3,387
1.0										157	2,534	150																					2,841
1.1											178	1,756	155																				2,089
1.2												169	1,303	106																			1,578
1.3													115	901	101	1																	1,118
1.4														96	574	93	1																764
1.5															69	355	56																480
1.6																58	252	52															362
1.7																	45	156	32														233
1.8																		33	96	26													155
1.9																			23	74	25												122
2.0																				20	46	9	1										76
2.1																					14	23	11										48
2.2																						10	13	6	1								30
2.3																						1	15	12	5								33
2.4																								7	9	3	3						22
2.5																									6	7	2	1					16
2.6																										3	7	1					11
2.7																											1	6	3	1			11
2.8																												2	1	2			5
2.9																													1	2			3
3.0																													1	2		1	4
>3.0																														1	1	12	14
Total							1	1,876	4,737	3,434	2,806	2,075	1,573	1,103	744	507	354	241	151	120	85	43	40	25	21	13	13	10	6	8	1	13	20,000

CALIFORNIA EXPERIENCE RATING PLAN
INDICATED MODIFICATION VS CURRENT MODIFICATION
Projection Year: 1991 5th Report - Iteration 2
Number of Risks - Quintile #3

Exhibit 14
Part 4

Indicated	Current Modification																															
Mod	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	>3.0	Total
0.0																																	
0.1																																	
0.2																																	
0.3																																	
0.4																																	
0.5																																	
0.6																																	
0.7								102	539																								641
0.8									5,549	1,105																							6,654
0.9										3,005	205																						3,210
1.0										7	2,486	37																					2,530
1.1											66	2,064	20																				2,150
1.2												171	1,341	17																			1,529
1.3													217	745	6																		968
1.4														225	476	6																	707
1.5															188	307	6																501
1.6																161	166	3															330
1.7																1	132	100	2														235
1.8																		119	54														173
1.9																			53	34	2												89
2.0																			5	54	18												77
2.1																				4	41	9	1										55
2.2																					6	16	6	1									29
2.3																						5	14	2									21
2.4																							3	15	6								24
2.5																								3	7	3							13
2.6																									6	11	4						21
2.7																									1	8	4						13
2.8																											2						2
2.9																												4	2				6
3.0																													3	1			4
>3.0																													2	2		14	18
Total								102	6,088	4,117	2,757	2,272	1,578	987	670	475	304	222	114	92	67	30	24	21	20	22	10	4	7	3		14	20,000

CALIFORNIA EXPERIENCE RATING PLAN
INDICATED MODIFICATION VS CURRENT MODIFICATION
Projection Year: 1991 5th Report - Iteration 2
Number of Risks - Quintile #4

Exhibit 14
Part 5

Indicated	Current Modification																															
Mod	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	>3.0	Total
0.0																																	
0.1																																	
0.2																																	
0.3																																	
0.4																																	
0.5																																	
0.6																																	
0.7																																	
0.8									2,775	1,795																							4,570
0.9										6,075	416																						6,491
1.0											2,000	195																					2,195
1.1											4	1,993	56																				2,053
1.2												271	1,320	33																			1,624
1.3												1	331	641	8																		981
1.4													25	251	392																		668
1.5														6	231	206	3																446
1.6															18	164	126	1															309
1.7															1	26	110	61															198
1.8																1	21	93	39														154
1.9																		13	53	18													84
2.0																		3	19	35	9												66
2.1																			3	15	27	6											51
2.2																			1		9	12	5										27
2.3																					4	9	8	4									25
2.4																					1	2	3	5	3								14
2.5																							1	3	2	1							7
2.6																							1		3	4	1						9
2.7																									4	2	1						7
2.8																										1	2	1					4
2.9																										1	1		1				3
3.0																											1	1					2
>3.0																														4	1	7	12
Total									2,775	7,870	2,420	2,460	1,732	931	650	397	260	171	115	68	50	29	18	12	12	9	6	2	1	4	1	7	20,000

CALIFORNIA EXPERIENCE RATING PLAN
INDICATED MODIFICATION VS CURRENT MODIFICATION
Projection Year: 1991 5th Report - Iteration 2
Number of Risks - Quintile #5

