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Modelling and forecasting brand share: A dynamic demand system approach☆

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Abstract

This paper proposes a dynamic state-space AIDS model of brand share. The model structure separates the transitory and permanent components of the data and offers several key advantages over conventional share modelling approaches. Firstly, it provides a general framework to examine the time series properties of brand share. Secondly, it provides an accurate assessment of the short-run effects of marketing mechanics. Thirdly, the extracted permanent component can be used in a separate auxiliary analysis of the long-run effects of marketing mechanics. The model is applied to a small segment of the toiletries category comprising four differentiated brands and covering over five years of quad-weekly time series data. The results demonstrate a significant improvement over the conventional AIDS model and indicate short-run competition on the basis of price and promotional activity. Long-run analysis, however, suggests that such activity exerts no sustainable impact on the share of competing brands. Out of sample forecasts are satisfactory and provide an improvement over both a standard dynamic AIDS and time-varying-parameter MNL model. Brand share forecasts, in conjunction with price and segment value forecasts, are then used to produce brand volume forecasts.

Keywords: Almost ideal demand system (AIDS); Kalman filter; Non-stationarity; Long-run effects; Co-integration

1. Introduction

One of the key features of imperfectly competitive markets is the presence of differentiated products that cater specifically for the heterogeneity of consumer tastes. Identifying substitution patterns between such products in response to changes in price and other marketing variables is central to an understanding and estimation of consumer demand. The varying parameter discrete choice Multi-Nomial Logit (MNL) model of McFadden (1973) represents a popular analytical framework for this purpose. However, owing to an assumption of independent and identically distributed (i.i.d) unobserved utilities or error terms, the basic MNL model embodies the Independence of Irrelevant Alternatives (IIA) prop-

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erty. This implies an unrealistic proportional pattern of substitution between competing products, driven solely by market share.

More flexible and realistic substitution patterns can be achieved in several ways. One approach is to allow tastes to vary either randomly or with respect to unobserved variables. This induces correlation between the error terms of each product and dispenses with the IIA feature such that substitution patterns are driven by similarities in characteristics rather than market share. Under these circumstances, however, the error terms are no longer i.i.d and the MNL model is a mis-specification of product demand. One solution to this problem is the generalised extreme-value model of McFadden (1978), which provides a structure that does cater for non-i.i.d error terms. Alternatively, there is the multivariate probit model demonstrated in the work of Jedidi, Mela, and Gupta (1999), or the more advanced approach of the mixed logit model illustrated by Berry (1994), Berry, Levinsohn, and Pakes (1995) and Nevo (2000).

An alternative method, which allows for both flexible substitution patterns and the heterogeneity of consumer tastes, is to assume that consumer preferences survive the aggregation process such that a representative consumer exists. This is the approach of the continuous choice Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980a). Many examples of the static AIDS exist and an application to the demand for differentiated goods can be found in Hausman, Leonard, and Zona (1994). Dynamic generalisations are also well documented and examples include inter alia Blanciforti and Green (1983) and Alessie and Kapteyn (1991). In this paper, we develop the static functional form of the AIDS to include additional marketing mechanics and provide an alternative dynamic generalisation based on state-space modelling techniques.

The proposed model improves on conventional dynamic econometric share models in three key ways. Firstly, the model structure explicitly separates the transitory and permanent components of each brand share. This allows a formal analysis of their time series properties that is statistically superior to the standard unit root tests generally employed in the literature (inter alia Dekimpe & Hanssens, 1995a; Mela, Gupta, & Lehmann, 1997). Secondly, the parameters of the marketing variables are directly interpretable as short-run demand effects: parameter estimates in standard short-run models formulated in first differences are not readily interpretable in this way (Hendry, 1995), whereas parameters based on short-run models using lagged dependent variables are biased. Finally, the extracted permanent components can be used to assess the long-run impact of marketing activity in a separate auxiliary model, providing an alternative methodology to existing approaches in the literature (inter alia Dekimpe & Hanssens, 1995a, 1999; Jedidi et al., 1999; Mela et al., 1997).

The paper is organised as follows. In Section 2, we present the static model. In Section 3, we discuss the dynamic generalisation and econometric methodologies. In Section 4, we present the data and estimation results. Results are split into statistical analysis, diagnostic checks of the model's data congruence, interpretation of the parameter estimates and an assessment of the long-run impact of price and promotions. In Section 5, we present brand share forecasts, together with a time series model for total segment spent. Together, these produce brand volume forecasts. Section 6 concludes with key learnings from the paper and avenues for future research.

2. The static model

Deaton and Muellbauer's Almost Ideal Demand System (AIDS) represents a good framework for analysing market level brand demand. Firstly, the model is derived from the theory of consumer choice, incorporating competitive interaction between differentiated brands and segment level income effects. Secondly, the structure is derived from the Price Independent Generalised Logarithmic preference class (Deaton & Muellbauer, 1980b), which allows exact aggregation over households.

The basic linearised AIDS model is written as:

$$s_{it} = \hat{\alpha}_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_{jt} + \beta_i \ln\left[\frac{w_t}{\tilde{p}_t}\right] + \varepsilon_{it} \quad (1)$$

where w_t=consumer expenditure on the segment at time t, p_{jt}=price of the jth brand at time t,