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Contents

Modeling Dynamic Relations Among Marketing and Performance Metrics

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ABSTRACT

Marketing and performance data often include measures repeated over time. Time-series models are uniquely suited to capture the time dependence of both a criterion variable and predictor variables, and how they relate to each other over time. The objective of this monograph is to give you a foundation in these models and to enable you to apply them to your own research domain of interest. To this end, we will discuss both the underlying perspectives and differences between alternative models, and the practical issues with testing, model choice, model estimation and interpretation common in empirical research. This combination of marketing phenomena and modeling philosophy sets this work apart from previous treatments on the broader topic of econometics and time series analysis in marketing.

1

Introduction

Marketing and performance data often include measures repeated (typically at equally spaced intervals) over time. Time-series models are uniquely suited to capture the time dependence of both a criterion variable (e.g. sales performance) and predictor variables (e.g. marketing actions, online consumer behavior metrics), and how they relate to each other over time. The objective of this monograph is to give you a foundation in these models and to enable you to apply them to your own research domain of interest. To this end, we will discuss both the underlying perspectives and differences between alternative models, and the practical issues with testing, model choice, model estimation and interpretation common in empirical research. This combination of marketing phenomena and modeling philosophy sets this work apart from previous treatments on the broader topic of econometics and time series analysis in marketing (e.g. Dekimpe and Hanssenss, Chapter 4 in Moorman and Lehmann, 2004; Hanssens *et al.*, 2001, Luo, Pauwels and Hanssens, Chapter 2 in Ganesan (2012)) to which we refer the reader for detailed reference.

Time series models on marketing and performance metrics come in different forms, and we distinguish between 'traditional' time series

Table 1.1: Comparing traditional and modern time series models of marketing and performance

Dynamic marketing phenomenon	**Traditional econometric model**	**Traditional time series**	**Modern econometric and time series**
Delayed response to Marketing action (Little, 1979)	Koyck + extensions: Fixed decay pattern Temporary effect	Impulse response simulation: Wear-in, wear-out from data Permanent effects possible	
Negative lagged effects such as post promotion dips (Blattberg and Neslin, 1990)	Requires additional modelling	Shows up as such in impulse response	
Customer holdover (Parsons, 1976; Leeflang *et al.*, 1992)	Add lags of performance	Unit root allows for (partial) hysteresis in performance	
Performance-marketing feedback (Dekimpe and Hanssens, 1999)	Partial adjustment		Granger Causality Marketing explained by past sales Vector error-correction
Competition and Intermediary Decision Rules (Pauwels, 2004)	Can be separately modeled, but only shown in their effect on company performance, not explained by its marketing, performance		May influence and be influenced by marketing, performance

models (the univariate and multivariate time series models popularized in the 1970s and 1980s) and the 'modern' time series models (the multiple time series models popularized in the last three decades). Table 1.1 compares how five key dynamic marketing phenomena are treated in traditional econometric models (column two), traditional time series models (column three) and modern econometric and time series analysis (column four).

The role of theory and data in time series models is important to clarify at this point. Because marketing (and economic) theory is

typically more informative on *which* variables affect each other than on the *timing* of these effects, time series models typically use theory to suggest the variables, but the data patterns themselves suggest the appropriate lags (or leads), the direction of causality and the presence of feedback loops. For instance, a company's paid search ad gets a higher click-through if it is placed higher on the consumer's screen, but the search engine also prefers to give these prime locations to companies that had higher-clicked ads in the past (marketing-performance feedback). A flexible, data-driven approach to causality and to lag structure allows researchers to separate short-term (temporary) from long-term (lasting) effects, to discover wear-in and wear-out of marketing impact, and to empirically demonstrate and quantify company, intermediary and competitive marketing decision rules. Its data-driven nature reflects Sims' (1980) philosophy that alternative models often have to place 'incredible' identifying restrictions on how key variables are allowed to behave and influence each other over time. If this holds true in economics, which typically assumes human rationality and often perfect information, marketing settings add several potential violations of these assumptions.

The structure of this monograph follows Table 1.1. First, we detail the analysis steps, interpretation and marketing insights from traditional time series models. We start with the univariate treatment of each separate marketing time series in evolution/stationarity tests and ARIMA models (Section 2). Next, we consider the over-time relation of multivariate time series in transfer functions and intervention analysis (Section 3). Next we turn to multi-equation models, which are the core workhorses of modern dynamic econometric and time series models of the dynamic relations among marketing and performance metrics (Section 4). In the concluding section, we discuss policy analysis based on modern time series models (responding to the Lucas Critique) and connect them to other time series developments.

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