Exhibit 14
Part 6

Indicated	Current Modification																															
Mod	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	>3.0	Total
0.0																																	
0.1																																	
0.2																																	
0.3																																	
0.4																																	
0.5																																	
0.6																																	
0.7																																	
0.8									167	232																							399
0.9									51	8,594	93																						8,738
1.0										4,012	4,066	168																					8,246
1.1												1,660	611	188	137	2																	2,598
1.2												9	1,363	606	120	140	76	30	4	1													2,349
1.3													121	686	337	42		7	31	27	27	6	1		1								1,286
1.4													8	64	257	234	58	11			2	5	13	6	4								662
1.5														2	43	148	180	51	16						5	5	3	3					456
1.6															2	45	72	97	23	18	3							1		2	1	3	267
1.7																2	29	43	57	13	7	5										2	158
1.8																	6	26	24	37	16	5	7	1								4	126
1.9																		1	12	20	19	12		4	4							1	73
2.0																			2	9	1	7	12	1	1	1	2						36
2.1																				5	5	7	6	11		1	2						37
2.2																					1	5	1	2	7	2		1					19
2.3																							5	2	2		4					1	14
2.4																				1			1		2	1	3	1				2	11
2.5																							1		2	1		2	5			1	12
2.6																								1		2			1	1			5
2.7																														1		1	2
2.8																																1	1
2.9																																	
3.0																																1	1
>3.0																																7	7
Total									218	12,838	4,159	1,837	2,103	1,546	896	613	421	266	169	131	81	52	47	28	28	13	14	8	6	4	1	24	25,503

