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Dual-fairness supply chain with quantity discount contracts

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ABSTRACT

This paper investigates quantity discount contracts in a dyadic supply chain that consists of one supplier and two retailers. We consider a setting in which two retailers sell a homogeneous product procured from the same supplier. The supplier sequentially offers the retailers similar quantity discount contracts by determining the optimal wholesale prices that maximize the total profits of the two games, whereas the retailers must choose the optimal retail prices to maximize their own utilities. The first retailer solely exhibits distributional fairness concern (i.e., when the payoff he receives is disproportionately smaller than that of the supplier) because he may not be aware of the second retailer's existence. The second retailer simultaneously concerns over two types of fairness: peer-induced fairness concern (i.e., when his payoff is less than that of a peer retailer interacting with the same supplier) and distributional fairness concern; and he observes a noisy signal by which the retailer can infer the wholesale price that the supplier offered to the first retailer. This information may affect the second retailer's decision. Equilibrium solutions under different conditions are subsequently derived. We demonstrate that this supply chain under behavioral concerns cannot be coordinated with quantity discount contracts in which the price breakpoints are dependent on the wholesale prices. Therefore, a coordination mechanism that combines quantity discount contracts with fixed fees is proposed. Furthermore, several interesting results derived from the wholesale price contracts cannot be applied to the quantity discount contracts.

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1. Introduction

Traditional Operations Management (OM) models are based on the assumption of self-regarding preference, which is characterized by an exclusive concern over one's own material payoff. This assumption, however, is challenged by numerous behavioral experiments, such as the Ultimatum Game, the Gift Exchange Game, and the Public Goods Game. These experiments show that people frequently choose actions that do not maximize their monetary payoffs. A large body of literature reports systematic inconsistencies with the implications of self-regarding preference models (Cox & Deck, 2005). Social preference, which is the opposite of self-regarding preference, emphasizing concern for others' payoffs, is an important behavioral factor ignored by conventional OM models. Social preference can be regarded as an important complement to the assumption of self-regarding preference. As the typical social preference, fairness concerns have non-negligible impacts on decision-making processes and the optimal choice of contracts in business decisions (Fehr, Klein, & Schmidt, 2007; Kahneman, Knetsch, & Thaler, 1986b). Over the past three decades, re-

search has shown that “there is a significant incidence of cases in which firms, like individuals, are motivated by concerns of fairness” (Kahneman, Knetsch, and Thaler, 1986a, p. S287) in business relationships, including channel relationships.

In fact, many business reports can be used to show that employees, customers and companies are fairness concerned. Words relating to ‘fairness’ appear 130 times in the Dodd–Frank Wall Street Reform and Consumer Protection Acts, thus implying that fairness is also important in financial markets (Angel & McCabe, 2013). Perceptions of unfairness could easily disrupt cooperation in modern business. Strikes appear often in the Western world when wages are too low and employees often believe that they are not treated fairly. Due to unfair benefits allocations, the Langsha Group, China's largest sock manufacturer, terminated cooperation with Wal-Mart in 2007. Similarly, Xuzhou Wanji Trading of China, an important distributor of P&G, stopped their transactions because it felt P&G was unfairly seizing a disproportionate share of the profits.

Many extant studies of fairness focus on distributional fairness concern in simple settings (e.g., the newsvendor problem or wholesale price contracts). On the basis of the classical fairness model proposed by Fehr and Schmidt (1999), Cui, Raju, and Zhang (2007) investigate how fairness may affect the decisions of the manufacturer and the retailer in a dyadic channel. The results

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show that a simple wholesale price above her marginal cost can be used by the manufacturer to coordinate this channel both in terms of achieving the maximum channel profit and in terms of obtaining the maximum channel utility if both members are concerned about fairness. Du, Nie, Chu, and Yu (2014) prove that the channel can also be coordinated in terms of achieving the maximum channel profit when the supplier and the retailer both have preferences for reciprocity. Loch and Wu (2008) experimentally study the influences of social preferences, such as relationships and status seeking, on supply chain decisions. Pavlov and Katok (2009) build a new model of fairness concern, which is distinct from previous studies in that it treats fairness concerns as players' private information. They find that incomplete information about fairness preferences results in rejections. Demirag, Chen, and Li (2010) consider a fairness-concerned model similar to that of Cui et al. (2007), but the demand function is nonlinear. Katok and Pavlov (2013) investigate the effects of three factors, i.e., inequality aversion, bounded rationality and incomplete information, on the inefficiency of coordinating a simple supplier – retailer channel.

