



Uncovering Patterns of Product Co-consideration: A Case Study of Online Vehicle Price Quote Request Data[☆]

Sina Damangir^{a,*} & Rex Yuxing Du^b & Ye Hu^b

^a College of Business, San Francisco State University, San Francisco, CA 94132, United States

^b Bauer College of Business, University of Houston, Houston, TX 77204, United States

Abstract

Consumers often consider multiple alternatives from the same product category prior to making a purchase. Uncovering the predominant patterns of such co-considerations can help businesses learn more about the competitive structure of the market in the mind of the consumer. Extant research has shown that various types of online and offline consumer activity data (e.g., shopping baskets, search and browsing histories, social media mentions) can be used to infer product co-considerations. In this paper, we study a case of uncovering co-consideration patterns using a massive dataset of online price quote requests from U.S. auto shoppers. The main challenge we face is that, for privacy protection, no unique individual identifier (anonymous or otherwise) is contained in the data. Such a data deficiency prevents us from using existing methods such as affinity analysis for inferring co-considerations. However, by leveraging spatiotemporal patterns in the data, we manage to probabilistically uncover the predominant patterns of co-considerations in the U.S. auto market. As a validation and illustration of its usefulness, we embed the inferred market structure in a sales response model and show a substantial improvement in predictive performance.

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Keywords: Big Data; Market structure analysis; Automotive industry; Sales response models; Privacy

Motivation

Consumers often consider multiple alternatives from the same product category prior to making a purchase. Uncovering the predominant patterns of such co-considerations can help businesses learn more about the competitive structure of the market as perceived by the consumer, which in turn can help managers make decisions such as product design (Bloch 1995), pricing (Choi 1991), and store layout (Brijs et al. 2004). However, it can be cost prohibitive to gather consumer self-reports on co-considerations at a large scale and on a regular basis. Extant research has shown that product co-considerations can be inferred from various types of

online and offline consumer activity data, where an individual consumer's activities regarding multiple competing alternatives can be tied together via a unique individual identifier, e.g., frequent shopper card numbers, phone numbers, credit card numbers, mail addresses, email addresses, and Internet Protocol addresses. Examples of such applications include the use of shopping basket/retail panel data (Lattin and McAlister 1985), Internet browsing history data (Park and Fader 2004), credit card transaction records, and mobile device log (Chen, Chiang, and Storey 2012).

Affinity analysis, a class of techniques using the co-occurrences of events to uncover meaningful associations between them, is one of the methods commonly used to take advantage of such consumer activity data. By design, affinity analysis requires unique individual identifiers in order to establish co-occurrences. For example, a retailer can use the fact that a significant number of customers buy shampoo and conditioner in the same shopping basket to infer that these two products are close complements.

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* Corresponding author.

E-mail addresses: damangir@sfsu.edu (S. Damangir), rexdu@bauer.uh.edu (R.Y. Du), yehu@uh.edu (Y. Hu).

Similarly, by tracking browsing and searching records of individual visitors, an e-commerce website can figure out which products are frequently considered together by the same individual and infer the intensity of competition between products (Ringel and Skiera 2016).

In this research, we conduct a case study to infer product co-consideration from a massive dataset of online price quote requests (OPQRs) made by U.S. auto shoppers. By providing an unobstructed view of the U.S. auto shoppers at the late stages of the purchase funnel, the OPQR data provides an excellent opportunity to study the consideration sets of U.S. auto shoppers. Despite its richness, due to privacy concerns, the OPQR data has a “deficiency”: it does not contain any unique individual identifiers, which precludes the application of affinity analysis. In this paper, we demonstrate that by leveraging spatiotemporal patterns in OPQR data, which is aggregated to five-minute level by vehicle and Zip code, we can overcome this data “deficiency” and uncover the predominant patterns of co-considerations in the U.S. auto market. As a validation and illustration of its usefulness, we embed the inferred market structure in a sales response model and show a substantial improvement in predictive performance.

