Literature survey: Mathematical models in the analysis of durable goods with emphasis on information systems and operations management issues

Ravi Mantena, Vera Tilson *, Xiaobo Zheng

William E. Simon Graduate School of Business Administration, University of Rochester, Rochester, NY 14627, USA

A R T I C L E   I N F O

Available online 25 January 2012

Keywords:
Durable goods
Literature survey

A B S T R A C T

Durable goods account for a significant portion of the economy and have been of considerable interest to academic researchers, especially economists, over the last four decades. Given the importance of strategic issues concerning durable goods markets to IS and OM researchers, our objective is to present a broad perspective of the research in this field that can serve as a starting point for their modeling efforts when analyzing these markets. Due to the complexity of these markets and the strategic interlinkage of decisions over time, a careful examination of the models is essential for the proper understanding and interpretation of the results from the literature. This paper provides a macro perspective of the research problems, a simple integrative framework for modeling durable goods, an introduction to the models and solution concepts commonly used in the literature, and a discussion of the primary results in the context of their modeling choices. Potentially interesting directions for future IS and OM research in this area are also identified.

1. Introduction

Many physical and information goods are not consumed during use, but rather endure to be used repeatedly over an extended period (e.g., cars, aircraft, consumer electronics, and software). These durable goods are often big-ticket items, requiring considerable investment from both consumers and producers. They constitute a significant part of the economy, with annual consumer expenditures exceeding $1 trillion. Therefore, understanding the functioning of markets for these goods and the incentives and actions of players in related industries is important to managers, regulators, and consumers. Not surprisingly, these markets have been studied extensively by economists over the last four decades. However, it is only recently that Information Systems and Operations Management researchers have really started paying attention to the durability of goods, the strategic behavior of consumers, and the resulting effects on strategic issues of interest to OM and IS. This is partly due to the complex, multifaceted nature of the modeling and analysis of these markets, which addresses consumers, value chains, and regulators, in addition to the producers and the products themselves. Existing literature uses differing modeling assumptions, arriving at a variety of findings, sometimes seemingly contradictory. As the authors can attest from personal experience, this imposes a relatively large starting cost on those trying to understand this literature sufficiently to make, or evaluate, contributions to it.

Our primary goal in this paper is to provide an efficient entry point for IS and OM scholars wishing to do analytical research on durable goods. The “big-picture” is presented in the form of an influence diagram and a modeling framework that together explain how the different pieces are connected, and where a particular paper or research question fits. The presentation of the major themes and the various analytical approaches taken, along with an explication of sometimes seemingly contradictory results, should aid researchers new to durable goods to “hit the ground running.” We also present a concise, yet thorough, discussion of the major themes and approaches of particular interest to IS and OM researchers. We encourage scholars intending to do research on durable goods to read the entire paper. Those seeking a quick overview, say to review a paper on a related topic, can skip Sections 4 and 5 which discuss modeling and focus on Sections 6 and 7, which discuss the key strategic issues.

Durable goods raise many vital strategic questions for sellers, consumers, and regulators. The first set of questions relates to issues of pricing and timing: How does durability affect a seller’s pricing? Our primary goal in this paper is to provide an efficient entry point for IS and OM scholars wishing to do analytical research on durable goods. The “big-picture” is presented in the form of an influence diagram and a modeling framework that together explain how the different pieces are connected, and where a particular paper or research question fits. The presentation of the major themes and the various analytical approaches taken, along with an explication of sometimes seemingly contradictory results, should aid researchers new to durable goods to “hit the ground running.” We also present a concise, yet thorough, discussion of the major themes and approaches of particular interest to IS and OM researchers. We encourage scholars intending to do research on durable goods to read the entire paper. Those seeking a quick overview, say to review a paper on a related topic, can skip Sections 4 and 5 which discuss modeling and focus on Sections 6 and 7, which discuss the key strategic issues.

We start by presenting an influence diagram (Howard and Matheson [42]) that provides a high-level perspective of the decision

---

* Corresponding author at: William E. Simon Graduate School of Business Administration, University of Rochester, Rochester, NY 14627, USA. Tel.: +1 585 2757956.
E-mail address: vera.tilson@simon.rochester.edu (V. Tilson).

0167-9236/$ – see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.dss.2012.01.012
problems that durable goods producers face (Fig. 1). These decisions are explored in detail in the rest of the paper. What the diagram makes particularly clear is that, in modeling demand, durable goods papers consider the influence of multiple factors. While we have depicted the most common assumptions about which variables are strategic (in boxes) and which ones are exogenous (in triangles), clearly other variations are possible. For example, the evolution of service quality could be a decision made by the manufacturer through his choice of durability.

While influence diagrams are useful for representing the key variables and their inter-relationships, they are poor at representing the dynamics of the problem. However, dynamic aspects are very important in modeling durable goods, since the temporal profile of the value provided to consumers and producers’ decisions over time are interlinked. Nevertheless, Fig. 1 is a valuable tool for conceptualizing the set of relationships explored in a particular paper and identifying the assumptions made, explicitly or otherwise, about other potential variables. Thus it provides a framework for understanding the findings across different streams of literature and for coping with the seeming contradictions among them.

While researchers from a variety of disciplines are interested in durable goods, the kinds of questions they ask, and, to some extent, the analytical approaches they take, are quite different. Economists, who have done much of the seminal work in the area, are primarily concerned with descriptive models that explain observed market outcomes and with questions of economic efficiency. Economic efficiency, or social optimality, means that the overall welfare, as measured by the sum of the producer’s profit and the consumer’s surplus, is maximized. OM researchers focus largely on normative models relating to producers’ decisions on production, capacity, inventory, and supply chains. New product introductions and the effect of digitalization to manufacturers’ decisions on production, capacity, inventory, and supply chains.

Table 1—Primary research issues, pointers to sections, and key references

<table>
<thead>
<tr>
<th>Research Issues</th>
<th>Sections in the paper</th>
<th>Models in the paper</th>
<th>Key references</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time inconsistency</td>
<td>2</td>
<td>3,2, 3,3</td>
<td>[4,12,13,16,17,24,26,28,29,45,47,54,63,68]</td>
</tr>
<tr>
<td>Pricing</td>
<td>6.1</td>
<td>3.3</td>
<td>[8,29,31,45,46,57,68]</td>
</tr>
<tr>
<td>Choice of production</td>
<td>6.2</td>
<td>3.3</td>
<td>[47]</td>
</tr>
<tr>
<td>technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Durability, planned</td>
<td>6.3</td>
<td>3.1, 3.3, 4.1, 4.3</td>
<td>[1,17,21,22,30,34,35,48,49,52,65,66,70,72,75]</td>
</tr>
<tr>
<td>obsolescence, and upgrading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leasing versus selling</td>
<td>7.1</td>
<td>3.2, 3.3, 5.1, 5.2</td>
<td>[9,11,12,15,16,25,32,41,43,44,46,73,74,78]</td>
</tr>
<tr>
<td>Complementary goods</td>
<td>7.2</td>
<td>4.2, 4.4, 5.1, 5.2</td>
<td>[9,19,20,38,66,70]</td>
</tr>
<tr>
<td>markets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary markets</td>
<td>7.3</td>
<td>5.1, 5.2</td>
<td>[2,3,36,60,77]</td>
</tr>
<tr>
<td>Channel design</td>
<td>7.4</td>
<td>5.1, 5.2</td>
<td>[4,10,26,62,63,71]</td>
</tr>
</tbody>
</table>

1 There are about 7500 journal articles in JSTOR related to durable goods. A similar search on ProQuest found more than 5200 journal articles.
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات