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Decision making in the newsvendor problem: A cross-national laboratory study

Tianjun Feng [a], L. Robin Keller [b,*], Xiaona Zheng [c]

[a] School of Management, Fudan University, Shanghai 200433, PR China
[b] The Paul Merage School of Business, University of California Irvine, Irvine, CA 92697-3125, USA
[c] Guanghua School of Management, Peking University, Beijing 100871, PR China

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ABSTRACT

In this paper, we conduct a laboratory experiment using the classic newsvendor problem to examine cross-national differences in inventory ordering patterns between Chinese and American decision makers based on a theoretical examination of the role of the Doctrine of the Mean in Chinese decision making. Drawing on the theory of context-dependent preferences (specifically extremeness aversion), we also revisit the flat-maximum hypothesis of Bolton and Katok [12], i.e., "thinning the set of order options leads to newsvendor decisions that achieve a higher proportion of maximum expected profit." The results show that the "pull-to-center" effect is more prominent for Chinese than Americans, i.e., average order quantities of Chinese subjects are closer to the anchor of mean demand than those of American subjects. Furthermore, we find that thinning the set of order options such that the optimal order quantity is a middle option, not an extreme option in the choice set, leads to better performance in newsvendor decisions, which complements the flat-maximum hypothesis.

1. Introduction

Cross-national differences have been well documented in judgment and decision making, including differences in probability judgments [1–3] and risk preferences [4,5]. For example, Yates et al. [2] found that Chinese respondents showed greater overconfidence in the accuracy of their answers to general knowledge questions than Americans and Europeans, and they proposed that cross-cultural differences in education might account for such cross-national differences in overconfidence.

Despite the prevalence of cross-national studies in judgment and decision making, there is little research in operations management that investigates cross-national differences in operations decisions. Nowadays business operations are set in a global environment and firms need to deal with suppliers and customers in global supply chains. For example, according to the World Trade Organization's annual report (1998, p. 36, http://www.wto.org/english/res_e/booksp_e/anrep_e/anre98_e.pdf), the production of a particular "American" car takes place across a number of different countries. Thirty percent of the car's value comes from Korea for assembly, 17.5% from Japan for components and advanced technology, 7.5% from Germany for design, 4% from Taiwan and Singapore for minor parts, 2.5% from the United Kingdom for advertising and marketing services and 1.5% from Ireland and Barbados for data processing. Also, about 70% of the products sold on Wal-Mart's shelves are made in China [6]. At the national level, trade between the United States and China has been dramatically increasing since China joined the WTO in November, 2001. According to the US Census Bureau, China was the second largest trading partner for the US in 2007 (specifically, the US imported goods worth nearly 321.5 billion dollars from China in 2007).

These above examples indicate that operations decisions within a global supply chain may come from parties with different backgrounds. Since cross-national issues can affect procurement, production and distribution in global operations, purportedly optimal solutions predicted by theories in operations management are unlikely to apply across decision makers from different countries. In addition, ignorance or misperception of cross-national differences may lead to substantial operational inefficiencies in international businesses. Thus, it is important to study behavioral differences in decision makers from different countries and understand the effect of cross-national differences in global operations.

In this research, we aim to examine cross-national differences in the newsvendor setting. Recently there has been a growing interest in behavioral operations management (see reviews in [7–9]). In this stream of research, a number of papers have employed the classic newsvendor problem to study decision

* Corresponding author.
E-mail addresses: tfeng@fudan.edu.cn (T. Feng), LRKeller@uci.edu (L.R. Keller), xzheng@gsm.pku.edu.cn (X. Zheng).

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makers' behavior by using laboratory experiments and present inconsistencies between theoretical predictions and empirical observations in the newsvendor setting [10–18]. It has been widely observed that average order quantities systematically deviate from the optimal expected profit-maximizing quantity and actually fall between the mean demand (e.g., the center of the uniform demand interval) and the optimal order quantity, i.e., subjects order too few when they should order more and vice versa. This is called the "pull-to-center" effect in [15]. Several decision biases have been proposed to explain the "pull-to-center" effect in the newsvendor experiments. Specifically, Schweitzer and Cachon [10] proposed two decision biases in their study, i.e., a preference for minimizing ex-post inventory error, and the anchoring and insufficient adjustment bias. Su [17] proposed the boundedly rationality bias, in which a boundedly rational decision maker is prone to errors in the newsvendor experiments. Croson et al. [18] proposed the overconfidence bias, i.e., subjects tend to underestimate demand variation in the newsvendor decisions.

As discussed above, the "pull-to-center" effect has been replicated in various studies [10–18]. However, almost all of these studies used subjects from western countries (e.g., the United States) for their experiments. Prior literature suggests cross-cultural differences in decision making between Western and Eastern countries [5,19–22], for example, the United States and China are two representative countries with different cultures and decision makers from these two countries may behave differently in many aspects. Thus, in this study, we chose to examine possible differences in ordering patterns between Chinese and Americans in the newsvendor setting.

