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Supply-chain performance anomalies: Fairness concerns under private cost information

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ABSTRACT

This work investigates how fairness concerns influence supply-chain decision making, while examining the effect of private production-cost information and touching on issues related to bounded rationality. We conduct laboratory work utilizing a supply-chain dyad with an upstream supplier feeding a downstream retailer under a simple wholesale-price contract. We perform human-computer (H-C) experiments where human subjects play the role of the supplier paired with the computerized retailer, as well as human-human (H-H) experiments where human subjects play the role of both supplier and retailer. These experiments allow us to isolate other effects like bounded rationality from the effects of fairness concerns on supply-chain decision making. We find that, compared to standard analytical model, the bounded rationality slightly reduces overall supply chain profit without changing its distribution between the supplier and the retailer, while fairness concerns lead to greater supply-chain profits and a more balanced supply-chain profit distribution. We further illustrate that under private cost information, the retailer's fairness concern is suppressed by the lack of reciprocity from not being able to observe her rival's profit information, but that the supplier's fairness concern from altruism persists. Based on our experimental results, we modify classical supply-chain models to include utility functions that incorporate both bounded rationality and fairness concerns. The estimated other-regarding coefficients are significantly lower under private information than under public information for the H-H experiments, and we find no evidence of inequity aversion for the H-C experiments.

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1. Introduction

Supply chain performance under various contracting mechanisms has been explored extensively in theory typically following the standard *homo-economicus* assumption that supply chain agents are rational and capable of making decisions to maximize their long-term financial returns. Studies in behavioral economics and marketing (Croson, 1996; Katok, 2011a) have long recognized that social interactions among business units also affect agent behaviors and, consequently, supply chain performance. One such social effect arises out of human preference for equity or fairness concern. As noted by Kahneman, Knetsch, and Thaler (1986), "The traditional assumption that fairness is irrelevant to economic analysis is questioned. Even profit-maximizing firms will have an incentive to act in a manner that is perceived as fair if the individuals with whom they deal are willing to resist unfair transactions

and punish unfair firms at some cost to themselves...The rules of fairness, some of which are not obvious, help explain some *anomalous* market phenomena."

For decades, powerful retailers in the supply chain have been known to erode suppliers' profits and take a bigger share of the overall channel profit. Wal-Mart is well known for using its power to squeeze supplier profits (Van Riper, 2007; Coolidge, 2015). Food suppliers in the United Kingdom have complained that they are unable to gain a sustainable margin from the retailer (Fredenburgh, 2015). Recently, stakeholders have started to realize that fairness and balance are vital in a strong retailer-supplier relationship, and can lead to better supply-chain performance. Empirical studies have shown fairness concerns have a positive influence on inter-firm relationships and mutual outcomes (Ring & Van de Ven, 1994; Arino & Ring, 2010). Such observations related to the importance of fairness concerns and equity have motivated recent behavioral operations-management (BOM) researchers to conduct various human experiments to investigate the impact of social preference over supply chain coordination (Loch & Wu, 2008; Ho and Zhang 2008; Katok & Pavlov, 2013).

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Unsurprisingly, the introduction of human subjects distorts the well-established modeling framework for even the simplest class of pricing contracts. Our behavioral study explores the issue of why experimental results tend to differ from traditional analytical findings in decentralized supply chains. We examine the performance of a wholesale price-only contract in a laboratory setting for the validity of three assumptions in standard models: (1) supply chain agents are fully rational; (2) agents are concerned with only their own profits; and (3) both cost and return information are public to all agents.

While recent work on fairness and supply-chain coordination has generated useful new insights (Cui, Raju, & Zhang, 2007; Demirag, Chen, & Li, 2010; Katok, Olsen, & Pavlov, 2012), these existing papers do not explicitly examine how private manufacturing-cost information may affect supply-chain interactions in the presence of equity concerns. Regardless of the degree of competition and the complexity involved, it is likely that no two firms in a supply chain share the same amount and type of information (Chen, Graves, & de Kok, 2001; Kostamis & Duenyas, 2011). Scenarios involving a private cost structure are common in business. For instance, a retailer may not know the manufacturer's true costs, which prevents her from knowing whether she attains an equitable payoff in the channel. Yet in some cases, entities in the supply chain may choose to disclose private cost information. As an example, before hundreds of dairy farmers from across Europe traveled to Germany in 2013 to protest against downstream price pressures, the European Milk Board (EMB) published a report revealing production cost (Case, 2013). In the automaker industry, "Ability to Recover Material Cost" is a critical factor when suppliers rate their working relations with automakers (Ford.com, 2008). Thus, it is interesting to examine if the supply chain can be better off with private cost information and if the supplier would have an incentive to disclose cost information to the retailer. Therefore, we also explore how the fairness perception of the agent changes when only the supplier, but not the retailer, knows the manufacturing cost information.

