A LINEAR PROGRAM TO COMPARE MULTIPLE GROSS CREDIT LOSS FORECASTS

Dr. Derald E. Wentzien, Wesley College, (302) 736-2574, wentzide@wesley.edu

ABSTRACT

A linear programming model is developed and used to compare alternative forecasts for a single variable. An inherent problem associated with generating multiple forecasts is the question of how to incorporate the results into a single forecast. The linear programming model is designed to assign weights to the different forecasting methodologies such that the mean absolute deviation between actual and forecast results is minimized. Senior executives can use the weights to analyze the accuracy of each forecast and incorporate each of the different forecasts into one set of numbers.

The model formulation, an example of an application using the forecast of gross credit losses for a credit card company, and a discussion of how the weights can be used to assess the different methodologies are presented. The four methodologies include a regression-based roll-rate forecast, a collection roll-rate forecast, a risk analysis invariation-based forecast, and a finance vintage-based roll-rate forecast. The model evaluates the accuracy of each forecast using an analytical approach. The information is then used to suggest how a single forecast can be selected using the best features of the different methodologies.

BACKGROUND

Credit card companies must plan and prepare for credit losses. It is imperative that a reliable credit loss forecast be available for planning purposes. The process often begins when different departments prepare separate forecasts. The numbers are presented to senior management at a monthly forecast meeting. The senior executives evaluate the information, ask questions, and then select the official "best" forecast. Some of the common methodologies to forecast credit losses include roll-rate models, vintage loss rate curves, credit bureau score loss rate models, and Markov chains. A discussion of these methodologies can be found on the FDIC website [1]. Credit management techniques including credit loss forecasting using Markov chains are analyzed and discussed by Resenberg and Gleit [2].

The forecast of gross credit losses used in this analysis were produced each month from November to June using variations of roll-rate and vintage based methodologies. Each forecast included monthly gross credit losses for a rolling twelve-month time period. Comparisons to actual gross credit losses reveal the accuracy of each methodology. Table 1 shows the absolute value of the forecast errors associated for the forecast of gross credit losses one-month out. The one-month mean absolute deviation (MAD) values were $2,749 (thousand) for the regression-based methodology, $790 (thousand) for the collection roll-rate methodology, $2,440 (thousand) for the risk analysis invariation methodology, and $1,752 (thousand) for the finance vintage roll-rate methodology. The forecast produced by the collection department had the smallest one-month MAD and was always selected as the "official" forecast at the monthly forecast meetings.

Table 1 One-month Forecast Error (in thousands)

Date	Actual GCL	Regression		Collection		Risk Analysis		Finance	
		Forecast	Error	Forecast	Error	Forecast	Error	Forecast	Error
Nov	$83,512	$83,674	$162	$85,895	$2,383	$89,109	$5,597	$84,424	$912
Dec	$92,248	$87,444	$4,804	$92,937	$689	$88,660	$3,588	$94,859	$2,611
Jan	$90,237	$89,768	$469	$90,873	$636	$90,329	$92	$90,710	$473
Feb	$98,319	$95,565	$2,754	$98,563	$244	$93,831	$4,488	$94,744	$3,575
Mar	$96,162	$98,871	$2,709	$95,437	$725	$95,280	$882	$94,082	$2,080
Apr	$98,980	$102,835	$3,855	$99,516	$536	$99,915	$935	$100,122	$1,142
May	$98,609	$101,723	$3,114	$98,035	$574	$98,303	$306	$99,193	$584
Jun	$94,470	$98,594	$4,124	$95,005	$535	$98,102	$3,632	$97,107	$2,637
MAD			$2,749		$790		$2,440		$1,752

The Collection Department was directly responsible for working the accounts and it was therefore not surprising that the forecast prepared by that department had the smallest MAD. However, the question of whether the other forecast methodologies can be used to provide additional information or improve the official forecast is not answered using this procedure. The linear programming model presented in this paper will help determine if and how the information from the other forecasts methodologies provide additional information for senior management. The linear program assigns weights to the different methodologies to help address this issue. The weights will reveal which methodologies should be used to minimize the MAD.

MODEL FORMULATION

The following linear program is designed to minimize the MAD of the four alternative forecast methodologies. Although in this case there were four different methodologies, this model can be used when there is any given number of competing methodologies. In addition, this model is not limited to the forecast of gross credit losses. This model can be applied to the forecast of any given value of interest.

