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Session 37CS
Year 2000 and Beyond: SOA New Course 7 Applied Modeling Demonstration

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Summary: This session is a preview of an actual Course 7. Attendees refresh their memories of common actuarial models in a relaxed setting.

Attendees participate in a demonstration of a case study from the modeling Course 7. They obtain some hands-on experience in looking at a problem, discussing the various possible models, and analyzing the results.

Current Fellows leave with an idea of the new skills that their employees can bring to the job after attending a Course 7 modeling seminar. Future Fellows have an idea of what to expect in the Course 7 seminar when they go through the Year 2000 transition.

Mr. Warren R. Luckner: I'm an actuary on staff with the SOA with the responsibility for providing actuarial support to the development and implementation of Course 7. Virginia Young (Jenny) is an FSA and Ph.D. She is on the actuarial science faculty at the University of Wisconsin-Madison. We are on the Common Core Subgroup of the Course 7 working group and we will be serving as common core instructors next year.

First I will give an overview of Course 7, based primarily on slides that Jeff Beckley has prepared. Jeff is the Chairman of SOA's Year 2000 Education and Examination (E&E) System Design team and he's also the chairman of the Course 7 working group. After I present that overview, Jenny will present the case study that she's developed for the common core part of the seminar.

Note: The charts referred to in the text can be found in the documents 9atl37ch2, 9atl37ch3, and 9atl37ch4.

Course 7 is part of the new education system that is effective January 2000. Throughout the new system, there's emphasis on modeling. Courses 3 and 4, in particular, cover the topics of actuarial models and actuarial modeling. However, they use a traditional approach of studying the topics and taking an exam to obtain credit. Course 7 adds to that a different way to get credit. It adds an intensive seminar, interactive component to the new system. The Course 7 Report Working Group, which some of you may have already seen, is on the SOA Web site. It gives more detail about what Course 7 is intended to do.

The five learning objectives we identified for Course 7 parallel very much what we consider to be the important components of the modeling process: The design, selection, and set up of the model; input data; selection analysis; output data analysis or analysis of results, communications of the modeling process, and results. Meeting the fifth objective is essential. If you meet all of the other objectives, but don't communicate the process or the results effectively, it's essentially been a waste of time or can even be counterproductive. So there is emphasis in Course 7 on communication of the process and the results.

The Course 7 format is similar to the current intensive seminar format. Some of you may have taken those elective courses in Applied Statistics or Risk Theory. The educational format has been found to be very effective in terms of developing skills different from the skills that you develop through self study or just studying and taking an exam. One of the motivations for developing Course 7 is the success of the current intensive seminars. Obviously, one of the differences between the current intensive seminars and Course 7 is that Course 7 is going to be required of everybody who goes through the system, while the current intensive seminars are elective.

Other differences include a substantial amount of pre-reading and a pretest for Course 7. Also, there will be a set of common core case studies that are going to be the same for all seminars. There also will be a general or practice-area-specific, day-long case study that is presented at the seminar. The difference between the general and practice-area-specific is that practice-area-specific presents an application that is specific to a particular single practice area, while a general case study presents an application that may cross practice areas, such as social insurance, or may not be specific to any particular practice area at this time, such as public school funding. One of the criteria in developing the general case study, because these case studies will be different for different seminars, is that it should be designed so that no particular practice area background is significantly advantaged or disadvantaged for that case study. It's a challenge to do that but using those kinds of case studies allows us some flexibility.

A bit about the pre-reading for the pretest. The pre-reading focuses on the modeling process, and is more in general than specific with respect to actuarial modeling. A lot of what you have in Courses 1 through 6 gives you specifics about actuarial modeling. There may be some seminar-specific pre-reading, depending upon the content of the general or practice-area-specific case study. In the pre-reading, there is some communication skills information, in particular some material from the Actuarial Standards Board that relates to communication.

What about the pretest? What's the purpose? The purpose of the pretest is to determine if the students are prepared for the seminar and prepared in such a way that the seminar does not have to review topics that were covered in previous courses, such as Courses 3 and 4. The pretest also allows us to have a shorter seminar time. Three-and-one-half days is what is scheduled. The pretest is designed so students will hopefully be better prepared, which would allow us then to have perhaps higher pass marks. The hope is that the pretest would also eliminate, or at least reduce significantly, the possibility that somebody would come into the seminar ill-prepared and trying to take it without much background.

For the pretest, the intent is to have a bank of questions and to offer the pretest monthly on an open-book basis. The format of the pretest will include both multiple-choice questions and written-answer questions. There is a sample pretest that's being developed. It's not quite ready yet, because we're working on finalizing the illustrative solutions. The sample pretest should be available soon on the SOA Web site.

The pretest grade will be on a pass/fail basis, with a predetermined pass mark, which is different from what we've done before. The period of validity for a pass on the pretest is six months for registration purposes, and 12 months for attendance purposes. That is, you have to register for a seminar within six months after having passed the pretest and you have to take the seminar within 12 months of having passed the pretest. This is partly to make sure that the pre-reading that you have studied is still relevant to the seminar that you attend, since the prereading can change over time.

Other requirements: as I noted, you have to have passed all the Courses 1–6 before you can take the seminar. You have to bring a laptop, and you have to have familiarity with a spreadsheet program and a word processing program.

A bit about the format. As I mentioned, it's similar to the current intensive seminar format. It's a little bit shorter since it is three-and-one-half days, compared to the current five-day seminar. The first day-and-a-half will be for the presentation of

several case studies that are common across all seminars. These case studies will cover various aspects of the modeling process. The presentation will be interactive in the sense that there will be some lecturing, but there will also be some assignments and some give and take in terms of the students doing some computer work and presenting results. The students will be asked to work in teams of no less than three when they work on these assignments. The faculty for the common core part will typically be academic faculty, but not always.