Our laboratory work utilizes a two-echelon supply chain with an upstream supplier feeding a downstream retailer. To account for the possible causes of supply-chain performance anomalies, we examine two potential explanations in this bilateral monopoly: biases related to individual bounded rationality and concerns related to the preference for equity (fairness concerns or avoiding inequity). Moreover, we examine the effect of private cost information in conjunction with fairness concerns and bounded rationality, as illustrated in the following graph:

As bounded rationality and fairness concerns may be confounded in subjects' decision-making, our experimental design must distinguish these two causes. To isolate the effect of bounded rationality, we conduct human-computer (H-C) experiments with subjects in the role of the supplier to minimize biases from social preferences such as equity concerns. Our results show that other than slightly reduced supply-chain efficiency (defined as the realized supply-chain profit divided by the integrated supply-chain profit), the human supplier's decision and profit share are not significantly different from the standard model predictions (Fig. 1).

Next, we examine a human-human (H-H) experimental setting where both agents are represented by human decision makers. In the H-H experiment, we find that supply-chain efficiency is higher than predicted by the standard model. Moreover, the distribution of supply chain profits between supplier and retailer becomes more balanced than predicted. We attribute this anomaly to fairness concerns of the participants'. We also consider a second treatment of our H-H experiments where the cost information is supplier's private information. Although fairness concerns appear to be at work under both public and private information cases, a closer look at our results reveals that private cost information breaks the reciprocity link (Kahneman et al., 1986) between

supplier and retailer, promoting retailer's self-interest and suppressing supplier's concern for equity.

Building on previous research (Heifetz, Shannon, & Spiegel, 2007; Loch & Wu, 2008), we then develop a behavioral model embedding fairness preference into the decision maker's utility functions and solve for the equilibrium. To measure the magnitudes of concerns for equity across all experimental treatments, we estimate other-regarding coefficients from our data using a maximum-likelihood method, leaving bounded rationality and other biases in the random error term. Our results indicate that withholding individual cost and benefit information weakens fairness considerations in the decentralized supply chain.

The remainder of our work is organized as follows. Section 2 provides a literature review of related work and presents the standard model as well as a fairness-minded behavioral model. Section 3 introduces our detailed experimental design and the hypotheses to test the model predictions and verify the appropriateness of its assumptions. Section 4 reports our experimental results and provides analysis. Section 5 develops the behavioral model and estimates the corresponding parameters with our experimental data. Section 6 provides conclusions and suggests possible directions for future research. Detailed lab instructions and experimental procedures are provided in the Appendix.

2. Related literature and standard economic model

2.1. Related literature

An abundance of papers has examined supply-chain contracting mechanisms analytically (see reviews by Cachon, 2003; Li & Wang, 2007; among others). These papers usually follow the standard economic framework building on analytical models of decision makers, who are fully rational and capable of maximizing his/her monetary returns. Various types of contracting mechanisms have been examined in a simple dyadic supply chain with an upstream supplier feeding a downstream retailer. Among these contracts are the common wholesale price contract (Cachon, 2003), the two-part tariff contract (Jeuland & Shugan, 1983), the buy-back contract (Pasternack, 1985; Kandel, 1996), the retail-fixed-markup contract (Liu, Fry, & Raturi, 2009, 2012), and the revenue-sharing contract (Cachon & Larivière, 2005).

Although theory on bounded self-interest within behavioral economics has long emphasized that people care about both giving and receiving fair treatment in a range of settings (Diamond & Vartiainen, 2007), biases from this preference for equity have only recently been introduced into the context of supply-chain modeling (Cui et al., 2007; Pavlov & Katok, 2011; Katok et al., 2012). Cui et al. (2007) show analytically that when supply chain members are concerned about fairness, the manufacturer may prefer a simple wholesale price contract to a more elaborate contract for coordinating the supply chain. Pavlov and Katok (2011) and Katok et al. (2012) further develop Cui's model by considering the case when the supply chain partners' fairness concerns are based on incomplete information. Their analysis shows that the supply-chain efficiency is strictly lower under incomplete information than when fairness preferences are common knowledge. The latter paper also provides an experimental test of their model predictions by obtaining the empirical distribution of the preferences.

Our paper extends the above work and investigates how private cost information may affect the supply chain dynamics under the influence of both fairness concerns and bounded rationality. Thus, it belongs to the relatively recent but quickly growing stream of BOM literature, which includes works such as Schweitzer and Cachon (2000), Lim and Ho (2007), Bolton and Katok (2008), Gino and Pisano (2008) and others. Loch and Wu (2007) and

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