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Predicting consumer variety-seeking through weather data analytics

Jing Tian, Yicheng Zhang*, Cheng Zhang

School of Management, Fudan University, Shanghai 200433, China



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ABSTRACT

Marketing decision support systems (MDSS) incorporate both internal and external data in performing analytics to improve business effectiveness. Weather data have long been considered a crucial external data input in practitioners' marketing strategy; however, academic research on how weather conditions affect consumer behaviors has been limited. To fill this gap, this research investigates how weather parameters, including sunlight, temperature, and air quality, can be incorporated into MDSS to predict consumers' variety-seeking in their purchases using public weather data and supermarket panel data for five typical retail products. Our analyses show that weather conditions are associated with greater variety-seeking behavior. The results afford insights into how to exploit weather data for data analytics and employ weather targeting strategies to save promotional expenses and increase profitability.

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1. Introduction

Data analytics are critical to business value creation because they improve the effectiveness of customer segmentation and targeted marketing (Olson and Chae, 2012). Based on various data techniques and models, *marketing decision support systems* (MDSS) are designed to improve the quality and timeliness of marketing decisions (Cassie, 1997; March and Hevner, 2007). As the marketing environment becomes more competitive, marketing problems have become more complex and are characterized by both consumer behavioral factors and uncertainties in the environment (Cassie, 1997). Therefore, integrating both internal and external data sources in data analytics and marketing decision support is an important direction to meet changing consumers' demands (March and Hevner, 2007).

Weather conditions constitute an important external factor and may profoundly affect people's daily life (Anderson, 1989). Armed with recent data analytics techniques, practitioners have attempted to incorporate this factor in their marketing strategies. Walmart, the world's largest retailer, has been using weather data in their marketing decisions for years and acting on the correlations between weather and store sales for store-level merchandising and hyper-local digital advertising. For instance, it has been discovered that ideal weather to sell berries appears to be low wind with temperatures below 80F degrees. Based on this,

Walmart has served up merchandising displays and digital ads for berries in zipcodes where such weather exists, which has resulted in tripling berry sales. However, the rationale behind why such weather effects work often remains a black box. Mr. Stephen Quinn, the U.S. Chief Marketing Officer of Walmart, said, "We didn't know, for example, that when it's low wind, that has some impact on whether or not people will eat berries" (Neff, 2014).

Compared to burgeoning industry practices of utilizing weather conditions in marketing decisions, academic studies on how and why weather conditions affect consumer behaviors are limited, particularly with regard to consumer variety-seeking behavior, which is a pervasive phenomenon in many markets (Kahn, 1995; Seetharaman and Che, 2009). *Variety-seeking* refers to an individual's tendency to seek diversity in their choices of products or services, such as trying different or multiple brands (Kahn, 1995; McAlister and Pessemier, 1982). For example, consumers go to different restaurants from one dining occasion to the next, choose different vacation spots for holidays, or buy different brands of cereals on different purchasing trips at the grocery store. Marketing based on consumers' variety-seeking behavior deserves more attention today, given the increasingly intense competitions among brands in a product market and accelerated product updates. For retailers, the variety-seeking tendency of consumers can be leveraged to increase sales by incorporating new brands or products into their product offerings. For brands, they need to introduce new variety into their product or service mixes from time to time to prevent their consumers from switching to other brands; they may also try to poach their competitors' customers who seek variety in their purchase-making.

* Corresponding author.

E-mail address: yichengzhang14@fudan.edu.cn (Y. Zhang).

As a key issue in marketing, variety-seeking behavior seems to be influenced by external situations, such as retailer store environment, price, online reviews and social environment (Chuang et al., 2008; Lin and Lin, 2012; Lin and Lin, 2009; Menon and Kahn, 2015; Wang and Goh, 2012). Based on theoretical arguments, we believe that weather conditions, as salient and pervasive external environmental factors, may have an effect on consumer variety-seeking behavior. The investigation of such effects may contribute novel and valuable insights for MDSS as a result. Specifically, by quantifying the effects of weather on consumers' variety-seeking behavior, retailers can better manage their demand, forecast fluctuation of sales revenue, and decide promotion timing. Our study examines public weather data and internal retailing data of a large supermarket chain to achieve this objective.

Prior studies have indicated that weather affects people's mood states, trading decisions and social behavior (Denissen et al., 2008; Hirshleifer and Shumway, 2003; Larrick et al., 2011). A few recent studies further suggest that weather may also affect people's shopping activities, such as car purchases and responses to promotion (Busse et al. 2015; Li et al., 2017). (See Table A1 in Appendix for a literature review.) Yet, the influence of weather on consumer variety-seeking, which is an important consumer behavior, remains unclear and untested, despite the potential relationships between the two. In this study, we theoretically assess why and how weather conditions may influence consumers' variety-seeking. We then test our hypotheses based on the integration of supermarket panel data and public weather data. We obtained the supermarket panel data through collaborating with a large chain store in China. Weather data were collected online. Based on the analysis of transaction records of five typical retail products, we show that consumers are more likely to seek variety under weather conditions accompanied with less sunlight, higher temperature, or worse air quality. These results are in accordance with our research hypotheses.