CALIFORNIA EXPERIENCE RATING PLAN Exhibit 15

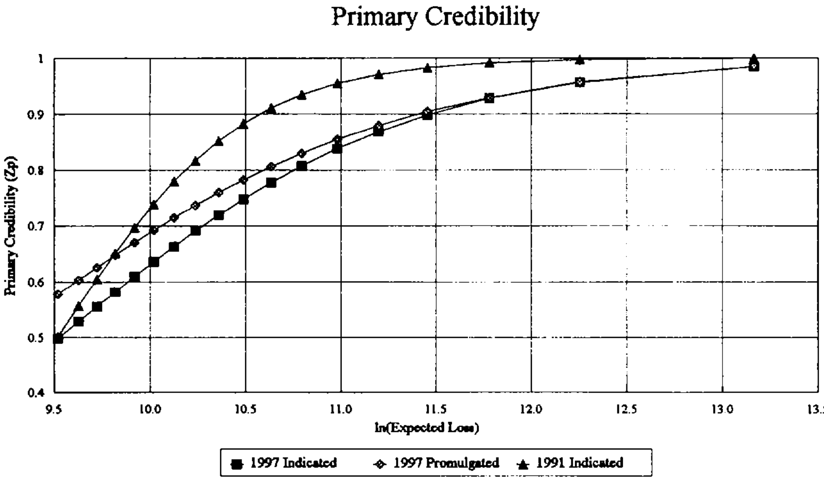
COMPARISON OF CREDIBLITIES

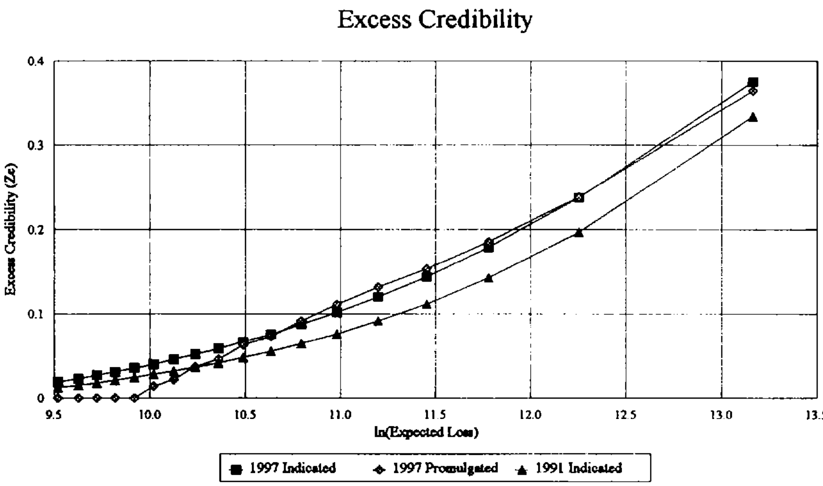
1997 Plan vs Projection Year 1991

Risks	Median Exper. Period Expected Loss	1997 Experience Rating Plan				1991 Iteration 2 (Final)	
		Indicated Values		Promulgated Values		Indicated Values	
		Zp	Ze	Zp	Ze	Zp	Ze
1 - 5k	520,196	0.98381	0.37463	0.98381	0.36401	0.99949	0.33379
5k - 10k	209,397	0.95602	0.23796	0.95608	0.23902	0.99661	0.19710
10k - 15k	130,614	0.92729	0.17917	0.92888	0.18578	0.99101	0.14274
15k - 20k	94,331	0.89826	0.14421	0.90415	0.15371	0.98246	0.11189
20k - 25k	73,038	0.86864	0.11991	0.87957	0.13194	0.97051	0.09114
25k - 30k	58,775	0.83801	0.10137	0.85460	0.11110	0.95444	0.07574
30k - 35k	48,710	0.80709	0.08684	0.82967	0.09126	0.93411	0.06394
35k - 40k	41,539	0.77752	0.07555	0.80597	0.07254	0.91056	0.05493
40k - 45k	35,917	0.74781	0.06602	0.78221	0.06258	0.88269	0.04746
45k - 50k	31,528	0.71903	0.05807	0.75920	0.04555	0.85159	0.04132
50k - 55k	27,940	0.69065	0.05120	0.73643	0.03682	0.81698	0.03608
55k - 60k	24,984	0.66303	0.04523	0.71416	0.02142	0.77963	0.03158
60k - 65k	22,444	0.63545	0.03984	0.69178	0.01384	0.73896	0.02756
65k - 70k	20,297	0.60875	0.03508	0.66993	0.00000	0.69667	0.02405
70k - 75k	18,366	0.58154	0.03061	0.64747	0.00000	0.65105	0.02078
75k - 80k	16,696	0.55512	0.02657	0.62541	0.00000	0.60478	0.01787
80k - 85k	15,175	0.52833	0.02275	0.60278	0.00000	0.55647	0.01513
85k - 90k	13,641	0.49826	0.01874	0.57701	0.00000	0.50131	0.01228
90k - 95k	12,083	0.46406	0.01447	0.54716	0.00000	0.43858	0.00928
95k - 00k	10,278	0.41901	0.00923	0.50685	0.00000	0.35817	0.00565

*1997 Plan credibilities based on 1989 projection year.

CALIFORNIA EXPERIENCE RATING PLAN **Exhibit 16**
COMPARISON OF CREDIBLITIES
1997 Plan vs Projection Year 1991





CALIFORNIA EXPERIENCE RATING PLAN
COMPARISON OF INDICATED AND 1997 PROMULGATED B & W PLAN
1997 Plan vs Projection Year 1991

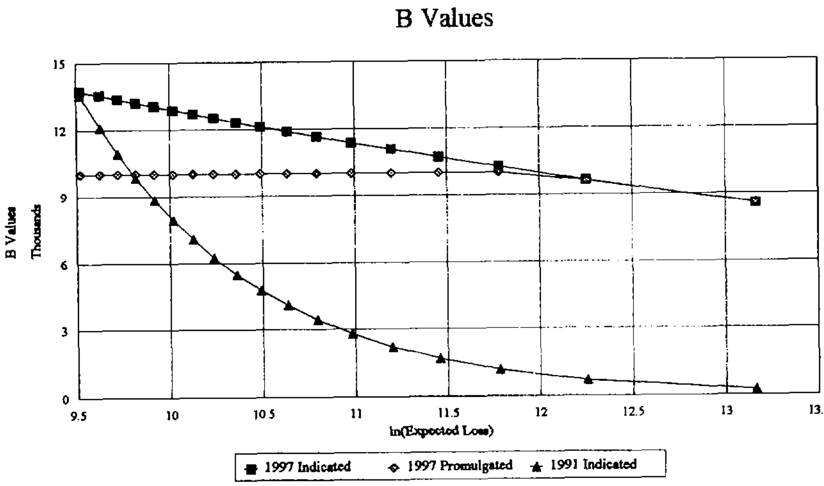
Exhibit 17

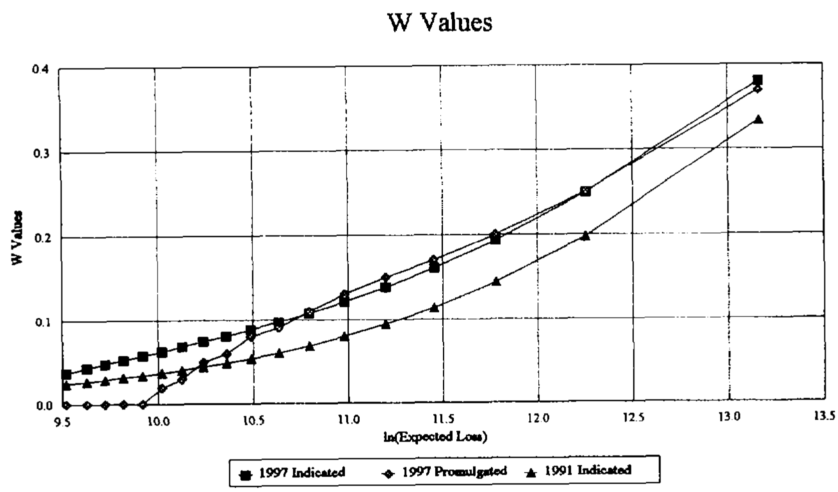
Risks	Median Exper. Period Expected Loss	1997 Experience Rating Plan				1991 Iteration 2 (Final)	
		Indicated Values		Promulgated Values		Indicated Values	
		B	W	B	W	B	W
1 - 5k	520,196	8,558	0.381	8,562	0.37	267	0.334
5k - 10k	209,397	9,633	0.249	9,620	0.25	712	0.198
10k - 15k	130,614	10,242	0.193	10,000	0.20	1,185	0.144
15k - 20k	94,331	10,684	0.161	10,000	0.17	1,684	0.114
20k - 25k	73,038	11,045	0.138	10,000	0.15	2,219	0.094
25k - 30k	58,775	11,362	0.121	10,000	0.13	2,805	0.079
30k - 35k	48,710	11,642	0.108	10,000	0.11	3,436	0.068
35k - 40k	41,539	11,886	0.097	10,000	0.09	4,080	0.060
40k - 45k	35,917	12,113	0.088	10,000	0.08	4,773	0.054
45k - 50k	31,528	12,319	0.081	10,000	0.06	5,494	0.049
50k - 55k	27,940	12,514	0.074	10,000	0.05	6,259	0.044
55k - 60k	24,984	12,698	0.068	10,000	0.03	7,062	0.041
60k - 65k	22,444	12,876	0.063	10,000	0.02	7,928	0.037
65k - 70k	20,297	13,045	0.058	10,000	0.00	8,837	0.035
70k - 75k	18,366	13,216	0.053	10,000	0.00	9,844	0.032
75k - 80k	16,696	13,380	0.048	10,000	0.00	10,911	0.030
80k - 85k	15,175	13,547	0.043	10,000	0.00	12,095	0.027
85k - 90k	13,641	13,736	0.038	10,000	0.00	13,570	0.024
90k - 95k	12,083	13,955	0.031	10,000	0.00	15,467	0.021
95k - 00k	10,278	14,251	0.022	10,000	0.00	18,418	0.016

