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The middleman as a panacea for supply chain coordination problems

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A R T I C L E   I N F O

A B S T R A C T

The prevalence of intermediaries (middlemen) in supply chains is often seen as a dying remnant of less efficient times. Despite predictions that supply chains will rapidly "cut out the middleman" as technological advances have eased logistics, middlemen have continued to thrive. In this paper, we demonstrate a transaction role of middlemen that may help clarify their staying power. In a model with self-interested decision-making by both a manufacturer and a retailer, wherein incentive misalignment creates investment and production inefficiencies, we show that the integrated (first-best) outcome can be achieved with simple cost-based contracts if and only if a middleman is present. We further show that the approach of utilizing a middleman to fully coordinate the supply chain is robust in that it can be applied to a variety of circumstances discussed in the literature, including multilateral investment/effort choices, multiple product providers, and logistical investments made by the middleman.

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1. Introduction

Supply chains typically include intermediaries, such as factoring firms, third and fourth party logistics providers, wholesalers, brokers, agents, and even coordinating divisions within firms. A common explanation for the existence of such intermediaries is that they fulfill a transactional role by reducing search and matching costs, providing inventory and capacity, or aggregating supply/demand to achieve economies of scale. Another explanation highlights the novel expertise of intermediaries in collecting and interpreting data thereby reducing information asymmetry concerns.

As technological advances have seemingly neutralized some of these natural advantages, many have predicted the imminent demise of such "middlemen", pointing to a coming era of supply chain disintermediation. As Anderson and Anderson (2002, p. 53), note, however, intermediaries have survived, even thrived: "The internet was supposed to bring manufacturers into direct contact with end customers in a ruthlessly efficient world that left no room for middlemen. But the opposite is occurring." In this vein, Belavina and Girotra (2012) also recognize the "phenomenal growth of supply chain intermediaries." As a notable example they discuss the case of Li & Fung Ltd., an entity that primarily serves an interface between multiple suppliers and retailers and whose client list includes Levis, Marks & Spencer, Phillip Morris, Target, Walmart, and Zara.

Belavina and Girotra (2012) provide a clever rationale for the use of such intermediaries: they enable rapid adjustment of supplier base to meet changing buyer needs while ensuring suppliers act as if they were facing long-term sourcing commitments. This paper presents a complementary view that also supports the continued strength of supply chain middlemen. We show that even if middlemen do not have any unique skills or information, they can still improve supply chain efficiency by helping to coordinate a supply chain that suffers from incentive misalignment.

To elaborate, we consider the canonical problem of two-sided self-interest between a manufacturer and a retailer. The manufacturer undertakes non verifiable investments that can reduce its marginal production cost. Under simple per-unit pricing contracts between the supply chain participants, if the unit price paid to the manufacturer is equal to marginal cost, it of course removes any incentives to curtail such costs. If, however, the contract entails a markup that restores investment incentives, such a markup also limits procurement incentives of the retailer. That is, the supply chain suffers from the usual tradeoff between alleviating hold-up upstream and reducing double-marginalization downstream. The end result is that self-interested behavior by the supply chain participants precludes full coordination under simple unit pricing arrangements such as wholesale price and cost-plus (e.g., Klein, Crawford, & Alchian, 1978; Williamson, 1979; Bajari & Tadelis, 2001; Cachon, 2003); this is true even if such cost-contingent variable charges are deployed in conjunction with fixed transfer payments as part of familiar two-part tariff arrangements.

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Our key insight is that when disintegration of a supply chain creates incentive conflicts, these conflicts can be resolved with further disintegration, i.e., the introduction of a middleman. In particular, we show that adding a middleman to the manufacturer–retailer relationship can achieve the integrated (first-best) outcome with simple linear cost-based contracts. Importantly, the model is constructed so that the middleman offers no other benefit – he does not provide better monitoring, improve contracting contingencies, or increase the value of the good through effort. Intuitively, efficient trade can be induced when the per-unit fee charged by the middleman to the retailer is such that the retailer bears the good's actual marginal cost. By making the retailer internalize supply chain costs, the contract ensures that the retailer procures the efficient quantity of units. With a cost-plus contract between the manufacturer and the middleman, the manufacturer's payoff is proportional to the markup times the traded quantity. In this case, the manufacturer does not have direct incentives to cut costs (he is reimbursed for all costs), but does have an indirect incentive, because cutting costs boosts the traded quantity. A judiciously chosen markup can then ensure efficient effort choice. Of course, fixed payments between the parties can then allocate the increase in expected surplus across all three parties.

The contractual arrangement we identify exhibits an interesting feature in that the middleman may engage in below-invoice pricing, i.e., he purchases the good from the manufacturer paying a markup per unit while selling it to the retailer below his own per unit purchase price. Although below-invoice pricing is common in a variety of industries (e.g., automobiles; groceries), it is usually viewed as a strategy to drive away competition and, thus, often raises concerns of regulators. Our model notes an upside to below-invoice pricing in that it can be an integral part of ensuring coordination and efficiency of the supply chain.

While our model focuses on the role of an intermediary in alleviating incentives of a single supplier and retailer, a prominent role for middlemen in practice is in consolidating goods of multiple suppliers. With this in mind, we demonstrate that our key results persist if the middleman has to coordinate multiple manufacturers each of whom can reduce its own costs through unverifiable effort. The middleman can again restore incentives with simple unit pricing so that the integrated outcome can be achieved. That is, the retailer purchases the bundle from the middleman at marginal cost per unit, while the middleman purchases the individual goods from various suppliers at a cost-plus markup.