After the first day-and-a-half, the next full day is presentation of a single, general or practice-area-specific case study that covers all aspects of the modeling process. The instructor will be from business or government. It will be a practical application. Again, the presentation will be interactive. The last day is the tough day. On the last day, the student will be given a project assignment and will be asked to complete that assignment and prepare a report. The assignment will be to analyze a practical problem. Instead of working in teams, the seminar attendees will be working individually to complete their assignments. The project assignment is the only evaluation means for the seminar.

The criteria for evaluating the written report that is the end result of the assignment includes use of an appropriate modeling process, the clarity and conciseness of the presentation of the report, and accurate and appropriate analysis of the problem.

Our goal is to provide results of the seminar within eight weeks after the seminar is completed. We expect that partly because of the pretest, 80–90% of the students will pass the seminar on their first try.

We expect that we may have to offer at least 15-20 seminars a year. We'll be offering seminars throughout the year at various locations, and with various general or practice specific case studies.

Two major concerns have been identified. How do we accommodate students outside of Canada and U.S. who may have difficulty getting to the seminar for financial reasons? How do we keep the fee in a reasonable range?

With respect to students outside Canada and the U.S., we are going to offer an alternative for students who meet certain criteria related to financial hardship. Two levels of criteria include: the income level of the country in which they're living, and the income level of the individual. The current alternative includes use of a video tape presentation, within the same timeframe as an actual seminar, with the same project as the actual seminar, and with the instructor being available via e-mail. We don't anticipate that we'll have a lot of these cases, but we feel an obligation to make sure that we're ready for any particular problems of financial

hardship. With respect to disability, there already is a procedure in place within the current E&E System guidelines.

We estimate that the fee for the seminar will be in the range of $700-1,200. It's a wide range, but even the endpoints of that range seem reasonable in terms of comparison to commercial three and a half day seminars. We understand some of the financial constraints on seminar participants, but we feel fairly comfortable that this is a reasonable fee to charge.

I'm going to conclude this part of the presentation by just giving a little bit of my personal philosophy about actuarial work and about education. I like the following definition of the work of the actuary because I think it's general enough to encompass a lot of different applications and a lot of different areas, yet specific enough to suggest distinctive skills. "The work of the actuary is to identify, quantify, assess, or manage risk and uncertainty to the benefit of society." As a profession, those last few words are particularly important: "to the benefit of society." We may not think of that all the time when we're thinking about the work we do but ultimately the things we do are of benefit to society.

I also think it's consistent with the SOA mission statement, which in part says, " . . . provide expert advice and relevant solutions for financial, business, and societal problems involving uncertain future events." This philosophy and this mission statement provide a general context for the development of our applied actuarial modeling seminar. A concise theory of how individuals learn is, "Tell me, I forget. Show me, I remember. Involve me, I understand." I think it summarizes well one of the key motivations for why we have a Course 7, and the importance of having interactive exercises. The participants in this seminar will better understand if they're involved in the learning process and interact through exercises.

Ms. Virginia Young: Before the Course 7 seminar, students will be given an overview of each of the case studies and it's usually just a synopsis of what that case study is going to be. For instance, in my case study, students might be given this sentence so they have an idea of what to expect: "Goal: By using survey data from risk managers of large U.S.-based organizations, relate the cost effectiveness to management's efforts to control costs, after adjusting for factors such as company size and industry type."

Now, there are several reasons for creating a model. I want to talk about three of them. We're going to demonstrate one of those three. What we're going to be looking at are data that are relevant for a risk manager who is working for a particular firm, not necessarily an insurance company. We'll be looking at the insurance costs for that firm, in addition to the uninsured losses. The losses we'll be

concentrating on will be property and casualty. Thus, FIRMCOST is our dependent variable, the variable we're trying to explain. In other words, FIRMCOST is the cost of insurance and uninsured losses. We'll be using some independent variables to help explain that cost to the firm.

One purpose of creating a model, in this case a regression model, is to understand how choices in the independent variables influence the dependent variable(s).

There are factors that the risk manager cannot control, such as the size of the firm or the industry type, but there are some things that the risk manager chooses, for instance, the amount of loss retained by the company for each occurrence. It's very common in property & casualty insurance to have a per occurrence retention.

What we're going to be doing is testing some hypotheses about how these chosen independent variables influence the overall loss cost. That's the goal of my case study. Another possible goal would be to predict or to estimate what the loss cost would be if one were to choose certain values of the controllable variables. One might study a collection of firms and their loss costs, together with the choices that they made, to see whether and how the choices influence the loss cost. Then we could use that model to predict whether or not choices we make would influence our loss costs. It's very similar to understanding the model, as in the first goal I mentioned before, but it's taking the model and going one step further.

A third use for regression models is to see whether or not a particular observation is unusual. Recall that you're a risk manager for a firm. Suppose your boss has asked you to determine whether or not your loss costs are unusual, either unusually high or unusually low. A regression model can do that.

Additional information that a student taking Course 7 will get is a list of the prerequisites for the case. In this case, a student would have to know: (1) How to do regression analysis, especially how to do it on the software that they're going to be bringing in. (2) How to create scatter plots, especially of the residuals of the model, and how to interpret those. That's an integral part of regression analysis, as I'm going to demonstrate. (3) The purpose of this case study is to test some hypotheses about how choices in these independent variables affect our loss costs. We need to know how to do hypothesis testing, as related to the regression analysis.