*1997 Plan credibilities based on 1989 projection year.

CALIFORNIA EXPERIENCE RATING PLAN
COMPARISON OF INDICATED AND 1997 PROMULGATED B & W PLAN
1997 Plan vs Projection Year 1991

Exhibit 18





$$\text{Modification} = 1 + Z_p\left(\frac{A_p - Ep}{E}\right) \quad + \quad Z_e\left(\frac{A_e - Ee}{E}\right) \qquad \text{Formula 5}$$

From

$$Z_p = \frac{E}{E+B} \qquad \text{Formula 3}$$

$$Z_e = \frac{E}{E+J_e} = \frac{W \cdot E}{E+B} \qquad \text{Formula 4}$$

it follows that:

$$\begin{aligned}
& 1 + Z_p\left(\frac{A_p - Ep}{E}\right) + Z_e\left(\frac{A_e - Ee}{E}\right) \\
= \; & 1 + \left(\frac{E}{E+B}\right) \cdot \left(\frac{A_p - Ep}{E}\right) + \left(\frac{E}{E+J_e}\right) \cdot \left(\frac{A_e - E_e}{E}\right) \\
= \; & \left(\frac{E+B}{E+B}\right) + \left(\frac{A_p - Ep}{E+B}\right) + \left(\frac{A_e - E_e}{E+J_e}\right) \\
= \; & \frac{E + B + A_p - E_p}{E+B} + \frac{A_e - E_e}{E+J_e} \cdot \left(\frac{E+J_e}{E+B} \cdot \frac{E+B}{E+J_e}\right) \\
= \; & \frac{E + B + A_p - E_p + \left[(A_e - E_e) \cdot \left(\frac{E+B}{E+J_e}\right)\right]}{E+B} \\
= \; & \frac{A_p + B + \left(\frac{E+B}{E+J_e}\right) \cdot A_e + \left[(E - E_p) - E_e\left(\frac{E+B}{E+J_e}\right)\right]}{E+B} \\
= \; & \frac{A_p + B + W \cdot A_e + (1 - W) \cdot E_e}{E+B} \qquad \text{Formula 1}
\end{aligned}$$

where:

