

Forecasting accuracy of industrial sales with endogeneity in firm-level data

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ABSTRACT: *Over- or underestimating sales is detrimental to marketing and sales efforts as well as inventories and cash flow management. Thus the purpose of this investigation is to evaluate the forecasting accuracy of three competing multivariate time-series models that take into account existing endogeneity in monthly firm-level data from an industrial manufacturing firm. Two-stage least squares transfer function model including instrumental variables, Vector Autoregressive (VAR) model and Bayesian VAR are estimated and their forecasting performances are compared to an autoregressive moving average model (benchmark). using out of sample error measures. According to forecasting accuracy measures, models that take into account endogeneity outperform the benchmark. They also performed better when applied to data that includes the 2008 financial crisis, reinforcing the use of these proposed models in turbulent times to forecast sales. Only a little effort has been made in companies to model the endogeneity of the data, however great are the gains in sales forecasting with such statistical tools. Whatever the company, these models can be applied since there exists historical data. Previous literature in management has resorted to standard time series forecasting techniques, but has not employed models that accommodate potential endogeneity among the explanatory variables in firm-level data. Marketing effort affects sales as well as managers' decisions regarding marketing investments and project proposals can also be affected by sales.*

KEYWORDS - *Industrial sales, Forecasting, Endogeneity, Time series*

I. Introduction

Firms of industrial products use sales forecasting to operate efficiently and meet customer demand. Substantial over- or underestimates of demand can cause serious problems in various firm's management areas [1]. Forecasting sales volume is crucial for creating operating budgets, which play an important role in a firm's internal planning, motivation and performance management functions [2]. Industrial products primarily constitute those used in the production of other products and are customized using a 'made to order' approach. Inaccurate forecasting affects a range of a manufacturer's activities from delivery schedules to capacity loss due to overstocking, suboptimal capacity utilization and excessive and obsolete inventory [3]. The inaccurate forecasts influence negatively efficiency and sales performance. Given the relevance of this issue, industrial sales forecasting has been studied by researchers and addressed in various ways.

The majority of previous studies focusing on sales forecasting models sought to explain sales behavior by examining time series of internal manufacturer variables, such as marketing expenses [4]. [5] and [6] demonstrated the importance of macroeconomic variables (e.g., price, demand, exchange rate) to forecast a firm's sales in the consumer market. These variables have also been included in studies of industrial markets [7]. In the auto-parts industry, forecasting models are a component of complex support systems that need to be parsimonious with respect to variable selection due to the cost of collecting and treating the data [8]. Even for small firms, [9] showed that using a formal sales forecasting framework there is a gain, and they applied a Bayesian decision theory in the production of sales forecasts.

Industrial products require particular attention of sales forecasting models. [10] noted differences between the statistical approaches applied to consumer products and the statistical approaches applied to industrial products. Sales forecasts in industrial markets are also modified using the opinions of the sales team and management [4], [13]. [14] highlighted this tendency and found that only 6% of the 300 industrial firms sampled used regressions as part of their forecasting method. [15] suggested that the accuracy of sales volume