These are all skills that they gain today under the SOA Course 120. The data we're working with is survey data, from risk managers of large U.S. companies. We have a response rate of 43% of the 374 surveys that were sent out. However, only 20% of all the surveys that were sent out had the figures for the variables we're interested in. Warren is going to talk later about data quality, but this is something to watch

out for. It's a red flag in this case. We're going to see later that it's going to cause some problems, but the data are still interesting in teaching other aspects of fitting models.

The dependent variable is FIRMCOST. It's the total property and liability premiums and uninsured losses as a percentage of total assets. ASSUME is the firm's retention as a percentage of total assets, another ratio. One hypothesis is that as the amount assumed per occurrence increases, our loss costs decrease. One argument for that is that as the retention increases, then the company is more careful. Also the expenses to cover that amount will decrease because they're not buying insurance for it. In general, we expect that the firm costs will decrease as the amount assumed increases, an inverse relationship.

Whether or not a company owns and uses a captive insurance company (denoted CAP) was a choice made by the risk manager. What we expect is if the risk manager chooses to use the captive insurance company, then the firm costs ought to go down, another inverse relationship.

Those two are choice variables. The third independent variable is the logarithm of total assets, denoted LN_SIZE. That's not a choice of the risk manager, but using that variable in our regression helps us control for the size of the company. In general, one expects that because of efficiencies of scale, that firm costs should decrease as assets increase, and we'll see that in our analysis.

Another measure of the company is the industry cost (denoted INDCOST) and it's a measure of the firm's industry risk. Industry cost is a standard measure obtained from an independent bureau, such as the Insurance Service Office. As with the assets, industry cost is not a choice; it helps us control for different industries.

The last two are choices. A risk manager for a large company can choose to use local managers in helping to decide insurance questions, or the risk manager can just do all the work centrally. This central variable (denoted CENTRAL) measures how much the local risk managers are used in making insurance decisions. Our hypothesis for this variable is that as the local managers are used more actively, then the loss costs ought to decrease, because the local managers have more information about what's actually needed. On the other hand, I can see an argument that would say maybe loss costs will increase the more you use the local managers because of an inefficiency of scale. Maybe it would be more efficient just to have the central office making all the decisions. One could argue either way.

The fourth choice is the level of analytical sophistication (denoted SOPH). What one hypothesizes there is that the more sophisticated method used by the risk manager to analyze losses, the lower the loss costs.

What's generally done as a preliminary analysis is to throw all those variables into a regression model and see what happens. We've got our dependent variable FIRMCOST and then our six independent variables. Here is the resulting equation.

INSERT 1
REGRESSION ANALYSIS

—(Possible) preliminary analysis fits the model:

- FIRMCOST=b_0 + b_1 *ASSUME* +b_2 *CAP* + b_3 LN_SIZE + b_4 INDCOST + b_5 CENTRAL + b_6 SOPH + *e.*

—The regression equation is

- FIRMCOST = 59.8-0.300 ASSUME + 5.50 CAP-6.84 LN_SIZE + 23.1 INDCOST + 0.13 CENTRAL- 0.137 SOPH

Let's look at the more detailed analysis of the numbers themselves (Table 1). In the first column we've got a list of the independent variables. The second column gives us the value of the coefficient that we got when we ran the regression. The next column is the standard deviation of that coefficient, it's also called the standard error of the coefficient. The greater that standard deviation is, the less sure we are of the value of that coefficient. The key ratio is the ratio of the coefficient to the standard deviation, the t-ratio. It gives us a standardized measure of how well we've estimated that coefficient. A way to think about the t-ratio is that if the absolute value is greater than two, then we usually say that the variable is significantly non-zero. As a rough estimate, that means there's only about a 5% (or smaller) chance that it could be zero. The P value gives us some more precise measure of what that percentage is.

TABLE 1
REGRESSION ANALYSIS

Predictor	Coef	StDev	t	P-value
Constant	59.76	19.07	3.13	0.003
ASSUME	-0.3004	0.2221	-1.35	0.181
CAP	5.498	3.848	1.43	0.158
LN_SIZE	-6.836	1.923	-3.56	0.001
INDCOST	23.078	8.304	2.78	0.007
CENTRAL	0.133	1.441	0.09	0.927
SOPH	-0.1367	0.3468	-0.39	0.695
S = 14.56		R^2 = 25.6%		R^2_a = 18.8%

We see from this analysis, that we do have a significant value for the coefficient of the size. It's as we expected, i.e., that as the size of the company increases, the loss costs decrease. Then also, as industry costs increase, the loss costs increase, as expected.

However, for the hypothesized signs of the coefficients of the four choice variables, none of them is very significant. You might say that for ASSUME and for CAP, they are somewhat significant. They'd be significant at the 10% level anyway. Note that ASSUME is in the direction we expected, negative, but it's not as strong as we might expect. Meaning that the more a company retains per occurrence, then the lower the loss cost. However, the one surprise is that if we use a captive insurer, then this is showing that on average our costs increase. That's a bit of a surprise.

Lastly, take a look at the R^2 values. R^2 measures the proportion of variability of the dependent variable explained by this linear relationship. Here we're only explaining about 25% of the variability of the loss costs; that's not very good. R^2-adjusted ($R^2{}_a$) measures the same thing that R^2 does, but it adjusts R^2 for the number of independent variables used. If we have two models with two different sets of variables, we can compare them using R^2-adjusted. In this case, R^2-adjusted is only 19%, not very large. Just plugging the numbers into a package isn't necessarily a good thing. Let me show you what some of the problems are with this particular regression. Chart 1 is a dotplot of the standardized residuals. Recall that all the hypothesis tests we were doing earlier assume that the residuals are distributed normally.