We also extend the analysis to incorporate efforts by the middleman and retailer, and to reflect investment spillovers (the manufacturer's investment can increase demand and/or the retailer's investment can reduce cost). Though previous work has shown that solutions that can achieve the first-best outcome do not necessarily work or have to be adjusted in fundamental ways in the presence of non-verifiable efforts and/or investment spillovers (e.g., Che & Hausch, 1999; Che & Chung, 1999; Cachon, 2003; Schweizer, 2006), we demonstrate that our coordination contract is remarkably robust even allowing perfect coordination in case of cross investments.

Broadly stated, our paper provides support for simple and commonly used contracts in conjunction with a middleman by showing that the integrated outcome can be attained with a middleman, but not without one. In contrast, previous literature on such coordination problems has shown that judicious, but not necessarily simple, contracts between the buyer and supplier when used with a deliberately designed renegotiation process can achieve coordination (e.g., Chung, 1991; Aghion, Dewatripont, & Rey, 1994; Nöldeke & Schmidt, 1995; Edlin & Reichelstein, 1996; Plambeck & Taylor, 2007; Taylor & Plambeck, 2007a). The theoretical advances come with the caveat that proposed mechanisms may not be common in practice; as noted by Schmitz (2002, p. 178): "the fact that there exists a bargaining game such that the first best is achieved does not guarantee that in real life contractual parties will actually always play this particular game." Similarly, Plambeck and Taylor (2007) and Taylor and Plambeck (2007a, 2007b) show that efficient supply chain coordination can be achieved in a long-term supply chain relationship through informal agreements, i.e., relational contracts, which do not require the verification of realized costs. However, crucial for this result is that the supply chain relationship exhibits an infinite horizon and is linked to specific off-equilibrium beliefs.

Our paper is related to work showing that a third party can restore efficiency for moral hazard problems in teams (Holmstrom, 1982), adverse selection with correlated types (Mcafee & Reny, 1992), and incomplete contracting models with message games and renegotiation (Baliga & Sjostrom, 2009). Our paper is also related to the scarce but emerging literature on the role of a third party mitigating coordination problems of decentralized supply chains (e.g., Hanany, Tzur, & Levran, 2010; Belavina & Girotra, 2012; Bakshi, Adida, & Demiguel, 2013). While these works analyze problems in the absence of moral hazard, our paper adds this critical element to extend this line of inquiry.

In the context of the familiar newsvendor problem, the supply chain literature has documented instances of failures when simple wholesale price contracts are utilized. In response, the literature has turned to more elaborate contractual arrangements to help restore a reasoned degree of efficiency (e.g., Pasternack, 1985; Moorthy, 1987; Lariviere & Porteus, 2001; Taylor, 2002; Cachon & Lariviere, 2005; see Cachon, 2003 for an excellent review). Taking its cue from this literature, this paper too first documents the drawback of simple contracts in a setting where trade and investment incentives provide opposing pulls. But rather than proceeding along the lines of adding complexity, our paper takes a different approach by seeking to boost the efficiency of the simple contractual scheme itself by adding a middleman.

Previous literature has studied the effect of middlemen on search and trading behavior (e.g., Rubinstein & Wolinsky, 1987; Biglaiser, 1993; Gehrig, 1993; Yavas, 1996; Rust & Hall, 2003; Masters, 2007, 2008). Middlemen can have advantages in that they can meet users with a higher frequency; have better information, higher expertise, or better reputation; can bundle risk; can reduce delivery distance and costs; or can hold inventories of varied types of goods (e.g., Kalai, Postlewaite, & Roberts, 1978; Biglaiser, 1993; Li, 1998; Johri & Leach, 2002; Shevchenko, 2004; Smith, 2004; Watanabe, 2010). To isolate the unique effects of the middleman in our analysis, we intentionally exclude these benefits of intermediaries, restricting attention only to their contracting role.

The remainder of the paper is organized as follows. The next section introduces the basic model. Section 3 presents the results; Section 3.1 presents the coordinated supply chain outcome; Sections 3.2 and 3.3 study the outcomes without and with a middleman; and Section 3.4 studies extensions.

2. Model

A manufacturer makes a good that is procured by a retailer. The manufacturer's per-unit cost to make the good is $c(a, \alpha)$, where $a \in \mathbb{R}_+$ denotes its private effort and α reflects cost uncertainty; $\alpha \in [\underline{\alpha}, \bar{\alpha}]$, $\underline{\alpha} < \bar{\alpha}$, is drawn from the probability density function $f(\alpha) > 0$. The manufacturer's effort entails a personal cost (investment) $v(a)$, where $v(a) \geqslant 0$, $v'(a) \geqslant 0$, and $v''(a) > 0$, with equalities holding only at $a = 0$. Effort reduces costs with possibly decreasing returns, i.e., $c_a(a, \alpha) < 0$ and $c_{aa}(a, \alpha) \geqslant 0$.

The retailer incurs a per-unit conversion (e.g., shipment and processing) cost of k, $k \geqslant 0$, and obtains revenue $R(q, \beta)$ for selling