



Production, Manufacturing and Logistics

## Reciprocal supply chain with intention

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## ABSTRACT

The traditional hypothesis of “rationality” is far from perfect. Models of fairness solely based on consequence cannot explain why the same consequence of an action is perceived and reciprocated differently. A reciprocity model which accounts for both consequence and its underlying intention is presented in this paper to illustrate the effect of intention in a traditional dyadic channel where one supplier plays a Stackelberg-like game with one retailer. This research aims to investigate how reciprocity may affect the members’ decisions and the channel’s coordination. In this study, two scenarios are discussed: (1) the retailer has a preference for reciprocity while the supplier does not and (2) both the retailer and the supplier have a preference for reciprocity. Results for acrimonious supply chain ( $\gamma\mu > 1$ ) and harmonious supply chain ( $\gamma\mu \leq 1$ ) are analyzed. Furthermore, we derive equilibria under the two scenarios and prove the existence and the uniqueness of the equilibria. The results show that intention plays an important role in decision making of the supply chain and will significantly change the equilibria. Moreover, an acrimonious supply chain can be coordinated with a simple wholesale-price contract under certain conditions, which can never happen in a traditional channel. A harmonious supply chain, however, cannot be coordinated in any way.

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## 1. Introduction

With the development of behavioral economics, more and more doubts regarding the traditional assumption of *rationality* have emerged. Many experiments have shown that the decision-maker considers not only the profits but also other behavioral factors such as fairness. Investigations of an ultimatum game demonstrated that a strong preference for fairness for both the proposer and the responder can lead to results significantly deviating from traditional theoretical predictions, although the influence of fairness will decrease and the results tend to approach traditional conclusions in cases of many competitors. Our research is based on a two-echelon supply chain system in which one supplier acting as the leader plays a Stackelberg-like game with one retailer as the follower, focusing on how to set an optimal price. According to Cachon (2003), this kind of model is not complex yet it is sufficiently rich to study important questions in supply chain coordination. Based on the supply chain system, our work aims to develop a model which incorporates behavioral factors so that both the supplier and the retailer are

concerned with fairness and the kindness of an action, considering both its consequence and the underlying intention.

Fairness is always a critical issue in the supply chain. However, traditional theories often neglect this aspect and assume that decision-makers will maximize their own profits as much as they can. In reality, many other important factors are taken into account to make a deal. For example, in the ultimatum game, a proposal which is very unfavorable to the responder will not be considered when both the proposer and the responder are concerned with fairness. Otherwise the proposer will suffer retaliation and both parties profit nothing. Therefore, the impacts of the behavioral factors cannot be ignored once the decision is made in terms of game theory. To date, many behavioral models have been proposed based on behavioral experiments. They can be classified into two major types. The first type is the so-called equity-based models which only focus on the consequence of an action. Another is defined as reciprocity models featured by taking the intention into account as well (Korth, 2009).

After comparing many existing reciprocity models, Korth (2009) conclude that the reciprocity model built by Falk and Fischbacher (2006) is the most successful in predicting behavior observed in experiments with computable unique equilibria for many games. Moreover, using two independent parameters for each player’s utility function, it can overcome previous models’ shortcomings

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and thus model and explain many phenomena such as pure selfish behavior, pure inequity aversion, or pure intentional reciprocity. Our model is developed based upon [Falk and Fischbacher \(2006\)](#) because it is a very powerful tool for predicting behavior resulting from a variety of preferences in many different games.

In practice, the attribution of intentions is an important issue in reciprocity because many relevant decisions are likely to affect each other. For example, political and business decisions often affect some parties' material payoffs negatively. It will be much easier to prevent opposition if the decision-maker can demonstrate that he is somehow forced by law, international competition and some other external forces to take that action if the response of the negatively-affected parties also takes into account the decision-maker's intentions ([Falk, Fehr, & Fischbacher, 2008](#)). For another example, a hardware store is often regarded as unkind to raise prices of snow shovels during a blizzard because it takes advantage of the accidental increase in demand, while a similar action of a grocer is more acceptable if the wholesale price has increased due to a transportation mix-up ([Kahneman, Knetsch, & Thaler, 1986](#)). The reason for different reception is that the latter is intent to achieve normal profit while the former appears to loot a burning house. Similarly, you may buy a product from a local convenience store with a low price but it is also acceptable when the same product is sold with a higher price in a big mall since you know that the costs are different. In addition, the attribution of intentions is important in law ([Huang, 2000](#)). Intentions are the key basis to judge whether the same action is a tort or a crime and whether an action is purposely taken. Thus, the penal code distinguishes quite carefully between the consequences of an action and its underlying intentions. For cases in which a consumer believes that the monopolist has obvious unkind intention, [Rabin \(1993\)](#) found that the consumer might refuse to buy a product from a monopolist at an "unfair" price even though he could get greater material value. In this case, the consumer intends to punish the monopolist and give up the deal. The study of [Blinder and Choi \(1990\)](#) suggests that employers are unwilling to reduce wages when there is high unemployment. Generally the owner believes that the wage level may affect a worker's propensity to cooperate, which indicates the employer's underlying intention, especially under the condition of high unemployment.