$$W = \frac{E+B}{E+J_e} = \frac{Z_e}{Z_p}$$

Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio
0005	4.50	0.301	2116	5.45	0.271	3085	5.68	0.289	4112	1.23	0.328
0016	7.22	0.298	2117	8.57	0.282	3099	2.65	0.333	4114	5.44	0.310
0034	6.48	0.284	2121	3.02	0.366	3110	5.70	0.324	4130	6.10	0.316
0035	4.16	0.280	2142	4.71	0.313	3111	5.05	0.286	4133	5.17	0.272
0036	5.76	0.291	2150	8.09	0.337	3131	3.09	0.326	4150	2.23	0.324
0038	10.79	0.261	2163	4.15	0.317	3146	4.38	0.312	4239	3.56	0.281
0040	3.69	0.305	2211	9.88	0.267	3152	2.42	0.330	4240	4.82	0.312
0041	3.01	0.291	2222	13.79	0.358	3165	4.94	0.276	4243	3.04	0.350
0042	6.58	0.298	2362	8.44	0.311	3169	3.56	0.309	4244	4.93	0.305
0044	4.10	0.309	2402	5.40	0.305	3175	5.13	0.325	4250	4.38	0.334
0045	3.69	0.323	2413	7.82	0.286	3178	2.13	0.324	4251	5.41	0.308
0050	6.29	0.274	2501	3.48	0.327	3179	3.14	0.327	4279	5.88	0.299
0079	3.88	0.248	2532	5.05	0.259	3180	6.67	0.318	4283	4.82	0.296
0103	5.36	0.382	2570	7.68	0.308	3220	3.06	0.328	4297	0.62	0.305
0106	15.87	0.221	2571	7.49	0.303	3224	2.15	0.384	4299	3.11	0.331
0171	8.16	0.252	2576	6.52	0.315	3241	6.42	0.320	4304	4.73	0.334
0172	5.80	0.254	2578	7.80	0.307	3255	4.22	0.341	4312	4.77	0.274
0251	3.85	0.304	2585	5.44	0.324	3257	5.00	0.303	4351	0.77	0.415
0400	4.41	0.293	2586	3.60	0.287	3300	5.85	0.379	4354	2.47	0.318
0401	11.06	0.287	2623	13.06	0.322	3339	6.45	0.305	4360	1.15	0.326
1122	3.83	0.225	2660	8.72	0.282	3365	8.85	0.285	4361	1.78	0.341
1123	4.96	0.258	2683	7.89	0.322	3372	6.58	0.298	4362	1.27	0.278
1124	2.45	0.266	2688	5.98	0.294	3373	4.29	0.353	4410	6.35	0.302
1320	1.89	0.273	2702	12.92	0.226	3383	2.38	0.301	4414	1.66	0.455
1322	10.91	0.240	2710	9.13	0.296	3400	5.82	0.311	4420	10.54	0.297
1330	6.05	0.260	2731	6.14	0.290	3507	6.36	0.303	4431	1.98	0.420
1438	5.95	0.305	2759	7.44	0.305	3574	2.67	0.347	4432	3.78	0.356
1452	2.48	0.275	2790	2.65	0.373	3620	5.74	0.297	4470	5.03	0.293
1463	2.51	0.309	2797	8.70	0.304	3632	3.48	0.322	4478	5.57	0.301
1624	8.65	0.289	2806	8.28	0.312	3643	3.19	0.323	4511	1.21	0.305
1699	2.17	0.339	2812	6.47	0.296	3647	8.67	0.310	4557	3.08	0.335
1701	3.29	0.231	2819	10.49	0.276	3681	1.25	0.322	4558	3.82	0.318
1710	3.28	0.296	2842	8.65	0.283	3686	0.00	1.000	4567	6.30	0.250
1741	3.25	0.307	2881	8.39	0.316	3719	4.27	0.262	4568	3.65	0.188
1803	8.33	0.269	2883	9.23	0.315	3724	5.05	0.278	4611	3.55	0.308
1925	6.33	0.299	2915	9.62	0.256	3726	5.33	0.297	4635	2.27	0.325
2002	7.60	0.342	2923	4.09	0.355	3805	1.76	0.349	4665	6.24	0.334
2003	4.65	0.308	2960	8.98	0.245	3807	5.81	0.273	4670	5.08	0.339
2014	5.50	0.286	3004	5.70	0.275	3808	1.80	0.436	4683	7.51	0.334
2030	3.91	0.301	3018	2.53	0.249	3815	8.87	0.307	4692	1.40	0.306
2063	3.71	0.334	3022	4.51	0.286	3821	11.12	0.251	4717	2.64	0.378
2081	11.93	0.329	3028	3.25	0.350	3828	6.28	0.317	4720	5.34	0.288
2095	7.58	0.309	3030	9.28	0.269	3830	2.63	0.294	4740	2.37	0.296
2102	4.32	0.330	3040	11.16	0.277	4000	4.53	0.259	4757	2.79	0.324
2106	6.45	0.357	3060	6.26	0.314	4034	8.51	0.277	4771	2.69	0.271
2107	5.87	0.330	3066	4.52	0.323	4036	3.97	0.282	4828	4.79	0.314
2108	6.22	0.303	3070	1.04	0.346	4038	5.49	0.308	4829	2.29	0.319
2109	6.60	0.323	3076	6.30	0.313	4041	5.70	0.251	4922	1.52	0.360
2111	5.01	0.330	3081	9.10	0.295	4049	4.74	0.311	4983	4.23	0.332
2113	7.55	0.332	3082	3.89	0.341	4111	1.92	0.394	5020	3.39	0.275

Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio
5022	6.54	0.237	6237	3.27	0.243	7855	5.35	0.259	8350	4.14	0.270
5040	10.09	0.229	6251	7.13	0.279	8001	3.23	0.321	8387	3.96	0.295
5057	13.46	0.221	6252	10.86	0.218	8008	1.72	0.331	8388	5.77	0.294
5059	15.59	0.229	6254	3.15	0.392	8013	1.19	0.292	8389	4.14	0.298
5102	5.91	0.253	6306	4.58	0.242	8015	4.06	0.308	8390	5.80	0.337
5128	1.13	0.341	6319	4.69	0.229	8017	2.62	0.333	8391	3.07	0.314
5146	4.45	0.289	6325	4.85	0.238	8018	4.75	0.310	8392	4.98	0.312
5160	1.70	0.266	6361	4.39	0.250	8021	9.11	0.298	8393	3.64	0.275
5183	4.04	0.288	6364	5.70	0.281	8028	5.03	0.282	8397	5.14	0.294
5184	6.53	0.286	6400	9.24	0.289	8031	4.46	0.325	8400	3.59	0.233
5188	4.06	0.261	6504	4.82	0.321	8032	4.37	0.341	8500	9.99	0.251
5190	3.35	0.284	6834	5.27	0.308	8039	2.93	0.368	8601	0.65	0.301
5191	1.85	0.326	7133	2.35	0.315	8041	5.59	0.289	8604	2.37	0.226
5192	3.73	0.342	7198	6.11	0.334	8042	3.22	0.316	8631	11.92	0.261
5200	4.69	0.268	7207	9.55	0.288	8046	2.86	0.331	8710	8.50	0.363
5207	5.13	0.278	7219	8.14	0.242	8057	4.96	0.246	8719	2.79	0.332
5212	4.11	0.265	7248	2.03	0.117	8059	3.46	0.225	8720	2.80	0.240
5213	5.73	0.251	7272	8.27	0.174	8060	2.93	0.271	8729	1.27	0.216
5214	3.72	0.256	7332	6.59	0.314	8061	5.23	0.280	8741	0.26	0.281
5222	8.79	0.236	7360	9.13	0.273	8062	1.16	0.321	8742	0.60	0.305
5225	5.42	0.250	7365	8.04	0.265	8063	2.58	0.306	8745	4.02	0.320
5348	3.77	0.280	7382	7.63	0.299	8064	3.48	0.308	8748	0.84	0.266
5403	6.85	0.246	7392	6.34	0.299	8065	2.75	0.384	8755	1.36	0.210
5436	6.06	0.266	7403	3.28	0.374	8079	0.00	1.000	8800	3.62	0.323
5443	4.48	0.267	7405	1.04	0.371	8102	4.44	0.270	8803	0.23	0.321
5445	5.27	0.247	7409	5.73	0.193	8103	8.97	0.300	8804	3.74	0.263
5462	7.64	0.283	7410	4.66	0.284	8105	9.00	0.357	8806	4.47	0.341
5473	18.98	0.347	7413	1.43	0.385	8106	6.24	0.319	8807	0.50	0.326
5474	6.95	0.235	7419	2.27	0.461	8107	3.54	0.325	8808	0.62	0.317
5479	11.14	0.266	7421	2.11	0.375	8110	3.29	0.258	8810	0.43	0.322
5480	8.16	0.238	7424	2.95	0.319	8111	4.70	0.318	8813	0.52	0.312
5506	4.89	0.262	7426	0.31	0.571	8113	12.25	0.279	8817	0.00	0.551
5507	3.81	0.241	7428	2.14	0.330	8116	4.07	0.307	8818	0.68	0.334
5538	4.80	0.285	7429	12.22	0.333	8117	4.96	0.303	8820	0.41	0.280
5551	17.20	0.205	7500	0.15	0.887	8203	0.00	1.000	8822	0.56	0.337
5606	1.84	0.293	7515	1.72	0.272	8204	18.94	0.227	8823	4.79	0.278
5645	9.78	0.244	7520	3.44	0.288	8209	6.60	0.294	8827	4.49	0.264
5650	6.25	0.266	7538	8.34	0.222	8215	8.69	0.239	8829	6.02	0.290
5703	14.92	0.224	7539	3.57	0.257	8227	3.68	0.270	8830	1.90	0.338
5951	0.65	0.284	7580	2.09	0.303	8232	5.17	0.285	8831	2.92	0.321
6003	8.99	0.174	7600	1.79	0.310	8264	6.98	0.300	8834	0.91	0.289
6011	7.80	0.215	7601	21.12	0.202	8265	13.27	0.255	8838	1.01	0.313
6204	10.97	0.239	7605	4.05	0.317	8267	7.20	0.265	8839	0.69	0.306
6206	5.62	0.243	7606	7.48	0.308	8278	121.83	0.266	8840	0.59	0.298
6213	3.66	0.200	7610	0.61	0.356	8286	6.64	0.269	8868	1.04	0.309
6216	6.97	0.215	7706	3.97	0.292	8291	5.13	0.295	8875	1.05	0.273
6217	3.73	0.238	7707	1529.26	0.193	8292	9.13	0.282	8901	0.96	0.320
6223	2.15	0.384	7720	6.44	0.278	8293	12.38	0.252	9008	7.45	0.298
6233	4.87	0.238	7721	5.35	0.295	8304	7.37	0.270	9015	5.31	0.270
6235	12.87	0.244	7722	19.83	1.000	8324	5.45	0.285	9016	4.21	0.322

Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio	Class Code	Exp Loss Rate	D-Ratio
9031	4.19	0.284	9085	6.29	0.288	9185	25.57	0.290	9507	3.75	0.301
9043	1.89	0.295	9092	3.06	0.303	9220	5.47	0.302	9519	3.47	0.299
9048	4.03	0.309	9101	4.97	0.281	9402	5.85	0.246	9521	4.75	0.260
9050	6.03	0.318	9154	2.15	0.340	9403	7.45	0.273	9522	4.78	0.296
9053	2.61	0.325	9156	2.67	0.354	9410	1.78	0.240	9529	9.65	0.210
9060	4.14	0.291	9158	0.00	1.000	9420	5.04	0.252	9545	1.95	0.350
9061	2.78	0.323	9180	6.20	0.305	9422	4.19	0.298	9549	5.47	0.297
9066	4.51	0.275	9181	11.39	0.315	9424	6.55	0.275	9552	10.81	0.211
9070	5.76	0.279	9182	1.69	0.384	9426	8.13	0.221	9586	1.61	0.295
9079	3.64	0.350	9184	10.20	0.313	9501	5.07	0.284	9610	1.53	0.318
									9620	2.57	0.279

COMPARISON OF EMPIRICAL AND MANUAL D-RATIOS

Benchmark Class Code	1991 Empirical D-Ratio	1991 Manual D-Ratio	Benchmark Class Code	1991 Empirical D-Ratio	1991 Manual D-Ratio
0016	0.30	0.32	7198	0.33	0.31
0042	0.30	0.34	7219	0.24	0.31
0172	0.25	0.32	8008	0.33	0.35
2003	0.31	0.33	8017	0.33	0.34
2501	0.33	0.35	8018	0.31	0.33
2883	0.31	0.34	8039	0.37	0.33
3632	0.32	0.33	8232	0.28	0.32
3681	0.32	0.34	8387	0.29	0.31
3830	0.29	0.39	8389	0.30	0.31
4478	0.30	0.32	8391	0.31	0.32
5183	0.29	0.30	8742	0.31	0.32
5190	0.28	0.31	8810	0.32	0.33
5200	0.27	0.32	8829	0.29	0.38
5213	0.25	0.30	8834	0.29	0.34
5403	0.25	0.30	9008	0.30	0.35
5445	0.25	0.32	9015	0.27	0.32
5474	0.23	0.29	9043	0.29	0.34
5551	0.21	0.28	9050	0.32	0.36
5645	0.24	0.30	9079	0.35	0.35
6217	0.24	0.29			

RIDGE REGRESSION OVERVIEW
Hoerl and Kennard's δ

Draper and Smith [4, pp. 318-319] discuss a procedure developed by Hoerl and Kennard which we call Hoerl and Kennard's δ. The basic idea is to calculate an initial θ, $\theta(0)$, then, using the parameters corresponding to $\theta(0)$, calculate the next θ. This continues until

$$\text{Criterion} = \frac{\theta(j+1)-\theta(j)}{\theta(j)} \qquad \text{Hoerl and Kennard's } \delta$$

where Hoerl and Kennard's $\delta = 20\{\text{trace}(\mathbf{Z'Z})^{-1}/r\}^{-1.30}$ and r is the number of parameters in the model. The trace of a matrix is the sum of the elements on the main diagonal. In our experience, this procedure did not work sometimes and in these situations we selected the θ corresponding to the minimum criterion. We term the final θ the indicated θ, $\theta(\mathrm{I})$. The procedure was performed for each group of 5,000. Sometimes the procedure resulted in selection of a θ for which Zp is greater than unity. Generally this happened only for the largest risks. As nearly full primary credibility is expected for these risks, this result was deemed to be within a reasonable variance about unity and did not justify rejecting the procedure for this reason alone. Though Hoerl and Kennard's δ generally gave a relatively stable pattern of results, the efficiencies were inferior to the Maximum Excess method.

PARAMETER REFINEMENT
Bias Adjustment Logic for the Quintiles Test Extension

Average is defined as a modification of unity and a standard loss ratio equal to the all risks combined standard loss ratio. Note that a risks modification is always bounded between this empirical modification and unity. Where a risk falls in this range is a function of credibility.

1. Risks with relatively good experience always have modifications less than unity. So,

A) Good experience and a standard loss ratio lower than average
=> that the modification is too high.
=> credibility is too low.