The main contribution of this paper is two fold. Firstly, to the best of our knowledge, our work is the first cross-national study in behavioral operations management using laboratory experiments. More specifically, from the perspective of cross-cultural differences between American and Chinese people, we conjecture that the "pull-to-center" effect is more prominent for Chinese than Americans, i.e., average order quantities of Chinese subjects are closer to the anchor of the mean demand than those of American subjects. The "pull-to-center" effect has been widely observed in the newsvendor experiments using American subjects. However, the ordering pattern is not known for Chinese decision makers in newsvendor decisions. Building on the theory of the Doctrine of the Mean, we hypothesize that Chinese tend to exhibit a more prominent "pull-to-center" effect than Americans in newsvendor decisions. This hypothesis is examined in Study 1.

Secondly, we identify conditions under which decision makers may perform better in newsvendor decisions. Previous experimental studies in the newsvendor problem suggest that decision makers nearly always incur inefficiencies by ordering a quantity different from the expected profit maximizing quantity. Bolton and Katok [12] propose that thinning the set of order options improves decision makers' performance in the newsvendor problem, which they called a *flat-maximum* hypothesis.[1] Through a laboratory experiment, they find that reducing the number of ordering options does not necessarily result in better performance for newsvendor decisions. On the basis of the theory of context-dependent preferences, we propose that extremeness aversion explains why the flat-maximum hypothesis was not supported. Specifically, we hypothesize that thinning the set of order options such that the optimal order quantity is a middle option, not an extreme option in the choice set, leads to better performance in newsvendor decisions. Study 2 is conducted to test this hypothesis.

The rest of the paper is organized as follows. Section 2 presents Study 1 to examine cross-national differences in ordering patterns between Americans and Chinese from a cross-cultural perspective. Section 3 describes Study 2, which revisits and complements the flat-maximum hypothesis in newsvendor decisions. We discuss some managerial implications and limitations of the study, and conclude the paper in Section 4.

2. Study 1

2.1. The Doctrine of the Mean

The Doctrine of the Mean (*Zhong Yong* or *Chung Yung*), attributed to Confucius and deeply embedded in the Chinese culture, has an extensive impact on Chinese people's thoughts and behavior [23–25]. In Confucian philosophy, the Doctrine of the Mean implies that it was "as bad to go beyond one's target as it was to come up short" [23]. It is also captured by two Chinese adages, one is "going too far is as bad as not going far enough" and the other one is "anything which is carried to the extreme will inevitably bring about just the opposite effect" [23,26]. Thus, according to Confucius, the "Mean" is "without inclination to either side," which can be rendered as "Equilibrium" and further identified as "Harmony." The Doctrine of the Mean also suggests that "if the goal is to attain prolongation and propagation of life, one must neither be excessive nor be insufficient, but always try to hold the Golden Mean as the best policy" [23,26].

Bian and Keller [27] applied the Doctrine of the Mean to explain why Chinese decision makers are risk averse in risky health and safety decisions and tend to avoid the options with extreme outcomes, whereas it is not the case for their American counterparts in these decision settings. Briley et al. [28] proposed that culture influences individuals' decisions when they are required to explain their choices. For example, due to principles such as the Doctrine of the Mean, Hong Kong decision makers' preference for compromises will increase when they need to provide reasons for their choices. Cui and Zhang [29] found that the Doctrine of the Mean guides Chinese Designers in their design inspirations. Lowe and Corkindale [30] showed that the Chinese are less willing to try a new product or adopt an innovative service than the Australians. They argued that Chinese may regard adopting or using this new/innovative product or service as an extreme behavior and a violation of the Doctrine of the Mean. Sui [31] suggested that the Doctrine of the Mean and the principle of harmony affect marketing practices of firms in mainland China, compared to those in the United Kingdom and Hong Kong. When investigating the differences in conflict management styles between Chinese and Western managers, Tang and Kirkbride [32] considered "Chung Yung" as one aspect of cultural values that lead the Chinese executives to favor the less assertive "compromising" behaviors as their dominant styles.

Based on the above discussion, we conjecture that the Doctrine of the Mean plays an important role in ordering decisions for Chinese decision makers, i.e., in the newsvendor problem, people of the Chinese culture tend to avoid extreme choices and lean toward middle options when faced with decisions under uncertainty. More specifically, when explaining the "pull-to-center" effect in the newsvendor problem observed in experimental data from American subjects, Schweitzer and Cachon [10] proposed the "anchoring and insufficient adjustment" bias, i.e., decision makers tend to anchor on the mean demand and

[1] Flat-maximum refers to the flatness of the newsvendor's expected profit function around the neighborhood of the maximum, which may impede learning. Bolton and Katok [12] hypothesized that "thinning the set of order options will both sharpen expected payoff differences between neighboring order quantities, and make comparison of draws for neighboring order quantities more reliable," thus leading to better performance.