



Interfaces with Other Disciplines

On modeling the advertising-operations interface under asymmetric competition

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ABSTRACT

Using a market share attraction structure of advertising competition and following a supermodular game approach, this article demonstrates for an asymmetric oligopoly, the directional impact of changes in model parameters on the marketing controlled variables of all rivals (advertising budgets) and the operations controlled variables of all rivals (ordered quantities). Importantly, the various changes are examined analytically, empirically and numerically in both non-dominated and dominated asymmetric oligopolies.

In this regard, the results indicate that firms in a dominated oligopoly (one firm of market share larger than or equal to 50%) behave differently compared to firms in a non-dominated oligopoly (each firm of market share less than 50%) in response to changes in model parameters. Furthermore, changes in model parameters are investigated in terms of their relative influential impact on a variety of equilibrium measures. In this regard, the findings indicate that for the analyzed model the marketing parameters exert much more influence on the equilibrium measures than the operations parameters.

Additionally, a change in the mode of competition from non-cooperation (oligopoly) to cooperation (joint ownership) dictates that strong asymmetric firms (of favorable marketing and operations parameters) continue advertising (but at lower levels) and weak asymmetric firms (of less favorable parameters) cease advertising altogether.

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1. Introduction

An important component in present-day modeling of marketing-mix effects is the accommodation of asymmetries in competition (Leeflang, Wittink, Wedel, & Neart, 2000, p. 286). The literature attributes unequal competition between brands in a product category to preference heterogeneity (Blattberg & Wisniewski, 1989), income effect (Allenby & Rossi, 1991), loss aversion (Hardie, Johnson, & Fader, 1993), or dominance effects (Heath et al., 2000). An assessment of alternative theories of asymmetry leads Neslin (2002, Chap. 13, p. 314) to conclude that *market share* is the key factor. Thus in today's environment, the question is *how*, not *whether*, asymmetry in competition should be accommodated (Leeflang et al., 2000, p. 287). Because change is the only constant in today's market environment, it is advantageous for a vigilant competitor to ascertain how to adapt its strategy in response to changes in the market to maintain or enhance its position (Mesak, 2003, p. 1792; Coughlan et al., 2010, p. 321).

Cross-functional interface encompasses the organizational structures, tactics and policies adopted by firms to manage the information flow, the conflicts and the mutual objectives between two distinct functional areas (Moenaert & Souder, 1996). Marketing and operations as functional areas represent the key value adding areas of the modern business enterprise. It is these areas that are influential in specifying what is produced, how it is produced and actually delivering goods and services to customers. Manifest interfunctional conflict (defined by Barclay 1991 as the degree to which managers in one functional group behave in a way that frustrates another functional group) between marketing and operations is common. Marketing often assumes that production can be increased (or decreased) instantly and, in turn, tends to provide imprecise forecasts and promise short lead times. But the production schedule, once made, can be significantly inflexible. Notable examples are provided below.

In early 1990, the Gillette Company (the dominant competitor in the Blades and Razors for Men category) spent millions of dollars advertising its new Sensor razor. The company underestimated the effect of its huge advertising launch, which resulted in poor volume forecasting. Retailers, faced with customers seeking the product,

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were unable to satisfy all of the demand. Furthermore, when customers they did find the product, they were subsequently unable to find replacement blades (Crittenden, Gardiner, & Stam, 1993). More recently, the Nintendo Wii was still hard to find almost a year after it was launched in 2006 since marketing failed to forecast such high demand. While operations attempted to triple the North American workforce and almost double the worldwide workforce to meet demand, marketing continued to advertise while the product remained in scarce supply – thus further exasperating the supply–demand imbalance.

Nintendo Wii continued to be in fierce competition with its two main competitors in the non-dominated video-game consoles category: Microsoft's Xbox and Sony's Play Station (Rusetski, 2012). The conflict between marketing and operations has been discussed in the literature in detail (Piercy, 2007; Shapiro, 1977) and how to reduce the conflict has been also addressed (Artz, Homberg, & Rajab, 2012; Omurgonulsen & Surucu, 2008; Piercy, 2010).

Since the publication of the pioneering article of Whitin (1955), several researchers developed different forms of operations–marketing interface models with the objective of integrating both functions. Eliashberg and Steinberg (1993, Chap. 18), Parente (1998), Yano and Gilbert (2004, Chap. 3), Chan, Shen, Simchi-Levi, and Swann (2004) and more recently Tang (2010) and Martinez-Costa, Mos-Machuca, and Lusa, 2013 provide lucid reviews of the literature on the subject. While several analytical models integrating the operations and the pricing and/or product assortment (product variety) in a competitive market have been published, published research integrating the operations and the advertising functions in a competitive market for which analytical findings supported by the empirical and numerical evidence are scarce.