If you look at the dotplot of these residuals on Chart 1, note that they're skewed to the right with two very large standardized residuals: one is larger than three- and-one-half and another one is approximately six. The model doesn't fit the assumption of normality for the residuals.

Another test we can do with residuals is to plot the standardized residuals versus the fitted values (Chart 2). Another assumption of our model is that not only do the standardized residuals have constant variance, but they have constant variance no matter where they are on the fitted hyperplane.

This scatter plot demonstrates we have different scatter depending where we are on that hyperplane. That violates one of the assumptions of regression analysis of the normal model. What we want to see is a similar scatter as we move around the plane. Here, we're just taking a cross section by looking at the height of the plane. What we want to see is what's called heteroscedasticity or similar scatter.

Generally, if you see data that's skewed to the right, or if you see residuals that are skewed to the right, it often indicates that you need to transform the dependent variable. In this case, we're going to use the logarithm to transform.

Transforming the dependent variables via a power or logarithmic transform can cure the problem of the skewed residuals and cure the problem of the heteroscedasticity at the same time.

What we're going to do is back up and perform a more thorough analysis. This is what we should have done in the first place. First look at histograms of the various variables. The dependent variable of loss costs is skewed to the right. That often indicates that a problem will occur if you just used this in a regression model without transforming it. That's what we saw with our residual analysis; that did lead to the problems of skewed residuals and heteroscedasticity.

The histogram of the loss costs indicates how we might transform it to get it a bit more normal. A log transform would do that by spreading out the small values and by shrinking the large values. It's common for financial data to need logarithmic transform. The amount assumed, or retained, is also skewed to the right.

The assets of the company have already had the logarithm taken and we see that that did help in making asset size less skewed.

Some of these things are standard in economics, i.e., to take logarithm of dollars, but it's not necessarily standard to take logarithm of ratios. That's what FIRMCOST is. It's a ratio of loss cost to assets and then the ASSUME, or retention, is also a ratio. We need to take a log of that ratio also. We use LN_ASSUM = ln(ASSUME + 0.01) to spread out the small values of ASSUME and contract the large values of ASSUME.

If you look at log of the loss cost (LN_COST) vs. ASSUME, then it's not a very linear relationship, and that's because ASSUME is skewed to the right. But if you look at log ASSUME versus log loss cost, you do see a more linear relationship. Remember that linear regression assumes we've got a linear relationship between the dependent and independent variable. Log size versus log loss cost shows a negative linear relationship.

For the captive insurance versus the log of the cost there is not much difference in whether or not you're using the captive insurer. What we're eventually going to see is having a captive insurer is not going to really matter very much.

Also, the degree to which you're using local risk managers doesn't seem to have an effect either, and the regression will also bear that out, and similarly for the degree of sophistication. What we notice from the three scatter plots is that there doesn't seem to be much relationship between these three independent variables and our loss cost. That will be born out by the regression.

Let's go to the results of the regression analysis.

INSERT 2
REGRESSION ANALYSIS

Fit the model LN_COST = $b + b_1$ LN_ASSUM + b_2 *CAP* + b_3 LN_SIZE + b_4 INDCOST + b_5 *CENTRAL* + b_6 SOPH + *e.*

The regression equation is

- LN_COST = 6.81 + 0.123 LN_ASSUM - 0.045 CAP - 0.670 LN_SIZE + 1.71 INDCOST - 0.0433 CENTRAL - 0.0007 SOPH

This time there is a positive relationship between log ASSUME and log of the firm cost. The reason we had a negative relationship before was really caused by just a couple of unusual observations. They are called high leverage points. Both the ASSUME and FIRMCOSTS were highly skewed to the right, and we had some unusual values at the tails. If you look at the scatter plot for log assume versus log of the cost, then that is showing a slight positive relationship, and that's what we've got here in the regression analysis. It's contrary to what you might think, but that's at least what the data is supporting. In particular, it's not supporting our hypothesis that as the amount retained increases, the loss cost decreases.

TABLE 2
REGRESSION ANALYSIS

Predictor	Coef	StDev	t	P-value
Constant	6.809	1.183	5.76	0.000
ASSUME	0.12305	0.06942	1.77	0.081
CAP	-0.0445	0.2206	-0.20	0.841
LN_SIZE	-0.6704	0.1240	-5.41	0.000
INDCOST	1.7143	0.4896	3.5	0.001
CENTRAL	-0.04330	0.08714	-0.03	0.621
SOPH	-0.00066	0.02062	-0.03	0.974
s = 0.8641		R^2 = 54.3%		R^2_a = 50.1%

Similarly, whether or not one uses a captive insurance company doesn't seem to make a difference, but wrong size is very significant. Note that the bigger the company, the lower the cost, as expected. As the industry costs increase, so do they for an individual firm, also as expected. Neither using local managers nor using sophisticated analysis seems to matter.

However, we have a little more confidence in our model than we had before when we used the loss costs before taking logarithms because R^2 adjusted is bigger; it's gone up from 19% to 50%.

Let's look at the residuals to see that they behave as we expect. Chart 3 is a dotplot of the standardized residuals. It is more symmetrically scattered around zero and less skewed to the right. The plot of the standardized residuals vs. the fitted values shows similar scatter (Chart 4). What you're looking for is that the majority of the points fall between plus and minus two, with a normal cross-section as one moves from left to right. It's much better than what we had before we took the log transform.

