



Strategic information sharing between competing retailers in a supply chain with endogenous wholesale price

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ABSTRACT

This paper introduces a new motivation for information sharing in decentralized supply chains—as a mechanism to achieve truthful information sharing and to reduce signaling costs. We study a two-echelon supply chain with one manufacturer selling a homogenous product to n price-setting competing retailers. Each retailer has access to private information about the potential market demand, and the retailers have an ex-ante incentive to share this information with each other and to conceal the information from the manufacturer. However, without a mechanism that induces the retailers to truthful information exchange as their strategic choice, no information can be exchanged via pure communication (cheap talk). To overcome this obstacle, two signaling games are analyzed: in the first game, information is shared truthfully among the retailers; in the second game, information is also shared truthfully with the manufacturer. We show that under some conditions sharing information with the manufacturer results in a higher profit for the retailers.

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1. Introduction

The estimated cost of stockouts and inventory are astronomical, ranging from \$14 billion for the food service industry (Troyer, 1996) to \$30 billion for the grocery industry (Kurt Salmon Associates, 1993). A key initiative commonly mentioned as a possible remedy to lower these costs is information sharing among partners in supply chains. Recently, there has been more research that emphasizes the value of information sharing for operational effectiveness, such as improved inventory control, the elimination of the bullwhip effect and better matching of supply with demand (Chen, 1998; Aviv and Federgruen, 1998; Lee et al., 2000; Cachon and Fisher, 2000 and Lee and Whang, 2000. An excellent survey of information sharing in supply chains can be found in Chen, 2003).

Although better information usually improves the performance of a supply chain, when the supply chain is comprised of independent profit-maximizing firms, some key obstacles exist in creating an information-sharing agreement. First, in equilibrium, each firm must be better off sharing information than concealing it. Even when information sharing achieves the efficient outcome for the firms in the supply chain, in many cases there is a tension between efficiency and self-interest. This tension, which is a type of the famous prisoners' dilemma, can lead to an inefficient

equilibrium, in which no-information is shared among competing firms (e.g. Gal-Or, 1985 and Li, 2002).

Furthermore, when the accuracy of the shared information cannot be verified, firms in the supply chain must select truthful revelation of their private information as a strategic choice. For example, Solectron, a major electronics supplier, had \$4.7 billion in excess component inventory because of the inflated forecasts provided by its customers (Engardio, 2001).

When the supply chain is comprised of competing retailers, an additional challenge exists when a retailer shares information with his supplier, since once a retailer shares its private information with his supplier, its ability to control leakage of this information to his competitors is compromised. Wal-Mart, for example, announced that it would no longer share its sales data with outside companies like Information Resources, Inc. and ACNielsen, which paid Wal-Mart for the information and then sold it to other retailers (Hays, 2004). Two recent papers, Li and Zhang (2008) and Anand and Goyal (2009), study the effects of information leakage on the incentives to share information in a decentralized supply chain with downstream competition.

The description above suggests that researchers view the complex structure of supply chains and the conflicting incentives of firms within the supply chain as obstacles to achieving information-sharing agreements. However, in this paper, we offer an alternative view: we assert that the same complex nature of a supply chain can provide firms with a tool to facilitate information-sharing agreements in settings of asymmetric information.

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To accomplish this, we model a two-echelon supply chain with downstream competition and present a new incentive for information sharing between the retailers and their mutual manufacturer—as a substitute for the signaling cost. When the retailers share *hard information* (information that cannot be manipulated) they have an ex-ante incentive to share private information about the future market demand and to conceal this information from their manufacturer. However, when the retailers share *soft information* (information for which the credibility of the shared information cannot be verified) each retailer has an incentive to manipulate the information; each retailer is better-off pretending that the market condition is better than his private signal suggests. Such information manipulation encourages the competing retailers to set a higher price, which benefits the manipulating retailer. As a result of this tendency to manipulate the shared information, the information-sharing agreement unravels; no information can be shared via means of cheap-talk.

To overcome the problem of accountability and to allow the retailers to share information in a credible manner, we study two signaling games: in the first mechanism (referred to as the *horizontal signaling game*), each retailer incurs some cost related to his shared information. The retailers design the mechanism in such a way that the cost associated with the sent message signals that the retailers are accountable for the shared information. In this game, the retailers exchange information horizontally and conceal their private information from their manufacturer.

