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Econometric modeling of the U.S. restaurant industry

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ABSTRACT

Predicting future sales in the restaurant industry and its subsegments is a critical activity for companies who seek to plan and control for what lies ahead. In this study, an econometric model was used to demonstrate its potential for such forecasting. Using aggregated data from the past 41 years, the model appears to have reasonable utility in terms of forecasting accuracy. Moreover, the fit across subsegments is consistent, except in the case of limited-service restaurants. As such, an underlying discussion regarding the limited service segment is offered and a rationale explaining why an alternative model should be used for this subsegment is presented.

1. Introduction

Forecasting future demand is vital to planning and operations in the restaurant industry at both the micro and macro levels. At the micro or organizational level, sales forecasts represent essential inputs to many decision-making activities in functional areas such as marketing, sales, production, purchasing, and finance and accounting (Mentzner and Bienstock, 1998). The role of forecasting in the restaurant industry is paralleled by its role in the broader economy. For example, Barksdale and Hilliard (1975) found that successful inventory management depended to a large extent on the accurate forecasting of retail sales. Extending this to restaurant suppliers and distributors, simple common sense tells us that being able to forecast expected growth in aggregate restaurant sales well in advance should help operators in planning, modernizing, or constructing facilities, hiring employees, and developing other related assets to ensure commensurate growth in services, revenue, and competitive advantage. Extended one step further, accurately forecasted aggregate sales will assist both the individual and large institutional investors, as well as lenders, in making the 'go, no-go' decision.

Very little prior research has assessed econometric models for the restaurant industry. Cranage and Andrew (1992) as well as Morgan and Chintagunta (1997) created econometric models for restaurants; however, these studies focused on data from a single operation and forecasted only weeks or months into the future. In addition, these studies lacked aggregated data that is practical at the unit level; moreover, there was no comparison of model fit across industry segments.

The ubiquitous nature of the foodservice industry suggests there is reasonable utility for sound econometric models that could be used in forecasting. The foodservice industry is the second-largest employer in the US, having achieved sales of $604 billion in 2011 with realized sales growth of 59% from 2000 to the present and 469% from 1980 to the present (National Restaurant Association, 2012a). In addition to population growth and increasing personal income, the major *raison d'être* for this growth can be attributed to changes in American consumer behavior as a result of which eating away from home has become more common, increasing from 33% in 1970 to 47.9% in recent times (USDA, 2012). The USDA's Economic Research Service (Blisard et al., 2002) predicts that, by 2020, the U.S. population will add between 50 and 80 million people and food establishments will see an additional $208 billion in revenue growth.

The preponderance of independent operators in the foodservice industry, most of whom have had no training in developing econometric models, has been cited to explain the lack of practitioner interest in such models (Sparkes and McHugh, 1984; Cranage and Andrew, 1992). This circumstance stands in stark contrast to that of operators in the lodging segment, who have long embraced related data in forecasting a variety of operational metrics, facilitated by such agencies as Smith Travel Research (Corgel, 2002). With no such third party methodically capturing sales revenue from a majority of US restaurants, an information asymmetry exists that makes it difficult to generate restaurant-industry forecasts. In addition, even if some restaurant chains use proprietary econometric models for forecasting, no model exists for the entire industry, or for segments within the industry.

The purpose of this study, then, is to explore likely predictor variables that should be integrated into industry-specific econometric models and to test the viability of these variables across subsegments. In particular, we consider general predictor variables

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such as percentile change in the consumer price index (CPI), percentile change in food expenditures outside the home, percentile change in population, and percentile change in the unemployment rate to see whether an econometric model can indicate their effects on aggregate annual restaurant sales lagged for one year. The data collected encompassed the years 1970–2011. Furthermore, we applied the model independently to full-service restaurant sales, quick-service restaurant sales, on-site foodservice restaurant sales, non-commercial restaurants, and what we call drinking places sales. The model and comparisons across segments will help operators, suppliers, and investors better understand related effects across subsegments and provide a basis upon which researchers can continue to develop such models related to the financial mechanisms of the restaurant industry. The following research questions are addressed through this study:

1. Is there an econometric model for predicting overall restaurant sales?
2. Is the model consistent in predicting sales across restaurant subsegments?

2. Background

Meijden et al. (1994) argue that the meaning of forecasts is sometimes blurred. They argue that effective, accurate forecasts exhibit two critical characteristics: (1) The functional area of the forecast is clearly identified, and (2) a time horizon corresponding to planning levels is specified. Such time horizons could be as long as five years for long-term strategic planning, up to a year for medium-term tactical planning, and perhaps up to three months for short-term operational planning.

