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Judgmental forecasting in the presence of loss functions

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Abstract

Many practicing forecasters operate in an environment where there are either implicit or explicit biases favouring under- or over-forecasting. For example some marketing executives may be rewarded for exceeding the forecast which operates, in effect, as a sales target. In other organizations, the forecast may be set high to encourage greater effort. Previous studies show that most practical forecasts are indeed significantly biased, with some organizations biased one way and some the other. One of the possible reasons for this bias is the rational reaction to asymmetry in the loss function faced by the forecaster. This paper reports a laboratory study on the reactions of forecasters to different types of loss functions. The subjects were given a cover story that they were the production manager in an organization with an asymmetric loss function. This was diagrammatically displayed, and operationalised in the experiment by paying money bonuses to the subjects. Two shapes of loss function were used differing in their kindness, and two directions of bias, one favouring over- and one under-forecasting. The results show that the subjects responded appropriately to the differing directions of the asymmetry and to the differing kindness shapes of the loss functions. These results support the field research showing that forecast biases can be the result of deliberate and rational decision making behaviour on the part of the forecasters.

Keywords: Judgmental forecasting; Loss functions; Asymmetric loss; Tolerance zone

1. Introduction

The predominant focus of attention for many studies in forecasting has been on error and its minimization. As an illustration, the important forecasting competitions (Makridakis et al., 1982) have mostly concerned themselves with determining the technique that had the lowest error. However, each unit of additional error may not 'cost' the same to the user or consumer of that forecast. For example, if people consider that they would rather take an umbrella and not use it compared to being caught in the rain without it, it would be beneficial for a weather forecaster to err on the side of forecasting rain, even if the chance was minimal. In this case, the cost of not forecasting rain when it occurs is greater than the cost of forecasting rain when it does not occur. In this example, there is a difference between a forecast error and the "cost" of it to the individual users of the forecasts. The relationship between the size of a forecast error and the cost to an organization or the user of a forecast has often been referred to as a loss function, or sometimes called an error cost function

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(Armstrong, 2001). In the above example, the unbalanced loss or cost function (or asymmetry as we refer to it in this paper) leads weather forecasters to report forecasts that are in-line with these loss functions. In addition to symmetry/asymmetry, the loss function may exhibit a linear or nonlinear shape. A particular example of a nonlinear shape, which we have observed quite widely in practice, is that of a tolerance zone for forecast error. When an organization adopts a tolerance zone, all forecasts whose errors fall within the zone are regarded as "accurate forecasts", and the forecaster is appropriately rewarded.

The above examples suggest that the loss function encountered by a user of a forecast is likely to affect the process of forecasting. While there has been considerable debate on appropriate metrics to be used in measuring accuracy in forecasting (Armstrong & Collopy, 1992; Bunn & Taylor, 2001), little debate has occurred as to the shape of common loss functions and the effect of this shape on the process of forecasting. In a perfect world the minimization of error (i.e. a zero error) will also minimize cost and maximize benefit. In a less-than-perfect world where errors are inevitable, the 'cost' to a forecaster (or a decision maker) of an under-forecast may not be the same as the 'cost' of an over-forecast, and if the error falls within the tolerance zone, the cost maybe zero. We note that the forecast user may face a different loss function to the decision maker. As Yates, Price, Lee, and Ramirez (1996, p. 41) comment "...The decision maker's values can differ substantially from those of other people—*including those individuals the decision-maker may consult for forecasts*" (emphasis in original). In this paper, we are interested in exploring the influence of a defined loss function on the forecast estimator.

This paper examines the ability of people faced with an asymmetric cost or benefit function and tolerance zone/no tolerance zone, to maximize their benefits or minimize their costs as a provider of that forecast. We also examine the situation where the loss function may be symmetric, but is not necessarily linear.

2. Literature review

In most studies of forecasting, the criterion of evaluation is the degree of accuracy of the forecast (e.g. Makridakis & Hibon, 2000). While this is appropriate in many situations, the ultimate benefit of a forecast is in its use—the extent to which it can 'add value'. In a prior study of sales forecasting (Lawrence, O'Connor, & Edmundson, 2000), a number of situations were observed where the shape of the loss function directly influenced the process of forecasting and its accuracy and bias. Specifically, two situations seemed to be ubiquitous to the organizations studied: the asymmetry of the loss function and the presence of acceptable regions for error. In both situations, a unit of error is not equivalent to a unit of 'cost' of that error. In the asymmetry condition, the 'cost' of under-forecasting may not be equivalent to the cost of over-forecasting. In the acceptable region condition, small errors may attract little 'cost' up to some point, after which each additional unit of error attracts significant 'cost'. As mentioned, this paper reports a study of the effectiveness of judgmental forecasts in these two situations.

2.1. Asymmetry of loss functions

In the context rich environment of practical forecasting and planning, a forecast may not be the same as the "most likely" value. The estimation of the forecast may itself be influenced by the loss function faced by the company. In many situations, to maximize value (or minimize 'cost') of the forecast to the organization, this loss function acts to bias the forecast from the expected value. From a normative perspective, Granger (1969) demonstrated that any optimal forecast under asymmetric loss will exhibit constant bias, the size of which will depend on the parameters of the loss function, and the constant error variance. Also Batchelor and Peel (1998) argued that the bias was rational. In this paper, they concluded that the forecasts of US Treasury bill yields are both biased and rational, since under-forecasts of interest rate changes are more costly than over-forecasts.

Strong evidence for this source of bias in forecasts is contained in a field study of sales forecasting in Australian business (Lawrence et al., 2000) and in the work of Bretschneider, Gorr, Grizzle, and Klay (1989) and Mathews and Diamantopolous (1990). In the political arena, Brouthers (1986) and Shamir (1986) found that forecast errors were affected or biased by the political ideology of the party commissioning the