Now one final step is to look for non-linear relationships. We've taken care of the linear relationships between firm costs and the six independent variables. Now plot the standardized residuals versus each of the independent variables, looking for possible nonlinear relationships. Sometimes they're easier to see after accounting for the linear relationships. The only one that seems to be possibly significant is shown in the residuals versus the industry cost. It almost appears now that we've got a slight quadratic relationship. It's worth a try to include industry cost squared.

At this point, we could take all six of our variables plus industry cost squared, or we could just take the ones that were very significant and then also include industry cost squared, and that's what I've done with Insert 3. Look at the three that were significant in the previous model, log ASSUME, log asset, and industry cost, and also include industry cost squared.

INSERT 3
REGRESSION ANALYSIS

Fit the model LN_COST = b_0 + b_1 LN_ASSUM + b_2 LN_SIZE + b_3 INDCOST + b_4 INDCOST^2 + e.

The regression equation is

- LN_COST = 5.84 + 0.109 LN_ASSUM - 0.687 LN_SIZE + 5.81 INDCOST - 3.33 INDCOST^2

The R^2-adjusted increased, and also industry cost squared is significant. Thus, we get a quadratic relationship between industry cost and log loss cost. None of the four hypothesis tests is supported by the data. That's not to say that those hypothesized relationships do not hold, but simply that this data does not support those hypotheses.

Mr. Luckner: For any kind of project involving looking at data, attention to detail is important. In a lot of data collection and analysis you can be fairly confident that the data are credible, if you're fairly confident of the source of the data, and you know that they provide good data. However, in other data collection analysis projects, particularly when you have a fairly complex data collection process or a new data collection process, you do need to spend time analyzing the quality of the data. That's the case in the case study that I'm going to talk about.

Some of you may be aware of the fact that we instituted an asset risk experience study several years ago. Before I get into talking about the data quality, I want to talk a bit about the model that is used for that study. Just as individuals can become disabled, and then recover, remain disabled, or die, assets can become disabled, recover, remain disabled, or die. One of the things that we thought could add value to an analysis of assets, would be to try to apply the disability model, which has two main components, incidence and severity, to assets. In some sense what we're talking about is taking the traditional actuarial model and applying it in a non-traditional context, with the hope that it adds value to an analysis of that kind of situation.

What do we mean by credit risk? Basically, the risk that the borrower will not make the payments as promised. In the SOA study, we looked at four types of credit events: complete default (that is, no more payments), bankruptcy of a company, restructuring of the payment, or a distressed sale to minimize the losses on an asset.

We looked at four different loss statistics. The first two are incidence rate by number and by amount. The number of credit risk events (CREs) in a cell divided by the number of assets in a cell gives you an incidence rate by number. Replace the number with amounts, and you get incidence rates by amount. Incidence rates give you an idea of how frequently events are happening. The two other loss statistics are: loss severity and economic loss per unit of exposure. Loss severity answers the question: given you've had a loss, how severe is it? Loss severity is defined as the ratio of the economic loss, which I'll explain a little bit later, in a cell of data to the amount of credit risk event exposure in the cell. That is, we had a credit risk event, how severe was it, what portion of the asset did we lose?

The fourth loss statistic—economic loss per unit of exposure or "basis point" loss—is the bottom line. It answers the question: what charge to your interest rates should you apply because of this risk? When we first did the study, we had four years of data (1986-89), which is not a very long timeframe, particularly for an economic cycle, which has a lot of influence on this risk. We're now up to about 9 or 10 years, which is becoming a long enough time series to warrant time series analysis.

The economic loss calculation for a given credit risk event is a critical calculation. The economic loss is equal to the outstanding principal from the previous year end, times a . The numerator of the ration equals the difference between the present value of the original cash flows (that is, the cash flows originally contracted for) and the present value of the revised cash flows. The denominator equals the present value of the original cash flows. Essentially that means the outstanding principal times a percentage of the present value of the original cash flows.

When talking about validating data, we can talk about either validating the data itself, or validating the data processing. In this case study, we focus on just the data itself.

The data processing, which in this particular project involves the compilation of the data, adjustments for missing data, and certain calculations, such as exposure calculation, present value calculations, economic loss calculation, and the calculation of the loss statistics, gives you another case study: validating the data processing.

There is an actuarial standard of practice on data quality. It suggests that there are two major considerations. Do you have appropriate data? How do you verify the quality of the data?

How do you know if you have appropriate data? To a great extent, that depends upon informed judgement or experience. You know what you want to accomplish in the project. You know what kind of calculation you want to make. You have to identify the data that you want to get.

Verification of the quality of the data is important. There are two major ways to verify data. One is reliance on others. Again, if you're confident that the data source is credible, you may take that approach. But if you're not, complete and independent verification of the data is what's called for. That's what we're illustrating in this case study.

The standard practice also talks about selection of data. What do you do when you have imperfect data? Even when you have relied on data supplied by others, there's the suggestion that you should at least check that data for reasonableness and consistency.

For data validation, what is our objective? Our objective is to determine the reasonableness, consistency, and completeness of the data submission. We all have limited time and resources. One of the first questions that comes up is how much time and effort should you spend on data validation? When you have different

types of data, should you spend more or less time on one particular type of data because of its impact on the results? In this case, we have two types of data, exposure data and credit risk event data.