Our research contributes to research and practice in several ways. First, we extend prior variety-seeking literature that has focused on intrapersonal motives, in-store environment, price promotion, purchase timing, and products characteristics (Ha and Jang, 2013; Kahn and Raju, 1991; Mohan et al., 2013; Menon and Kahn, 2015; Shukla, 2009; Simonson, 1990) by highlighting the effect of weather. To the best of our knowledge, this is the first study to theoretically develop and empirically examine their relationships. Second, we contribute to big data research by illustrating the potential value of combining consumer behavior and big data to help tease out the subtle weather effects that are hard to detect with small samples. The findings could serve as a demonstration of how data analytics cutting across different areas can afford interesting and valuable insights. Third, such relationships are useful for retailers and brands to increase their sales and can be incorporated into MDSS to automate marketing decisions (e.g., providing product promotions) based on real-time weather conditions. Our findings of the relationship between weather and consumers' variety-seeking can be readily applied in practice.

2. Conceptual background

We first review the previous literature on consumer variety-seeking to obtain a better understanding of this behavior. We then discuss the Mehrabian-Russell model, which serves as an overarching framework to understand how weather conditions may affect consumer variety-seeking behavior.

2.1. Variety-seeking behavior

Variety-seeking has been a major focus of interest in the marketing, psychology, consumer behavior and microeconomics liter-

ature (Givon, 1984; Kahn, 1995; McAlister and Pessemier, 1982; Sajeesh and Raju, 2010; Seetharaman and Che, 2009; Wang and Goh, 2012). Generally, variety-seeking refers to an individual's tendency to seek diversity in their choices of products or services such as trying different or multiple brands (Kahn, 1995; McAlister and Pessemier, 1982). Rooted in existing studies, we accordingly define *consumer variety-seeking* in our supermarket context as their behavior for choosing different brands over a sequence of purchase transactions.

Prior research considers variety-seeking as a purchase behavior associated with feelings and psychosocial motivations, rather than cognitive process and functional benefits, and as an example of low-effort decision-making (Baumgartner, 2002; Van Trijp et al., 1996). Satiation and stimulation, external situations, and future preference uncertainty have been identified as the major factors that influence consumers' variety-seeking behavior (Kahn, 1995; McAlister and Pessemier, 1982; Simonson, 1990; Sajeesh and Raju, 2010). Among them, satiation and stimulation are related to intrapersonal motives and may cause variety-seeking behavior directly (Kahn, 1995; McAlister and Pessemier, 1982). In situations of satiation, researchers have proposed that once consumers consume an optimal level of a product's attributes, they may experience satiation, and thus will be less likely to choose the same product or brand on the next occasion. Stimulation concerns situations where consumers alternate between familiar products and new products to satisfy their internal need for stimulation. Both internal motives may be precipitated by external situations, although the main driver of variety-seeking is still intrapersonal.

Existing studies suggest that changes in consumers' mood state and their frequency or intensity of product decision can both alter the internal motives and influence their variety-seeking tendency (Kahn, 1995). Moreover, variety-seeking has also been shown to occur if the external environment changes, owing to consumers' responses to these changes (Kahn, 1995). External situations may result in variety-seeking through exerting cognitive or affective influences on consumers. For instance, external situations may result in mood state swings and alter consumers' internal need for stimulation, which acts as a direct variety-seeking driver. Also variety-seeking due to consumer preference uncertainty typically implies that consumers seek variety so that they will have a portfolio of options as a hedge against future uncertainty or to protect interests in their favorite options (Harlam and Lodish, 1995; Kahn, 1995). In these circumstances, variety in a choice set is sought not because of the utility for diversity per se, but because of the uncertainty about what future preferences will be.

External situations' effect on variety-seeking, due to its prevalence in daily life and potential use in practice, has attracted longstanding interest from both practitioners and researchers. Our review of the extant literature shows that a number of external situational factors have been investigated, including in-store environment, price promotion, purchase timing, and products characteristics (Ha and Jang, 2013; Kahn and Raju, 1991; Mohan et al., 2013; Menon and Kahn, 2015; Shukla, 2009; Simonson, 1990). However, none has considered weather as a salient external situational factor, which we posit to non-trivially influence consumers' variety-seeking behavior based on the Mehrabian-Russell model as discussed below. (See Table A2 in the Appendix.)

2.2. Mehrabian-Russell (M-R) model

The *Mehrabian-Russell (M-R) model*, based on the *stimulus-organism-response (S-O-R) paradigm*, relates features of the environment (S) to people's approach and avoidance behaviors (R) via their emotional states (O) aroused by the environment (Mehrabian and Russell, 1974). Stimuli in an environment include visual cues (design of landscapes, buildings, furniture, color, light-

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