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Sex, risk and the newsvendor

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ABSTRACT

We present results from two experiments that reveal significant gender differences in ordering behavior in the newsvendor problem. In high margin settings, males tend to order more than females, and they also tend to achieve higher profits. There are no gender differences in low margin settings. We show that the observed gender differences are partially driven by (or mediated by) gender differences in risk appetite. Males tend to prefer taking greater risk than women, and this leads them to order more in the newsvendor problem (in high margin settings). We show that the risk-ordering relationship is related to financial risk attitudes but not to social risk attitudes, and also that the effect is not driven by gender differences in affect, a likely alternative explanation for the results.

1. Introduction

Ordering behavior in the newsvendor problem has now received considerable attention in the growing literature on behavioral operations management (e.g., Bolton and Katok, 2008; Bostian et al., 2008; Schweitzer and Cachon, 2000; and many others). This research has demonstrated quite clearly that actual ordering behavior often departs systematically from the ordering behavior of normative agents. Most robustly, the experimental research finds that the average order quantities of actual people tend to be more regressive – i.e., toward the mean demand – than the normative order quantities, a finding that has been dubbed the pull-to-center effect. Despite the striking regularities in the average order quantities observed across many studies, there is still considerable variability in ordering tendencies at the individual subject level. And to date this individual heterogeneity has received relatively little attention (for some nice exceptions, see Bolton and Katok, 2008; Cui et al., 2011; Gavirneni and Isen, 2010; Moritz et al., 2009). In the current paper, we show that a significant proportion of the observed variability is linked to gender: men and women, on average, order differently. Deeper analyses reveal that the observed gender differences in ordering behavior are due to well-established gender differences in risk preferences.

1.1. Risk appetite in the newsvendor problem

A risk-averse newsvendor orders fewer papers than his risk-neutral counterpart (see Eeckhoudt et al., 1995, and references therein). In general, increasing risk aversion is equivalent to a concave transformation of the newsvendor's utility function (see Pratt, 1964); more intuitively, increased risk aversion decreases the newsvendor's appetite for payoff variance, that is for outcome uncertainty. While risk-aversion has been proposed as one potential explanation for departures from the optimal (risk-neutral) order quantity in previous newsvendor studies and then refuted by the aggregate data (see, for example, Schweitzer and Cachon, 2000), so far no one has tried to measure risk appetite ex ante and use it to predict newsvendor order quantities at the individual level in an experimental setting. (Corbett and Fransoo (2007) used a survey methodology to examine the newsvendor ordering preferences of small business owners, and found that their ordering preferences were associated with their risk preferences. The newsvendor decisions were highly contextualized and tailored to each participant's own business and products.) Here, we measure risk preferences and use them to predict newsvendor decisions in a controlled task similar to those used in previous newsvendor experiments.

1.2. Gender differences in risk preferences

There are well-documented differences in risk attitudes between men and women (Byrnes et al., 1999; Croson and Gneezy, 2009; Harris et al., 2006). Most notably, in many domains across a range of tasks, men tend to show a greater appetite for risk. Byrnes et al. (1999) reviewed more than 150 papers on gender differences and risk, and concluded that in general "male participants are more likely to take risks than female participants" (p. 377). These

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observed differences obtain reliably not only in laboratory studies but also in real world settings.

As one relevant example from a financial setting, gender has been linked to investor behavior, with men showing a greater tendency to trade more frequently (Barber and Odean, 2001). Recently, Dorn and Sengmueller (2009) reported evidence that investors who enjoy gambling turn over their portfolio at twice the rate of their peers, and – consistent with the prior work by Barber and Odean (2001) – that men have greater turnover than women. Following up on these findings, Markiewicz and Weber (2011) measured investors' gambling risk appetite using a sub-scale of the Domain-Specific-Risk-Taking (DOSPERT) scale (Weber et al., 2002), and found that it predicted individual trading volume, specifically that individuals with greater gambling risk appetite traded more frequently. Crucially, gender was correlated with risk appetite (with men having a greater one), and yet the risk preferences were still predictive of portfolio turnover even after controlling for gender. In other words, the finding that men trade more frequently is driven at least in part by their greater risk appetite – and not simply by their gender qua gender.