Let's examine the impact of an error in either of those types of data. For example, on the 1994 aggregate basis point loss, given an economic loss of $107.7 million and exposure of $102.5 billion, the basis point loss is a little over 10.5 basis points. That is 1/10th of 1%. Suppose there was a $10 million overstatement in exposure, or a $10 million overstatement in the economic loss. Which has the most impact? If there was a $10 million overstatement in exposure, the actual exposure should have been $102.490 billion, instead of $102.5 billion. The impact is relatively minor. The basis point loss is still just a little bit over 10.5 basis points. If the overstatement was in the economic loss, the impact is more significant. The actual basis point loss is then about 9.5 basis points. If you consider the relative error, the relative error in the case of an overstatement in economic loss is almost 1,000 times more significant than the relative error in the case of an overstatement of exposure. That suggests that we need to pay more attention to the calculation of economic loss, which depends upon the credit risk event data, the original cash flows, the revised cash flows, and the outstanding principal. That's where we ought to focus our time. Now in the actual seminar, we'll be talking about the exposure data as well. But in the interest of time, I'm just going to focus on the credit risk event data.

What are the types of problems you can have with credit risk event data? One problem is errors relative to dates: beginning and ending date of study, credit risk event date, dates of cash flows. We won't talk too much about that.

The credit risk data in this study had to be manually submitted because it's not something that most companies have electronically provided. The cash flow information is a paper file, so it had to be converted to an electronic format. That conversion is a possible source of error.

Another possible cash flow error is that there is a CRE data submission which has original cash flows but no revised cash flows or vice versa. There's also the possibility that you have CREs for which the outstanding principal is missing. The outstanding principal for the previous year end is needed to calculate the economic loss. Sometimes that can be inferred, or you can go back to the data source and see if you can get that filled in. If you don't have that outstanding principal, you can't calculate the economic loss.

Then there's the possibility that you have some CRE assets with the present value of the remaining original cash flows, at the original coupon rate, as of the loss calculation date, significantly different from outstanding principal as of the previous

year end. The ratio of the present value to the outstanding principal ought to be close to one. CRE assets with ratio significantly different from one should be flagged. There may be some other CRE data problems, but the ones that we're going to focus on have to do with the cash flows. In the process of this project, Kin On Tam, who is an actuary with Metropolitan, developed some data quality checks. Although others were involved, he contributed the most to the development of these data quality checks.

Because we have different files with information about the same assets—an exposure file and a credit risk event file—a couple of the data quality checks have to do with linking files, to make sure that we have the same information in both files for the same characteristics.

DQ5 or DQ6 are the data quality checks that will be highlighted in the Course 7 seminar. DQ5 is an asset listing that considers the pattern of an asset over a number of years. DQ6 compares the present value of original cash flows to the original outstanding principal.

Now with CRE data, as in a disability study, as you add years to the study, if you have a CRE that occurred originally in a prior year, it may be restructured again, but you want to allocate that loss to the first time it had a restructuring. You may have to do some updating of the previously submitted CREs because of further changes on their cash flows. Identifying the CREs and then updating the ones that were CREs in previous studies are important as you continue to add years to the study.

For reasonableness and consistency, the items to consider are the dates, the outstanding principal compared to the original cash flows, and the revised cash flows compared to the original cash flows. This is a little trickier to objectively say what ought to be the relationship. But there are some solutions to flag. If the revised cash flows end up with the asset losing everything—that is, no revised cash flow—it might get flagged. If the revised cash flows end up with the asset generating exactly the same cash flow, there might be a flag. If the revised cash flows end up being better than the original cash flows on a credit risk event, that might be a flag. That is, you get more value from the restructuring.

Reasonableness, consistency, and completeness are the three main things we want to talk about. For completeness of the CREs, the items we need are the original cash flows, the revised cash flows, the outstanding principal, and the loss date. Also, as I mentioned, there's a question about making sure that we link the data file for exposure and the data file for CREs.

I'm going to illustrate the procedures by looking at the diagnostic ratio, the present value of the coupons at the original coupon rate divided by the outstanding principal, and by looking at the loss severity. Table 3 lists assets that raise questions either because of the diagnostic ratio value, or the loss severity value, or both.

TABLE 3
DIAGNOSTIC RATIOS AND LOSS SEVERITY 10/18/92

	Loss Year	A	B	C	D	E	F	G
1	89	2,400,000	6,573,132	2.73881	6,744,235	5,564,723	0.17489	419,741
2	89	2,400,000	4,364,254	1.81844	4,493,279	4,478,013	0.00340	8,154
3	86	4,200,000	5,120,603	1.21919	5,691,016	3,145,096	0.44736	1,878,902
4	89	7,050,000	11,270,745	1.59869	12,480,868	13,535,176	-0.08447	-595,541
5	88	3,500,000	3,812,310	1.08923	3,343,689	11,419,192	-2.41515	-8,453,017
6	88	7,000,000	6,565,116	0.93787	6,770,995	0	1.00000	7,000,000
7	89	2,686,233	2,251,753	0.83826	2,457,688	2,457,688	0.00000	0
8	88	9,250,000	11,101,124	1.20012	12,359,160	11,624,153	0.05947	550,103

A Outstanding Principal from the Previous Year
B Present Value of Coupons at the Original Coupon Rate
C Ratio of B Over A = Diagnostic Ratio
D Present Value of Original Cash Flows
E Present Value of Revised Cash Flows
F Loss Severity = (D-E)/D
G Economic Loss = D-E.

A diagnostic ratio between 0.85 and 1.15 was considered reasonable. The loss severity values that raise questions are: a loss severity of one means all the asset value is lost, a loss severity that's negative means there was a gain in value as a result of the credit risk event, or a loss severity of zero means nothing was lost or gained as a result of the CRE. Those three situations raise questions because you intuitively think they shouldn't happen. But it may be the case. We need to check these assets further.

