A New Approach to Forecasting Container Throughput of Guangzhou Port with Domain Knowledge

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ABSTRACT

Although judgmental models are widely applied in practice to alleviate the limitation of statistical models ignoring domain knowledge, they are still suffering from many kinds of biases and inconsistencies inherent in subjective judgments. Moreover, most of the prior studies are often concentrated on making judgmental adjustments to statistical projections and ignore incorporating domain knowledge in other forecasting steps. This paper proposes a framework under which domain knowledge are integrated with the whole forecasting process and a new forecasting method is developed. The new method is applied to forecasting the container throughput of Guangzhou Port, one of the most important ports of China. In order to test the effectiveness of the new method, the authors compare its performance with that of the ARIMAX model. The results show that the new method significantly outperforms the ARIMAX model.

Keywords: Container Throughput Forecast, Domain Knowledge, Guangzhou Port, Judgmental Adjustment, Markov Chain Monte Carlo (MCMC) Algorithm

1. INTRODUCTION

Although statistical forecasting methods have made great success and have been widely used in practice, e.g., (Xiao, Xiao & Wang 2012), they still suffer from criticism of their unsatisfactory performance under complex and high volatile conditions, due to the limitation of generating projections based solely on the historical data (Armstrong, Collopy & Thomas 2005). Therefore, judgmental forecasting methods have been increasingly attractive, e.g., Bunn and Wright (1991) and Fildes, Goodwin, Lawrence and Nikolopoulos (2009), and Richard
& O’Connor (2011) have made a thorough investigation of the issue. Generally speaking, judgmental forecasting methods have at least three advantages: (a) Judgmental methods take advantage of rich valuable information that are not included in statistical models, such as contextual knowledge and expert experience. (b) Judgmental methods are more reliable than statistical models when facing with high volatility (Sanders & Ritzman 1992), because it is more possible that the patterns dug out of the historical data by statistical models become invalid in a volatile environment. (c) Judgmental methods are more effective when confronted with high complexity such as autocorrelated cues (Lawrence & Makridakis 1989; Mosteller, Siegel, Trapido & Youtz 1981), benefiting from experts’ knowledge and experience.

Substantial studies show that statistical forecasting models with judgmental adjustments perform better when the adjustments are based on reliable contextual knowledge (Donihue 1993; Clements 1995; Batchelor & Dua 1990; Edmundson 1990; McNees 1990; Turner 1990; Lim & O’Connor 1996; Huang, Xiao & Wang 2011). In business practice, judgmental methods are also in wide use. As suggested by a survey of 240 US corporations by Sanders & Manrodt (2003), only 11% were using forecasting software, of whom 60% acknowledged their routine judgmental adjustments to the predictions. Fildes and Stekler (2002) reviewed substantial macroeconomic forecasts and stated that the evidence unequivocally favoured judgmental adjustments.

However, judgmental methods are often criticized because of bias and inconsistence inherited in subjective judgements (Goodwin & Fildes 1999). Some experimental results show that forecasters tend to make unnecessary judgmental adjustments to statistical projections (Lawrence, Goodwin, O’Connor & Onkal 2006), even when they do not possess additional contextual information. One possible reason is that forecasters make judgmental adjustments in the hope of alleviating effects of noise in the time series (Harvey 1995; O’Connor, Remus & Griggs 1993). Another reason is probably the illusion of control effect, where forecasters make judgmental adjustments to exhibit confidence in their projections (Kottemann, Davis & Remus 1994). Even worse, some forecasters persist in making judgmental adjustments, though their adjustments are proved to be harmful (Lim & O’Connor 1995).

Plenty of evidences have suggested that incorporating domain knowledge in an unreasonable manner is actually harmful rather than helpful. Therefore, this paper proposes a forecasting method which integrates statistical models with domain knowledge and effectively alleviates bias and inconsistence inherent in subjective judgement. Besides, considering that most of the prior studies focus only on making judgmental adjustments to the projections, the last forecasting step, and ignore the other steps, this paper suggests a framework of incorporating domain knowledge into the whole forecasting process.

The remainder of this paper is organized as follows: Section 2 discusses the approaches to incorporating domain knowledge in statistical models, including a newly proposed framework; Section 3 concretely illustrates the proposed forecasting method; Section 4 compares performance of the proposed method with that of the ARIMA model. Conclusions are made in Section 5.

2. INCORPORATING DOMAIN KNOWLEDGE IN STATISTICAL MODELS

Because every forecasting model has its weaknesses and merits, the most applicable way to obtain higher accuracy is to integrate them together. Therefore, nowadays combined forecasting models are frequently used in practice (Fildes & Goodwin 2007). Clemen (1989) and Wallis (2011) respectively made a thorough and influential survey of combination forecasts. Both of them concluded that the combined forecasts enjoyed improved accuracy. Some evidences show that combining a judgmental with a statistical forecast brings greater gains.
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