There are a number of ways of measuring risk appetite. Methods that attempt to characterize the nature of people's utility functions (in the expected utility sense) are notoriously unreliable and different methods often produce different classifications of the same individuals (see, for example, Fox and Tannenbaum, 2011; Slovic, 1964). Hence the predictive validity of risk aversion coefficients derived from these methods is quite suspect (see, for example, Bromiley and Curley, 1992). Recently, there has been an increase in scale-based methods for assessing risk attitudes. In the current paper, we, like Markiewicz and Weber (2011), use components of the DOSPERT scale to measure risk attitudes (Weber et al., 2002). The DOSPERT has sub-scales that capture attitudes toward risk in five domains: financial, social, ethical, health, and recreational. Given that the newsvendor problem is akin to a financial decision making task, we expect that ordering decisions in the problem will be related to scores on the financial sub-scale of the DOSPERT. (We give more details on the DOSPERT, including example items, when we present Study 2.)

Croson and Gneezy (2009) concluded that one of the basic underlying drivers of observed gender differences in risk taking is emotional differences between genders, namely that females tend to experience stronger emotions than men (see Harshman and Pavio, 1987, for a review). They argued that emotional differences can affect the utility of risky choices, and that heightened anticipation of negative outcomes, for example, can induce greater risk aversion in females. Here, we try to control for emotional differences by measuring them. Specifically, in Study 2 we use the Positive and Negative Affect Schedule (PANAS, Watson et al., 1988) to measure each subject's mood just prior to making newsvendor decisions. The PANAS has been used in a number of prior studies linking emotion to risk-taking behaviors (e.g., Fessler et al., 2004; Maner et al., 2007). To be clear, for us, the PANAS measure serves as a check on one salient alternative factor – besides general risk preferences themselves – that might affect newsvendor behavior. (We provide more details on the measure when we describe Study 2.)

To preview, we demonstrate in Study 1 that there are indeed gender differences in newsvendor ordering behavior. Then, in Study 2, we show that the results from the first study replicate, and also that financial risk appetite plays an important role in generating the observed gender differences. Further, the observed differences do not seem to be the result of gender differences in social risk or affect. But before presenting the experiments, we will first describe the basic newsvendor problem and our metrics for analyzing the experimental ordering behavior.

2. The newsvendor problem

2.1. Optimal order quantity

The newsvendor can sell each unit for p at cost c. He must specify his order quantity q before observing demand D. If demand exceeds his order quantity, then he will sell exactly his order quantity. On the other hand, if demand is less than his order quantity, he will sell D units. He knows that demand is a random variable with distribution function F and density f. Hence, when he orders q and demand is D, his *realized profit* is

$$\pi(q, D) = p\ \min(q, D) - cq,$$

while his expected profit is

$$E[\pi(q, D)] = (1 - F(q))\pi(q, q) + \int_0^q f(x)\pi(q, x)dx. \quad (1)$$

It is well-known that the order quantity that maximizes expected profit, q^*, i.e., that maximizes Eq. (1), satisfies

$$F(q^*) = \frac{p - c}{p}.$$

2.2. Metrics for analysis

We use two measures to evaluate each subject's performance: average order quantity and average expected profit. For each subject i, we computed the empirical average order quantity Q_i over n rounds of ordering:

$$Q_i = \frac{1}{n}\sum_{j=1}^{n} q_j,$$

where q_j is the order quantity of round j. The empirical average of the expected profit for subject i is given by:

$$EP_i = \frac{1}{n}\sum_{j=1}^{n} E[\pi(q_j)],$$

where $E[\pi(q)]$ is the expected profit of the newsvendor problem given in (1). Throughout the paper, we use these *subject-level* summary measures to evaluate newsvendor performance.

3. Study 1

Given that risk appetite affects the optimal order quantity for a normative newsvendor agent and that men tend to have a greater risk appetite, we predicted that men and women would order differently in the newsvendor problem. Specifically, *ex ante* we predicted that men would order more than women (as, normatively, more risk averse agents tend to order less – for any given set of cost parameters). Study 1 effectively serves as a pilot study to examine whether there are in fact measurable differences in ordering behavior that are linked to gender.

3.1. Experimental protocols

We used the same cost parameters and demand distributions used in Bolton and Katok (2008) (Study 1). We ran both high and low margin conditions. In the *low margin* condition, $p = 12$, $c = 9$, and $D \sim U(50, 150)$, while in the *high margin* condition $p = 12$, $c = 3$, and $D \sim U(0, 100)$. (We did not used a fixed cost (rent) in our experiments.) In both conditions, $q^* = 75$. The expected (per period) profit in the low (high) margin when ordering q^* is 187.50 (337.50).