B) Good experience and a standard loss ratio higher than average
=> that the modification is too low.
=> credibility is too high.

2. Risks with relatively poor experience always have modifications greater unity. So,

A) Poor experience and a standard loss ratio lower than average
=> that the modification is too high
=> credibility is too high.

B) Poor experience and a standard loss ratio higher than average
=> that the modification is too low
=> credibility is too low.

If we order risks by their modifications then look at the pattern of the standard loss ratios, we may see:

Modification	Standard Loss Ratios	
< Unity (good experience)	Low	High
> Unity (poor experience)	High	Low
Correlation between modifications and SLRs	Positive (Direct)	Negative (Inverse)
Implies credibility is	Too Low	Too High

No pattern implies credibilities are in balance by experience.

COMPARISON OF HISTORICAL D-RATIOS FOR BENCHMARK CLASSES

Class	Manual D-Ratios by Policy Year								
Code	1998	1995	1991	1990	1989	1985	1980	1975	1970
0016	0.29	0.32	0.32	0.33	0.34	0.42	0.39	0.40	0.47
0042	0.30	0.32	0.34	0.34	0.35	0.44	0.38	0.42	0.47
0172	0.31	0.32	0.32	0.33	0.33	0.40	0.42	0.38	------
2003	0.33	0.34	0.33	0.35	0.36	0.42	0.42	0.42	0.51
2501	0.32	0.33	0.35	0.36	0.38	0.43	0.43	0.42	0.51
2883	0.30	0.31	0.34	0.34	0.36	0.42	0.45	0.41	0.51
3632	0.31	0.31	0.33	0.33	0.34	0.41	0.41	0.40	0.48
3681	0.31	0.31	0.34	0.34	0.36	0.41	0.41	0.37	0.46
3830	0.31	0.35	0.39	0.38	0.36	0.45	0.41	0.43	0.49
4478	0.30	0.34	0.32	0.33	0.35	0.40	0.42	0.41	0.50
5183	0.30	0.31	0.30	0.32	0.34	0.41	0.40	0.37	0.48
5190	0.26	0.28	0.31	0.33	0.34	0.38	0.39	0.38	0.46
5200	------	------	0.32	0.34	0.34	0.42	0.43	0.41	0.47
5213	0.30	0.31	0.30	0.31	0.31	0.42	0.40	0.40	0.48
5403	0.28	0.29	0.30	0.32	0.34	0.41	0.40	0.36	0.47
5445	------	------	0.32	0.32	0.35	0.42	0.44	0.44	0.50
5474	0.27	0.29	0.29	0.30	0.33	0.36	0.38	0.36	0.46
5551	------	------	0.28	0.30	0.31	0.39	0.43	0.35	0.46
5645	0.28	0.29	0.30	0.32	0.34	0.42	0.43	0.41	0.51
6217	------	------	0.29	0.31	0.33	0.38	0.39	0.35	0.44
7198	0.30	0.32	0.31	0.32	0.33	0.41	0.45	0.42	0.42
7219	0.30	0.32	0.31	0.32	0.33	0.41	0.41	0.41	0.50
8008	0.32	0.33	0.35	0.34	0.35	0.43	0.39	0.41	0.48
8017	0.31	0.33	0.34	0.34	0.35	0.42	0.40	0.39	0.48
8018	0.31	0.32	0.33	0.34	0.35	0.41	0.42	0.40	0.48
8039	0.35	0.35	0.33	0.33	0.36	0.42	0.39	0.39	0.48
8232	0.29	0.30	0.32	0.31	0.33	0.40	0.39	0.38	0.48
8387	0.31	0.30	0.31	0.32	0.34	0.39	0.40	0.39	0.48
8389	0.30	0.31	0.31	0.30	0.34	0.40	0.40	0.39	0.48
8391	0.30	0.31	0.32	0.33	0.34	0.41	0.42	0.41	0.46
8742	0.30	0.31	0.32	0.32	0.33	0.38	0.38	0.34	0.43
8810	0.32	0.33	0.33	0.34	0.35	0.40	0.41	0.38	0.46
8829	0.33	0.36	0.38	0.37	0.39	0.48	0.44	0.43	0.53
8834	0.33	0.34	0.34	0.35	0.36	0.42	0.41	0.38	0.48
9008	0.31	0.33	0.35	0.37	0.36	0.44	0.42	------	------
9015	0.29	0.30	0.32	0.33	0.33	0.39	0.40	0.39	0.49
9043	0.32	0.33	0.34	0.33	0.35	0.40	0.42	0.38	0.47
9050	0.31	0.33	0.36	0.37	0.38	0.41	0.41	0.39	0.51
9079	0.31	0.33	0.35	0.35	0.36	0.41	0.42	0.41	0.51