Charts 5 and 6 are graphic illustrations of the diagnostic ratio for credit risk event assets, providing a comprehensive summary of assets with potential data quality problems. The vertical lines represent the range that we consider reasonably between 0.85 and 1.15. Chart 5 graphs the diagnostic ratio versus the outstanding principal. There are a number of assets outside the range, but fortunately most of them are at the lower values of outstanding principal. So presumably they have less impact on the results.

Chart 6 graphs the diagnostic ratio by loss severity, which gives additional information because it also summarizes the extent of potential data quality problems due to loss-severity considerations. Charts 5 and 6 give you an idea of some ways to flag the assets for further investigation. Of course, we could look at the cash flows for all CREs, but that's rather tedious and time consuming. This gives you a way to select assets for further investigation.

Tables 4–6 illustrate one of the potential problems with the asset cash flow submission. Table 4 summarizes the original cash flows in a natural format. Given

a coupon rate of 8% with quarterly coupons, that means 2% each quarter compounded. With $10,000 beginning outstanding principal in September 1988, there is an interest coupon of $200 because of the 2% coupon rate and so you had total cash flow of $200. In December 1988 there is a principal repayment of $6,000, so there is a cash flow of $6000 plus the $200 coupon. Because of the principal prepayment, there is a lower coupon and future cash flows.

TABLE 4
PRIVATE PLACEMENT BOND
OCF IN A "NATURAL" FORMAT

OCF	Date	OP	Int Paid	Princ Repaid	Total CF
1	9/88	10000	200		200
2	12/88	10000	200	6000	6200
3	3/89	4000	80		80
4	6/89	4000	80		80
5	9/89	4000	80		80
6	12/89	4000	80	4000	4080

Coupon Rate: 8.00%
Coup/Year: 4

TABLE 5
PRIVATE PLACEMENT BOND
OCF IN DATA-SUBMISSION FORMAT (000s)

OCF Stream	Date of 1st Pymt	Mos Bet Pymts	Pymt Amt	# of Pymts
1	9/88	3	200	2
2	12/88	0	6000	1
3	3/89	3	80	4
4	12/89	0	4000	1

TABLE 6
PROBLEM: COUPON NOT REDUCING
WITH PRINCIPAL PAYMENT

OCF Stream	Date of 1st Pymt	Mos Bet Pymts	Pymt Amt	# of Pymts
1	9/88	3	200	6
2	12/88	0	6000	1
3	12/89	0	4000	1

For our study, we asked that cash flows be submitted in a more concise format of cash flow streams, as shown in Tables 5 and 6. For each stream of equal cash flows, the format consists of the date of the first payment, the months between payments (three months means that it's quarterly), the payment amount, and the number of payments.

Table 6 illustrates one potential problem. Many of the potential problems are simple problems in the sense that you can easily see why they happen. You can see that they're fairly easy to fix. If you look at Table 6, what is the problem with this data? The coupon is not reduced. It's an easy error to make.

Those are the kinds of things that you can do, after you've identified the assets to look at. Investigate their cash flows and check if there are any potential data problems. Once you have identified the problems, there are two things you can do. You can use some judgement to infer the fix to make. Also, if it's relatively easy and you know the source of data, you can go back to the data submitter and ask if your analysis of the problem is correct, and they can supply the correct data. If it's an easy fix that's obvious, like the problem of the coupon not reducing, the inference change is the quickest thing to do. But generally, you want to make sure that you're confident that you've got the correct data. A lot of times when there are any questions, you go back to the source. What that does, though, and this is the tradeoff, is it delays the completion of the project. If you're doing it internally, like you're doing a credit risk study for your company, there may not be a big delay.

But what's the bottom line in all this? Why do we go through all this? We talked a little bit about the impact on the analysis of results. We talked about looking at the data that has more impact on those results, the credit risk event data as opposed to the exposure data. But what about the impact on the communication of results, particularly if you can't completely resolve the data problems? What do you do? Again, referring to the Actuarial Standard of Practice on data quality, it's important to document what you've done. In your report there's a number of things that you should include, and if you have these data problems, you might want to make a comment or two upon limitations on the use of the end product. In the original credit risk report, which was for 1986-89 calendar years, we had a fairly strong caveat about use of that data, somewhat due to the data quality, but even more so because of the fact that it was over a short period of time. When you're talking about economic data, you must make sure you think about the impact of just taking one small segment of the economic cycle as opposed to going through a full economic cycle.

Now as I mentioned, one of the things that we think is important is the interaction of students, both in the presentation and in terms of having assignments and working in teams. What kind of exercise could we have them do on data quality with this particular case study? We can give them a project that might involve some private placement bonds, CREs from the investment department of their company, and ask them to do some calculations like loss severity, economic loss, and the diagnostic ratios we talked about. That's a fairly simple spreadsheet type of

calculation. We can then ask them to identify potential data problems, analyze them, and write a report consistent with the Standard of Practice.

I think this is an important thing for us to remember whenever we're doing modeling. "Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise." Tukey said that in 1962. What it suggests is to not spend a lot of time fine tuning your model, if it's addressing the wrong question. Spend more time trying to figure out what the right question is.

Finally, to help us keep things in perspective, "Don't fall in love with your model because, ultimately, it will be unfaithful to you." Of course, this applies to all kinds of models, but the point here is that assumptions change, techniques change, and the tasks you want the model to do change. You should always be considering how your model will be changed, or scrapped and replaced by a new model. Modeling is not a once and for all time exercise.

Mr. Robin Fichtelberg: I just want to know what kind of software we would need to bring?