We first analyze the channel in which only the retailer has a preference for reciprocity while the supplier merely seeks to maximize her<sup>1</sup> profit. After that, we extend our study to the case where both members have reciprocal preferences. In the paper, we refer to a channel with single or multi reciprocity-preferred members as a *reciprocal channel*. Our study shows that whether or not the supplier has a preference for reciprocity, the channel can be coordinated with a wholesale-price contract as long as the retailer has such a social preference in an acrimonious supply chain ( $\gamma\mu > 1$ , where  $\gamma$  and  $\mu$  are the fairness parameters of the retailer and the supplier respectively. Detailed explanations are below). However, it is strange that the wholesale-price contract should have failed to coordinate a harmonious supply chain ( $\gamma\mu \leq 1$ ). Furthermore, some counter-intuitive phenomena may appear. In the acrimonious supply chain, the retailer may charge a price which is lower than the optimal retail price of the traditional channel when the supplier's wholesale price is relatively high and the retail price may decrease with the wholesale price.

Our research makes the following contributions to the literature. Firstly, the present paper, to the best of our knowledge, is the first one to investigate a psychological game within the context of supply chain. Numerous behavioral experiments not only

demonstrate that the traditional assumption of economic-man is not precise but also show that a concern for fairness is not enough to describe the rule of decisions. Therefore, it is necessary for us to incorporate some psychological factors such as intention into the supply chain since they have non-negligible impacts on decision making. We would like to start this work with a dyadic channel. Secondly, we provide supply chain members with indications of how their intentions affect the interactions between them and derive psychological equilibria. Thirdly, our model indicates that it is possible to coordinate the channel with a wholesale-price contract.

The rest of the paper is organized as followed. Section 2 presents a review of literature related to social preference models, including fairness and reciprocity, and relevant applications within a supply chain context. In Section 3, the psychological game model of considering intention within a supply chain context is given. In Section 4, we analyze the model in detail and derive the equilibria under different scenarios. The impacts of some important parameters on the equilibrium are presented in Section 5. Section 6 summarizes our conclusions and recommends future research.

## 2. Literature review

Individuals who have social preferences are willing to make material sacrifices to reward others who are kind to them, and to punish those who are not. Their motivation for doing so does not arise from any prospects of future material reward. [Fehr, Fischbacher, and Tougareva \(2002\)](#) observes that, both in the high and the normal stake condition, fairness concerns are strong enough to outweigh competitive forces and give rise to non-competitive wages. Additionally, fairness concerns may play an important role even at relatively high stake levels. Such preferences not only help account for experimental data from a diverse set of sources, they also are in accord with the facts of everyday experience. [Fehr and Schmidt \(2006\)](#) provide a comprehensive overview of recent papers based on social preference where players not only care about their own material payoff but also about other things like fairness. Hitherto many models have been built based on social preferences of fairness. Generally, they can be classified as either equity-based or reciprocity-based.

Equity-based models assume that the agents have preferences for exhibiting inequity aversion. These agents try their best to decrease the other party's payoff in order to narrow the difference between the two payoffs (it applies to games with more than two players), even at the cost of sacrificing their own material payoff. There are two prominent models in this domain: the equity-based approaches by [Fehr and Schmidt \(1999\)](#) and [Bolton and Ockenfels \(2000\)](#). The model of [Bolton and Ockenfels \(2000\)](#) assumes that the disutility of inequality is symmetric regardless of who receives the higher payoffs. The subjects compare their material payoff with the average material payoff of the group rather than comparing directly with each other. [Fehr and Schmidt \(1999\)](#) instead argue that individuals have a stronger aversion to disadvantageous (i.e., one has less than others) inequality than to advantageous inequality (also see [Loewenstein, Thompson, & Bazerman, 1989](#)). It incorporates the guilt arising from obtaining too much in the model.

An important characteristic of the models of inequality aversion is that they focus exclusively on outcomes. Papers reporting experiments with some other games, however, also derive the conclusion that both intentions and outcome preferences are need to be taken into account. For example, people tend to respond more negatively to an unequal outcome that is the result of an intentional choice than to an unequal outcome brought about by nature. Individuals seem disposed to positively reciprocate kind intentions, and to display negative reciprocity in response to hostile intentions. This is

<sup>1</sup> "She" and "he" are used to represent the supplier and the retailer respectively throughout the paper.

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