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Asymmetric loss function in product-level sales forecasting: An empirical comparison

In the paper we study the behavior of models estimated using asymmetric loss function for the prediction of product-level sales. The paper is focused on the deriving of a loss function from the newsvendor model where the cost of sales over- and underprediction are not equal. We describe the properties of the asymmetric loss function and validate its performance on transactional sales data. The results show that when costs of sales over- and underprediction are non-equal, the prediction function obtained using asymmetric loss leads to lower economic costs compared with symmetric one. Our findings suggest implementing this type of forecasting method to predict product-level sales in the retail and restaurant industries to better accommodate business goals when solving inventory planning tasks.

Keywords: demand estimation; loss function; accuracy metric; prediction; retail.

JEL classification: D12; C52; C53.

1. Introduction

The problem of daily product-sales forecasting is an important area of research in economics and management. A huge amount of transactional data is collected in retail, restaurant, and fast food chains, giving the opportunity to employ them in different business problems: sales volume predictions, optimal assortment management, supply planning, inventory management, labor scheduling, and others. Many studies in economics and machine learning (Klassen, Flores, 2001) have investigated various approaches to forecasting in order to improve sales prediction accuracy. Accurate sales forecasts significantly improve retail chain profits by reduction of unsatisfied demand, reducing food waste, and optimizing operations (Chen et al., 2014). Sales forecasting is the cornerstone of data-driven revenue management. However, few studies have been done on the importance of the choice of the loss function in product-sales forecasting.

A standard assumption in econometric and machine learning models is that the desired prediction is the mean or median of the conditional distribution of the forecasting variable. In other words, the prediction is better when it is closer to the actual observed or theoretical values on average. However, in some applications the loss associated with deviation from the actual value depends on the sign of that deviation, making treatment of over- or underprediction different.

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