As an alternative mechanism to the *horizontal signaling game*, we investigate the effect of including the manufacturer in the information club (we denote this option as the *public signaling game*) on the ability of the retailers to reach an information-sharing agreement. We demonstrate how the presence of the manufacturer in the information coalition affects the retailers' incentives to manipulate the shared information and consequently affects the signaling cost required to achieve truthtelling as the retailers' strategic choice. The presence of the manufacturer allows the retailers to expand the set of available mechanisms that result in truthtelling information sharing; that is, when the retailers share soft information, they benefit from the information-sharing agreement, but must incur some cost in order to be accountable for the shared information. The retailers can decide to share information with the manufacturer when the cost of reaching a truthtelling equilibrium under this setting is lower than the cost incurred in order to share information credibly when the manufacturer is not exposed to the shared information.

The remainder of the paper is organized as follows. [Section 2](#) discusses some of the relevant literature. [Section 3](#) introduces the model, and [Section 4](#) analyzes the incentives of the retailers to share information (horizontally and vertically) when the accuracy of the information can be verified. [Section 5](#) relaxes the assumption that information is exchanged truthfully and examines the incentives of the retailers to truthfully exchange their private information in the presence of the manufacturer and in the absence of the manufacturer from the information club. [Section 6](#) analyzes the two signaling games that result in truthtelling as the retailers' strategic choice. We conclude and offer future research path in [Section 7](#).

2. Literature review

Our study relies on three different bodies of research: the first line of research focuses on the value of information sharing; the second group of studies investigates the incentives for truthful information sharing and the mechanisms that induce truthful information sharing, and the third explores the value of pure

communication (cheap talk) and its effect on the results of the strategic interaction between supply chain participants.

As discussed above, the merits of information sharing in supply chains have been well documented. However, some of the research that studies the value of information ignores the role of incentives to share information. The first stream of papers to consider the incentives for information sharing under horizontal competition includes Novshek and Sonnenschein (1982), Vives (1984), Gal-Or (1985, 1986), Li (1985), Shapiro (1986) and Raith (1996). These papers demonstrate that the benefit from information sharing is increased precision about the market condition due to the pooled information. However, by sharing information, rivals also obtain more precise information. Thus, the positive effect of the increased precision on a firm's profit might be balanced against the increased precision of rivals' information. The above papers consider the effects of the competition mode (Bertrand or Cournot), the type of products (substitutes or complements) and the type of information (common demand intercept or private production cost). In general, the researchers conclude that under a Bertrand (or Cournot, respectively) competition with substitute products, firms will share (or not share) their private demand information, and under Bertrand (or Cournot) with complementary products, firms will not share (or share) their private demand information. The key assumptions of these models are that the decision to share information is made ex-ante, prior to observing the actual private information, and that the information is exchanged truthfully. Our paper differs from this line of research in two ways: we study the retailers' incentives to share information—not only with each other, but also with a mutual manufacturer. More importantly, we relax the assumption that information is exchanged truthfully and search for a mechanism that induces truthful information exchange as the retailers' strategic choice.

Ziv (1993) was among the first researchers to consider the problem of ex-post truthful information exchange. He endogenizes the incentives for the truthful exchange of private cost information in a Cournot competition model with substitute products and considers the ex-post incentives of firms to truthfully reveal their private cost information with horizontal competing firms. Ziv demonstrates that without commitment to truthful information sharing, firms will manipulate their announcement and report lower costs than their actual costs. As a result, each firm will discard its competitors' report and act as though no information had been exchanged.

Considering the incentives for information exchange in supply chains, Li (2002) studies the incentives for vertical information exchange in an environment with horizontal competition. Li develops a model with multiple retailers and one mutual supplier, in which each retailer is endowed with a private demand signal. The retailers are engaged in a Cournot competition and can decide whether to share their signals truthfully with the supplier. The supplier sets the wholesale price based on the shared information. Li demonstrates how, based on the wholesale price, the retailers who do not share their demand signals can infer the value of the average signal of the retailers who choose to share their information with the supplier. As a result, sharing demand information with the supplier is equivalent to sharing it with competing retailers; consequently, the retailers would choose not to share their private information with the supplier. Using a similar model, Zhang (2002) explores the incentives for vertical information sharing in a supply chain with duopoly retailers and reaches similar conclusions.

In a recent paper, Li and Zhang (2008) explore the incentives for vertical information sharing in a supply chain consisting of one mutual manufacturer and multiple retailers engaged in a Bertrand competition. The model is similar to that of Li (2002).

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