Forecasting models or processes fall into two general classes: (1) qualitative or judgmental and (2) quantitative (including time series studies and econometric models). Combinations of these models have been used at times to increase forecasting accuracy (Bayus et al., 1989).

2.1. Qualitative forecasts

Qualitative or judgmental models have traditionally been favored in the restaurant industry for forecasting purposes. Such forecasts use estimates of variables based on managerial recall of past performance. Studies by Johnson and Schmitt (1974) and Critchfield et al. (1978) found that qualitative models outperform quantitative models. However, many other studies, for example Armstrong (1983), Lorek et al. (1976), and Libby (1976), have challenged these results, arguing that statistical models are superior to judgmental models. Nevertheless, independent restaurant owners generally use the judgmental forecasting method because they lack the resources (time, money, tools, and skills) needed to use quantitative or statistical forecasting models.

2.2. Quantitative forecasts

2.2.1. Time series models

Time series models identify patterns (trends, cycles, or seasonal influences) in a single series of data over time and capture these patterns in mathematical formulas. Such formulas are then used to project future time patterns. Several studies have argued for the superiority of this forecasting method (Dalrymple, 1975; Makridakis and Hibson, 1979; Poulos et al., 1987). However, Cranage and Andrew (1992) argue that time series models do not respond as quickly as econometric models do to changing situations, such as changes in consumer behavior patterns.

2.3. Econometric models

Econometric models characterize an economic or behavioral system (Fildes, 1985). Such a model utilizes a set of regression equations to establish a causal relationship between the dependent variable (e.g., industry sales) and exogenous variables such as the CPI, unemployment, and population growth. Econometric models make it possible to formulate a model based on a hypothesized cause-and-effect relationship between the causal variables and future industry sales. More importantly, as Fildes (1985) stated, this forecasting method is far superior to other models because econometric models typically are aggregate linear or almost linear models with well defined stochastic structures. An appropriately specified econometric model of a system with stable predictive power to describe behavior in that system is as rigorous a definition of 'causality' as any experimental science can specify (Zellner, 1979). Furthermore, Bayus et al. (1989) affirm that econometric models are well suited to empirically estimating aggregate future sales based on historical sales figures.

2.4. Econometric model in depth

In its simplest form, a single-equation econometric model links a dependent (endogenous) variable Y_t linearly to a number of distinct inputs (or exogenous 'causes'), which are specified as X_{it}: $i = 1, \ldots, j$. Mathematically such a model is written thusly:

$$Y_t = \beta_o + \sum_{1}^{J} \beta_i X_{it} + e_t,$$

where e_t is the error term associated with modeling Y_t by the above equation and includes both a stochastic component and any error caused by the use of an approximate model. The parameter vector β can be estimated using least squares to minimize Σe. Under the assumption that e_t is an independent, identically distributed and normal set of random variables, the least squares estimates are maximum likelihood estimates with the concomitant desirable properties. This simple model can be extended to include polynomials and delays (Fildes, 1985).

Fildes suggests the following sequence of actions when developing an econometric model: (1) define the system; (2) adapt from theory-based model to data model; (3) collect and refine data; (4) specify the functional form and stochastic structure of the error term; (5) conduct misspecification tests; (6) conduct specification tests; (7) evaluate the effects of uncertain exogenous variables; (8) compare ex post and ex ante forecasts with the base-line (naïve) forecasting model; and (9) use the model.

Utilizing a regression approach involving multiple indicators as explanatory variables, Ingenito and Trehan (1996) developed a GDP forecasting equation that began with 34 candidate variables from interest rate spreads, commodity price growth, a variety of employment indicators, and other indexes. Ingenito and Trehan then tested alternative combinations of variables in forecasting regressions, choosing only those that minimized the root mean square error, supported by Pindyck and Rubinfeld (1981). They ultimately relied on monthly employment and consumption data for their model. They found that including too many variables in an equation resulted in over-fitting and poor forecasting performance. The last statement is also recognized by other studies (e.g., Fildes, 1985; Klapper and Herwartz, 2000). Another well known use of the regression-based approach to predicting GDP growth comes from the use of Bureau of Labor Statistics series on aggregate hours of nonfarm production workers (Kitchen and Monaco, 2003). Among studies involving restaurants, Hua and Templeton (2010) devised a regression based econometric model to investigate growth drivers of the