A supply chain, however, is a network structure consisting of many peers in the same echelon. These peers compare with each other in terms of status, income and other aspects, which is defined as peer-induced fairness concern (Clark & Oswald, 1996; Dahl, Løken, & Mogstad, 2014; Easterlin, 1995; Kawamoto, 2009). This type of supply chain structure is prevalent in practice. A large supplier, e.g., P&G, sells the same or similar products to dozens or even hundreds of different retailers with different scales. Due to their small scale, some retailers may not insist on obtaining as much profit as their larger counterparts, but whether their profits are disproportionately smaller than those of a large retailer matters to them. There is no shortage of anecdotal evidence to show that peer-induced fairness is a universal phenomenon in business. For example, some dealers were not satisfied with Chrysler, because Chrysler unfairly discriminated against them by giving others disproportionately large allocations of the best-selling models (Kumar, Scheer, & Steenkamp, 1995; Wall Street Journal, 1992). When a supplier cannot handle this relationship well, the stability and competitive power of the entire distribution channel will be reduced. According to Christopher (2005, p. 28), in the modern business environment, “supply chains compete, not companies”.

The present paper investigates the influence of two types of fairness concerns, i.e., peer-induced and distributional fairness concerns, on the decision-making processes of a two-echelon supply chain wherein two retailers sell the same product procured from the same supplier using quantity discount contracts. In our setting, peer-induced fairness concerns only exist between peers, whereas distributional fairness concerns only exist between the supplier and the retailer. If a retailer's payoff is less than that of a peer retailer who uses the same supplier, then the retailer exhibits peer-induced fairness concern. The latter retailer exhibits distributional fairness concern when the payoff he receives is disproportionately smaller than that of the supplier. In this triangular setup, the supplier plays two Stackelberg games with two retailers by offering sequential quantity discount contracts. The former retailer exhibits distributional fairness concern only because he may not be aware that there is another retailer interacting with the supplier, whereas the latter retailer exhibits both types of fairness concerns.

It is well known that quantity discount contract can coordinate a single supplier – single retailer supply chain when demand is stochastic and can increase supply chain efficiency. Is this conventional contract capable of coordinating a supply chain consisting of one supplier and two retailers when two types of fairness concerns exist simultaneously? How do their preferences for fairness affect the supply chain's decisions? Are the decisions of the supply chain

with two types of fairness concerns different from those of a supply chain considering distributional fairness concerns alone? Will a peer-induced fairness concern offset a distributional fairness concern? Do the fairness concerns increase or decrease the efficiency of the supply chain? Our study will shed light on these interesting questions.

Two important papers are related to our study. The first is the seminal work of Ho and Su (2009), who consider peer-induced fairness and distributional fairness simultaneously in the setting of two independent ultimatum games played by a leader and two followers. They show that the second follower will be at an advantageous situation because he is probably given a higher offer than that of the first follower. The second is the article of Ho, Su, and Wu (2014), which applies the model of Ho and Su (2009) to the supply chain setting wherein a supplier sells identical products through two independent retailers with wholesale price contracts. However, the result of Ho et al. (2014) predicts that the second retailer will be charged a higher wholesale price and receive a lower profit than the first retailer. According to their explanation, the supplier increases the wholesale price offered to the second retailer because the latter wants to choose a retail price to prevent from being behind both the supplier and the first retailer. The fact that these two papers produce contradictory results is indicative of the importance of context.

Although we are enlightened by the two articles cited above, our paper differs from them in the following respects. First, based on the seminal work of Ho and Su (2009), Ho et al. (2014) go further to consider simple wholesale price contracts and to derive some important managerial insights. However, in our model, we consider more complex contracts, i.e., quantity discount contracts, which they argue is an interesting extension and is identified as an avenue for future research. Quantity discounts provide suppliers with the ability to implement price discrimination between high-volume and low-volume buyers (Dolan, 1987). They are common practices in marketing and supply chain management. For example, travel agencies often use quantity discounts in their contracts with travel agents in the slack season. Membership cards, which are a type of quantity discount, are commonly used in health clubs and the beauty and catering industries. Many e-commerce sites (e.g., Amazon.cn) and supermarkets (e.g., Carrefour and Wal-Mart) offer a percentage (e.g., 25%) off when one purchase up to a certain amount of money.

Second, the problem of channel coordination is discussed and the impacts of both fairness concerns are analyzed. More importantly, a coordination mechanism combining quantity discount contracts with fixed fees is developed. Coordination is an important issue in supply chain management. The supplier(s) and retailer(s) are often concerned with optimizing their own objectives instead of the whole channel's profit. This is identified as the “double marginalization” problem and it frequently results in poor performance. In order to solve this problem, various coordinating contracts are proposed in different supply chain structures. However, coordinating conditions and the degrees of difficulty of coordination change after considering behavioral factors. Several scholars have made contributions to this issue (Cui et al., 2007; Katok & Pavlov, 2013). To the best of our knowledge, however, no study has considered the problem of channel coordination considering dual fairness concerns in more complex contracts. Incorporating dual fairness concerns into channel coordination is nontrivial because these fairness concerns may interact with each other, which may result in the change of coordination conditions.

Finally, we compare the results of the wholesale price contracts and quantity discount contracts.

Our main results are as follows. First, we investigate a three-player game that captures two types of fairness concerns under price-sensitive demand when the supplier provides quantity

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