More specifically, the price quote request data used in our study are gathered through a popular service offered by most of the major automotive shopping websites in the U.S. Fig. 1 shows the user interface of this service at the Kelley Blue Book website. Visitors to the site who are interested in requesting an online price quote from a local dealer can do so by selecting the brand (or “make” in auto industry lingo, e.g., Chevrolet) and

model (e.g., Malibu), entering the Zip code, and clicking on the “get your quote” button (see highlighted rectangular area in Fig. 1). After clicking on the “get your quote” button, the visitor would be asked to provide his/her email address in order to receive a price quote from a local dealer. Autometrics (www.autometrics.com), a startup “Big Data” company, has entered agreements with most of the major automotive shopping websites in the U.S. to receive a record every time a visitor to a site selects a brand and model, enters a Zip code and clicks on the “get your quote” button. Each record contains four pieces of information: the time stamp, the brand, the model, and the Zip code associated with each OPQR. Every year Autometrics receives about 200 million such records.

Collecting and sharing individual level data on online activities poses serious security and privacy concerns, especially when it is done at a massive scale (de Montjoye et al. 2015). Due to such concerns, Autometrics has no access to any information identifying individual website visitors (e.g., the email address provided by a site visitor is not shared with Autometrics). In other words, from the records received by Autometrics, one can tell when and where a car shopper is interested in getting a price quote for which vehicle. However, because there is no unique individual identifier in Autometrics’ data, one cannot tie multiple OPQRs to any individual car shopper, even though the same shopper may send in multiple OPQRs as she compares alternative vehicles in her consideration set.

The kind of online consumer activity data gathered by Autometrics is obviously less informative than the raw records

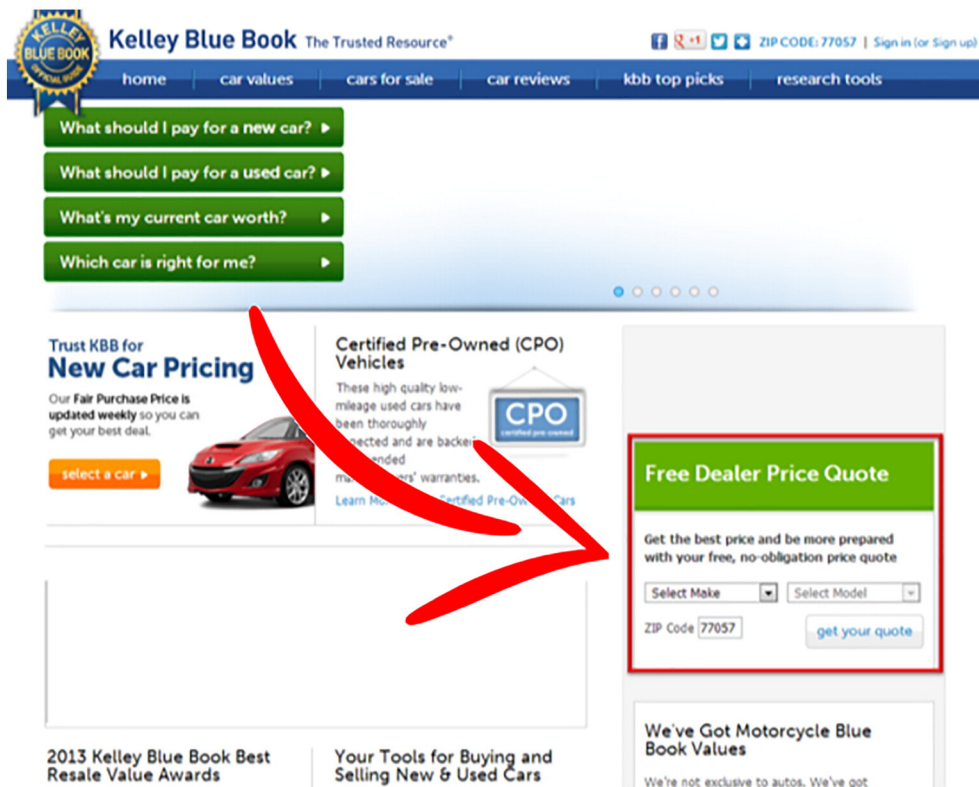


Fig. 1. Screenshot of a typical interface for submitting an online price quote request. (For interpretation of the references to color in this figure, the reader is referred to the web version of this article.)

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