According to the *Statistical Abstract of the United States* (2012), aggregate advertising expenditures in the U.S. has grown to \$170 billion dollars in 2010 whereas according to an *US Census Bureau* (2011) report, American 2010 year-end total manufacturing inventories were worth \$534 billion dollars. Given that individual business enterprises commit significant resources on advertising and inventory, investigating better ways of investing such large sums of money would undoubtedly be fruitful.

Our investigation focuses on the development of a competitive inventory model with advertising-dependent demand. Asymmetry is accommodated by using a market share attraction model of advertising competition (Cooper & Nakanishi, 1988). The present study has three main objectives. The first objective is to investigate analytically how a firm would adapt an optimum advertising expenditure and optimum ordered quantity in response to changes in any of its own parameters, rival parameters, or the parameters that are common to all firms in an asymmetric oligopolistic market. The second objective attempts to answer a research question that has not been fully addressed before. In a dominated asymmetric oligopolistic market (where market share of one firm is larger than or equal to 50%), should rivals adjust their advertising expenditures and ordered quantities in a manner consistent or inconsistent with a non-dominated asymmetric oligopoly (where every market share is less than 50%)? The third objective is to examine the effect of the interaction between the mode of cooperation and asymmetry on the advertising policy of a given firm. A related literature review and the main contributions of the study are highlighted next.

1.1. Literature review

Operations managers are often evaluated on cost performance while marketing managers are often rewarded based on revenues. However, actions that minimize costs or maximize revenue may not optimize profit. There is a stream of the literature that explicitly models the interactions between these two areas in order to maximize the profitability of a firm. Our research is part of this stream.

To meet customer demand, firms face conflicting pressure to keep inventories low enough to reduce the holding cost but high enough to reduce ordering and setup costs with the objective of minimizing the total cost of inventory (Stevenson, 2008). This is accomplished by determining the right quantity to be ordered. Several models are used for this purpose of which the economic order quantity (EOQ) model, along with its different variations have been studied intensively assuming a constant demand rate which is determined exogenously (Buzacott, 1975; Chandra & Bahner, 1985; Chung, 1989; Moon & Lee, 2000).

Whitin (1955) was the first to integrate purchasing and marketing decisions by incorporating the effect of price on demand within the inventory model where the retailer has to decide both the price and order quantity optimally. This article triggered much research with the objective of integrating price-dependent demand with inventory models or ordering policies (Abad, 1988; Arcelus, Shah, & Srinivasan, 2003; Lee, 1993; Ray, Gerchak, & Jewkes, 2005; Viswanathan & Wang, 2003). Additionally, the price-dependent demand model was extended by another stream of research to integrate the inventory model with advertising dependent demand (Freeland, 1980; Khouja & Robbins, 2003; Sana & Chaudhuri, 2008; Subramanyam & Kumaraswamy, 1981; Urban, 1992).

The research mentioned above strictly considers a single firm, and therefore, competition was beyond their scope. Yet, a few studies within a static (time-independent) framework do focus on advertising competition within a duopoly/oligopoly (Friedman, 1958; Gupta & Krishnan, 1967; Mesak, 2003; Mesak & Calloway, 1995, 1999; Mills, 1961). The above studies, however, do not consider inventory related costs in the modeling effort. (This literature review does not incorporate supply chain management models as such models are not relevant to the scope and purposes of the present research. While supply chain management models examine vertical integration among channel members representing different organizations, the present research primarily considers horizontal integration among members within the same firm. Readers interested in supply chain management models may refer to Aust & Buscher (2014) for a recent review).

While the above stated studies are primarily analytical in nature, some research provides empirical evidence related to the benefits of integrating marketing and operations. Notable examples include, but not limited to, Hausman, Montgomery, and Roth (2002), Sawhney and Piper (2002) and Kulp, Lee, and Ofek (2004). These studies use survey data.

1.2. Contributions

The closest studies to the present research are Mesak (2003) and Min and Chen (1995). Mesak (2003), who has not explicitly considered inventory costs, employs a Nash equilibrium solution concept in conjunction with a market share attraction model for which the attraction function of a competitor depends upon its own advertising effort. In turn, similar to this study, Min and Chen (1995) who have not explicitly considered advertising, each firm aims at maximizing its profit in a situation for which all the assumptions of a traditional EOQ model hold. In contrast to Mesak (2003) and Min and Chen (1995) who only analyze symmetric competition, the present study is broader in scope as it analyzes asymmetric competition for which symmetric rivalry is a special case. The main contributions of the present study are highlighted below.

- (1) Using 'supermodular games approach', considered as a novel application in the marketing–operations interface literature, this research derives a sensitivity analysis (comparative statics) related to an asymmetric competitive inventory model with advertising-dependent demand in an integrated

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