Evaluation Set Size and Purchase: Evidence from a Product Search Engine ☆

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Abstract

The last decade has seen a dramatic increase in the popularity of product search engines, yet the analysis of consumer behavior at such sites remains a challenging research problem despite its timeliness and importance. In this article, we develop and estimate a copula model of evaluation set size and purchase behavior employing data from 3,182 hotel searches by customers at a large travel search engine. The model allows us to jointly study purchase behavior, evaluation sets, and their antecedents. Our results reveal that evaluation set size and purchase are negatively correlated and that factors typically presumed to be associated with purchase—i.e., when users sort search results by price or quality, request many rooms, disclose that there are many guests in their party, or arrive from other search engines and/or partner sites—actually relate to larger evaluation sets but lower purchase probability. In contrast, when users filter the search results, we observe smaller evaluation sets and higher purchase probability. The theoretical background and practical implications of our findings suggest that efforts to increase purchases need not necessarily be predicated on cultivating larger evaluation sets.
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Introduction

Product search engines such as Amazon, Angie's List, CNET, EBay, or Travelocity, offer access to information on a large number of products and services and cater to customers with various characteristics and experience. To facilitate product evaluation and purchase, search results can typically be manipulated by sorting and filtering on characteristics such as brand, price, or quality. The number of options actually evaluated by a customer—the evaluation set size (ESS)—and whether a purchase is made are key components in the interaction between consumers and the product search engine. However, in

spite of the widespread use of product search engines, there is little empirical evidence on customer behavior at such sites, including how past experience, filtering and sorting tools, referring site, volume of search results, or user characteristics such as usage magnitude (# of rooms, # of guests, # of nights) or time to consumption, influence ESS and purchase probability.

Consequently, our investigation centers on the following main research questions: What are the antecedents of ESS? What are the drivers of purchase decisions in product search engines? And, what is the relationship between ESS and purchase? The evaluation set is analogous to the consideration set in marketing, which in prior studies employing supermarket scanner data has remained unobserved and has subsequently been imputed and considered exogenous to purchase (e.g., Andrews and Srinivasan 1995; Mehta, Rajiv, and Srinivasan 2003; Siddarth, Bucklin, and Morrison 1995). In contrast, as a result of a customer's interaction with the search engine, in our context the evaluation

set is observed, enabling the investigation of its antecedents, and the relationship between ESS and purchase. Survey-based studies in which the consideration set is stated (Hauser and Wernerfelt 1990; Roberts and Lattin 1991), have considered the composition of this set but not its size. However, there are important reasons to focus on ESS. On the one hand, larger evaluation sets can enhance customers' involvement, knowledge, and confidence with a particular purchase. On the other hand, larger sets may deter purchase due to information processing costs. Hence, understanding the net effect is an empirical question of high relevance. These issues are particularly important for product search engine managers, who care about how purchases in general can be facilitated, in contrast to the more narrow goals of product managers, whose focus is on how purchases of a specific product can be facilitated. To address these questions, we study data on Budapest hotel searches by 3,182 customers on a large travel website. Here ESS corresponds to the number of hotel links a consumer clicked on, where after each click detailed information about that option was revealed, e.g., price, amenities, and geographical location.

The empirical analysis of such data can proceed by either structural or reduced-form modeling, each having its advantages and drawbacks. Structural models take an explicit stand on the process by which interactions are structured and data are generated, e.g., how (sets of) alternatives are evaluated, how purchase decisions are reached, whether choices are sequential or simultaneous, and so on. For example, Moe (2006) has successfully employed a structural two-stage model to show that product attributes of nutritional products, such as price and size, employed in the evaluation stage, are different from the ingredient attributes employed in the purchase stage. However, a structural model can be particularly challenging to formulate in the absence of sufficient a priori theory, in the presence of conflicting theories, or if the imposition of a realistic structure (e.g., flexible correlations) could make identification tenuous or estimation prohibitively difficult, especially when a plethora of available alternatives exist and the majority of customers do not purchase, as is common at product search engines. In contrast, reduced form models are more robust to theoretical conflicts, can be specified more parsimoniously, and can still be informative about the role of key covariates or the interactions among multiple outcomes. Consequently, we design a reduced form model to help investigate the antecedents of ESS, link ESS and purchase probability, and deal with a setting where there are few purchases relative to the number of shoppers.

Our econometric strategy is to start with two simple marginal models—one for ESS and the other for purchase—and then employ a copula to couple them into a joint model for the two outcomes. The first component entering the copula is a negative binomial model for ESS, which is a count variable. The specification involves the antecedents of ESS, i.e., past experience with the site, the referring site (where customers arrive from), the use of search tools (e.g., sorting or filtering), the volume of the corresponding search results, and user characteristics such as usage magnitude (# of rooms, # of guests) and time to consumption (the number of days the user's search precedes their planned travel). The second component entering the copula is a

probit model for purchase, with the complication, however, that the binary purchase decision is unavailable for individuals whose evaluation sets are empty. Unobserved factors and individual heterogeneity can simultaneously affect both of the equations in the model, leading to correlation between the count and binary outcomes. Therefore, we focus on joint modeling and simultaneous estimation that allows for interactions and flexibility, and formally accounts for non-randomly missing outcomes. The econometric methodology also allows us to address model uncertainty and compare relevant competing specifications.

Our study reveals three main results. First, ESS depends positively on past experience with product category searches on the site, arrival from another search engine or partner site, use of sorting tools, volume of search results on browsed pages, and usage magnitude (# of rooms, # of guests). Second, ESS depends negatively on the use of filtering tools, volume of search results, and average price of search results. Third, there is a significant negative correlation between ESS and purchase, whereby smaller evaluation sets are associated with higher purchase probability. Purchase is also found to depend on the average quality of all options included in the search results. The results link increases in ESS and decreases in purchases to price- and quality-based sorting strategies, while brand-name and other filtering strategies are related to reductions in ESS and increases in purchases. Arrival from other search engines and partner sites, as well as usage magnitude (# of rooms, # of guests), both presumed to promote purchase, are associated with larger ESS and lower purchase probability.

Our work offers theoretical, methodological, and managerial contributions. The paper advances a conceptual framework on the antecedents of ESS and purchase and presents expectations based on economic search and behavioral information-processing theories, which are then confronted with evidence from the data. To deal with the estimation challenges in this setting, we employ methodology that is tailored to the data. A key commonality in the product search engine context is that very few purchases are present relative to the number of evaluated alternatives. This makes the estimation of saturated single-equation reduced-form models for purchase infeasible; instead, identification issues can be handled by carefully combining a richer model for the data on products evaluated with a parsimonious model for purchase, thereby leveraging inference in the joint model. In addition, there are very few evaluated alternatives relative to the number of available alternatives, which together with other data limitations, makes the estimation of multinomial choice models or models with sophisticated parameter heterogeneity across customers impractical. On the managerial side, our results suggest that executives' efforts to increase purchases need not necessarily be coupled with efforts to increase ESS, and that this task can be better accomplished by promoting filtering, presenting search results in ways that focus attention to only a few options at a time, or providing more higher-priced (rather than lower-priced) options, particularly to low-usage (in terms of # of rooms, # of guests) users. Our conclusions section revisits the results for the antecedent variables and presents a number of managerial implications.