Mr. Luckner: All you'll need is a spreadsheet package and a word processor. But we're not saying that you have to use a specific program such as Excel, but we will say that you have to be able to do a spreadsheet and you can use Excel, Lotus, any kind of spreadsheet program. As Jenny mentioned, we will be telling people in advance which types of spreadsheet functions they'll need to know how to do. We're not going to require sophisticated programs.

Mr. Fichtelberg: Okay, because I was just looking at the examples, and when I use Excel, I have never done some of that stuff. I wasn't even sure if it could do it.

Mr. Luckner: I think that you can. You might be learning more techniques in Excel, but that's the kind of stuff we will be giving in advance.

From the Floor: Speaking of learning techniques, do you think there would be any value for the experienced FSAs, people who haven't gone through the current structure, to take this course or is it designed for pre-FSAs only?

Mr. Luckner: I think that's an open question. At this point, the folks we're focusing on make it available for are the candidates who need to take it. There's a question of priorities. Ultimately, there may be something similar for experienced FSAs. I guess the thing I would say though in terms of learning techniques about models and modeling, the real meat of that is in Courses 3 and 4. And so, to really prepare

for a seminar like this, you've had to have had the background in the new Courses 3 and 4. Like the stuff that Jenny did, the regression stuff, would have already been covered. We're not going to teach you how to do regression in this course. I think that it's certainly something that, in the ideal world, we would have available for experienced FSAs too.

From the Floor: With this particular course, how does the preparation compare to the preparation today for an exam? I have a student program and they have study time and things like that. What is it going to take and how does that compare to what you know when you use a cost benefit?

Mr. Luckner: That's a very important question. I'll try to give a response, but Marta Holmberg, is the SOA managing director working most closely with this course. With the pretest, there's a fair amount of time and effort to prepare for this seminar. And in terms of time out of the office, there are probably four days at least, out of the office. I think the whole issue of how the new courses relate to the old courses is somewhat tricky in terms of amount of time and effort. But in terms of a seminar itself, my sense is that it would be very comparable in terms of time and effort and value to the new Courses 1-6. I don't have a better answer at this point.

Ms. Marta Holmberg: In terms of preparing for the pretest, that is probably somewhat less than what you would require in study time now for a ten credit exam. There's more preparation in between passing the pretest and preparing to come to the actual seminar itself. It's not going to be anything that lines up real neatly, which is part of why we're trying to get away from talking about equivalence of credits and things, because they don't translate particularly well.

From the Floor: People who attended the 121 and 152 Intensive Seminars have told me that the working hours in those five days were 14–15 hours per day. Would that be the same case in this?

Mr. Luckner: That's a good question because I neglected to mention what happens in the evenings. The way we're structuring it, it's one and one-half days of work in terms of our presentation, but the evening is when the students will be working on the exercises and projects. It's full days of work. Basically most of your waking hours will be focused on the seminar. It is condensed from five days to three-and-a-half days compared to the intensive seminars but it will be intense and the focus of everybody when they're attending the seminar will be on the seminar.

Ms. Karen J. Sasveld: When would I take Course 7? It'll be five years since I took 120. I'm not real thrilled about spending my personal time to review something I haven't used in five years. I haven't used regression analysis since I took the exam.

Will we know ahead of time what types of models will be covered at a particular course location so that we can maybe pick something that is more geared to what we do in our day to day job?

Mr. Luckner: There will be information provided in advance for the common core case studies, what they involve, and specific types of techniques you may need to use for your spreadsheet. There will also be information on the general or practice specific case study, in terms of at least the topic content.

Ms. Sasveld: Would it be fair to say that, if I could follow the example that was done here today, I probably have sufficient background to go in and take Course 7?

Mr. Luckner: I think so. If you could follow Jenny's. Mine was pretty easy, but hers was more difficult.

Ms. Julie K. Bohning: When do you expect the first Course 7 seminar to be offered?

Mr. Luckner: Our current goal is to have the first one in February 2000. We'll do our best. We have the common core faculty mostly recruited and we're having a trial run of the Common Core portion in July. We're in the process of recruiting the business faculty and hope to have a trial run of at least one business case study in September. I'm hopeful that we'll be able to have at least one seminar up and running in February and we estimate we have to have 16 in 2000. We will be offering them throughout the year and at various locations. We identified the locations where a cluster of potential candidates for a seminar would be. Large exam centers will be in Chicago, New York, and Toronto. There will be some others throughout the country. We are scheduling one in Hong Kong because of the number of potential candidates in that part of the world. There will be a variety of topics. That may be the one complication in the sense you get to choose which seminar you want to go to, with a given general or practice-specific topic. The first one that we will offer is a general one, which means that no particular practice-area background will be significantly disadvantaged or advantaged by taking the seminar.

From the Floor: What sort of screening are you going to do for the faculty and what kind of feedback will you get once they've taught one or two sessions?

Mr. Luckner: First of all, we asked for volunteers. We got a good response. We did some screening by looking at the people who have been involved with the intensive seminars before, and people who we knew had background experience in either teaching or the practice areas that we wanted to have for the business faculty. For the common core, we have some instructors who were involved in the 121 or 152. Some people have been involved in the academic teaching, which we think is

good. We are asking for a commitment, both from us and from the instructors, that each faculty member do at least two seminars, partly because it takes a lot of time and effort to prepare for the seminar. To get the investment of time and effort back it's better for them to do more than one seminar. We don't guarantee that we will be having course evaluations.

From the Floor: What about computer resources?

Mr. Luckner: We're requiring that they bring their own laptop.