The model is stated as follows:

$$Min \quad z = \sum_{j=1}^{m} \left| \left[\left(\sum_{i=1}^{n} w_i \cdot F_{ij} \right) - A_j \right] \right|$$

Subject to:

$$\sum_{i=1}^{n} w_i = 1$$

$$w_i \geq 0$$

Where, n = number of forecast methodologies

m = number of observation

w_i = weight assigned to forecast methodology i

A_j = Actual Gross Credit Charge-off in month j

F_{ij} = Forecast of Gross Credit Charge-off in month j by methodology i

RESULTS

The weights assigned to the different methodologies which minimize the one-month gross credit loss forecast error from the linear program are presented in Table 2. The numbers in the table indicate that the weights stabilized when four or more months of observations are included in the model. The weight (0.8746) assigned to the collection roll-rate methodology is relatively large, validating the decision that it produces the best one-month forecast of gross credit losses. This indicates that the collection roll-rate methodology is accurate at predicting gross credit losses one-month in the future and that it will be a major factor in determining a combined forecast. An interesting result and question is why the model assigned a weight to regression-based methodology when it was the methodology with the largest MAD.

Table 2 Assigned weights for one-month gross credit losses

Date	Regression	Collection	Risk Analysis	Finance
Nov	1.000	0	0	0
Dec	0.3521	0	0	0.6479
Jan	0.3521	0	0	0.6479
Feb	0.1255	0.8745	0	0
Mar	0.1254	0.8746	0	0
Apr	0.1254	0.8746	0	0
May	0.1255	0.8745	0	0
Jun	0.1254	0.8746	0	0

The MAD comparisons between the regression-based methodology, the collection roll-rate methodology, and the combined forecast using the weights of the linear programming model are presented in Table 3. The combined forecast yielded a MAD of $635 (thousand) representing an average improvement of $155 (thousand) per month over only using the collection roll-rate methodology. Since the regression-based roll-rate methodology had the largest MAD, an interesting question is what additional information can be obtained from the regression-based methodology?

Table 3 One-month Forecast Error (in thousands)

Date	Actual GCL	Regression		Collection		Combined	
		Forecast	Error	Forecast	Error	Forecast	Error
Nov	$83,512	$83,674	$162	$85,895	$2,383	$85,616	$2,104
Dec	$92,248	$87,444	$4,804	$92,937	$689	$92,248	$0
Jan	$90,237	$89,768	$469	$90,873	$636	$90,734	$497
Feb	$98,319	$95,565	$2,754	$98,563	$244	$98,187	$132
Mar	$96,162	$98,871	$2,709	$95,437	$725	$95,868	$294
Apr	$98,980	$102,835	$3,855	$99,516	$536	$99,932	$952
May	$98,609	$101,723	$3,114	$98,035	$574	$98,497	$112
Jun	$94,470	$98,594	$4,124	$95,005	$535	$95,455	$985
MAD			$2,749		$790		$635

An investigation into why the regression methodology was assigned a weight was conducted. It was discovered that on several occasions the regression-based roll-rate methodology served as a check for the collection roll-rate methodology. Specifically, in six of the eight months the regression-based roll-rate numbers were lower than the number produced by the collection department when the collection number was too high or higher than the number produced by the collection department when the collection number was too low. Therefore, the regression-based forecasts could serve as a check to the collection roll-rate model. It could be used to indicate when the collection department was overestimating the roll rates or underestimating the roll rates. Although the forecast produced by the collection department was always used as the "official" forecast, senior management looked at the regression-based number to verify the forecast. When large differences between the two methodologies were observed, members of the collection department were asked to check their numbers to see if there was something that they missed or wanted to correct.

CONCLUSION

The linear programming model results can also be used to determine a combined forecast by calculating a weighted average of the different methodologies for each of the twelve months in the forecast horizon. Although the results are not available yet, weights can be produced to answer the question of how far into the future can the collection department accurately predict credit losses or do the other methodologies work better for longer time horizons.

Senior management executives can use the weights of the linear program to assess the effectiveness of the alternative forecast methodologies in the short-term. This methodology can also be used to develop medium-term and long-term forecasts. In this example, the collection roll-rate methodology performed the best (as defined by the largest weights) in the short-term. Senior management used the collection roll-rate forecast to predict the short-term gross credit losses with the regression-based methodology as a check. They were reluctant to use a combined forecast in the short term because they liked the reliability of the collection roll-rate methodology and knew that the collection department was ultimately responsible and accountable if the actual losses were much different than forecast.

REFERENCES

[1] http://www.fdic.gov/regulations/examinations/credit_card/ch12.html#sec5

[2] Rosenberg and Gleit, "Quantitative Methods in Credit Management: A Survey," Journal of the Operations Research Society of America, 1994, 4, 589 - 613