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Healthcare supply chain operations: Why are doctors reluctant to consolidate?

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ABSTRACT

Despite the widely reported speculation in the 1990s that the era of small medical practices would end within a short period of time, the majority of physicians today still work as solo practitioners or in groups of five or fewer. Personal goals and values in addition to a lack of room for negotiation and difficulties in "being heard" in large organizations are just a few of the potential reasons why physicians resist consolidation and mergers. In this paper, we study the impact of different levels of cooperation on independent medical practices (healthcare providers) in the context of a healthcare supply chain to look into operational reasons why providers are reluctant to merge. In particular, we consider the competition for patients between two providers via insurance reimbursement rate and drug procurement contracts related to demand uncertainties. Assuming that the provider forms a conjecture about its competing provider's response to its action, we analyze different levels of cooperation between these two providers—from no cooperation to full consolidation in terms of market shares. Our results show that (1) operational costs and demand uncertainties may prevent healthcare providers from pursuing a full consolidation strategy; (2) there exists a unique level of consistent and evolutionarily stable cooperation, and the parties may suffer losses if they consolidate beyond that level; and (3) even when the stable level of cooperation increases, the providers, the drug supplier, and the entire supply chain do not necessarily improve their profits.

1. Introduction

In this paper, we address how different levels of cooperation between two competing healthcare providers influence the providers' profits and the profits of the entire healthcare supply chain. A significant body of research has been devoted to the simultaneous modeling of price competition and operational competition among multiple firms. These studies, which assume that the competing products are substitutable, show that a retailer's price decreases when it or any of its competitors increases its target sales levels. This conclusion corresponds to the classical Cournot (quantity) and Bertrand (price) competition models. Bernstein and Federgruen [1], for example, examined the coordination of a two-echelon supply chain, taking into consideration one supplier serving multiple competing retailers, fixed ordering costs, and deterministic demand levels that are dependent on the firm's prices. Later, Bernstein and Federgruen [2] investigated price and operational performance competition among multiple firms under stochastic demand. Their work focused on how firms choose base stock policies to enhance their order-fulfillment performance. Bernstein et al. [3] further considered two-echelon supply chains with a single supplier servicing a network of retailers, who compete with each other by selecting sales quantities. They showed that under the standard inventory model, vendor-managed inventory (VMI) plays a fundamental role in creating echelon operational autonomy, thus enabling coordination to be achieved with simple pricing schemes. In addition, a number of papers have studied competing firms with demand spillovers, i.e., situations in which a portion of the unsatisfied demand in one firm (resulting from stockouts) is transferred to another firm. Lippman and McCardle [4], Anupindi and Bassok [5], and Cachon and Harker [6] combined fundamental operations management models, such as the $M/M/1$ and the EOQ, with differentiated Bertrand competition models to study the competition between two firms that face scale economies. They highlighted how outsourcing changes the nature of downstream competition when some firms provide the services that are outsourced by others.

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The above stream of research adopts the Nash equilibrium concept to model horizontal competition. The concept is founded on the idea that firms choose their individual strategies non-cooperatively. A generalization of the Nash equilibrium approach assumes that a firm forms a conjecture regarding how its competitor's output will vary in response to any change in the firm's own output [7]. The conjecture may induce cooperation to a certain extent and even result in joint monopoly in terms of decision making. Several studies in supply chains have also relied on this conjectural variation approach to explore retail-level price competition in a single industry [8], in the presence of buyer–supplier bargaining [9], in multiple industries [10], between store and national brands [11], and with horizontal pricing competition between manufacturers [12]. In particular, Sudhir [12] explored manufacturer behaviors and showed empirically that manufacturer pricing can be collusive. This is consistent with the argument that firms involved in long-term competition in concentrated markets often engage in implicit collusion.

In contrast to the supply chain related literature, which usually also accounts for operational (rather than pricing only) competition and assumes either horizontal/vertical Nash or Stackelberg leader–follower interaction games, Kadiyali et al. [13] proposed a model that allows for a continuum of possible channel interactions between manufacturers and a retailer. The researchers' findings suggest that it is not uncommon for channel participants to deviate from the prices predicted by the usual Stackelberg/Nash pricing games examined in the literature. This conclusion warrants further exploration of conjectural models that incorporate both pricing and operational competition in a supply chain, which is the focus of this paper.

The traditional criticism of models using conjectural variations is that a given firm's conjecture regarding the output response of its competitor may not be confirmed if such a firm actually alters its output level from the equilibrium defined by that conjecture. As a result, there has been considerable interest in oligopoly models with "consistent" conjectural variations. A conjectural variation is defined as consistent if the actual slope of the reaction function of the firm is equal to the conjecture. It has been shown that the notion of the consistent conjecture is closely related to the evolutionarily stable conjecture, i.e., the conjecture of a player that no other conjecture performs better or equally well. The work is associated with the optimal outcome. This concept, as explained by Guth and Yaari [14], is based on the evolutionary premise that a conjecture that results in better performance is "selected for", i.e., firms that adopt it are more likely to succeed, whereas less successful conjectures ("mutations") are eliminated. Muller and Normann [15], however, showed that a consistent conjecture is not necessarily evolutionarily stable. Similarly, Dixon and Somma [16] found that the consistent conjecture is not evolutionarily stable in the case of constant marginal costs. Possajennikov [17] generalized the results of Dixon and Somma [16] by showing that equilibrium with evolutionarily stable conjectures is equivalent to that of consistent conjectures for a class of two-player games.

In this paper we consider two healthcare providers that are served by a single wholesaler. These providers form conjectures about each other's strategic actions based on either explicit or implicit collusion. Like Muller and Normann [15], who analyzed the evolutionary stability of conjectures for horizontal Cournot and Bertrand competition, we apply the static concept of an evolutionarily stable strategy to study the selection of conjectures by the providers. Unlike Muller and Normann [15], however, we consider supply chain interactions and include operations under demand uncertainty. Specifically, the providers compete for insurance reimbursement rates by choosing their respective market shares and operational strategies, under stochastic demand for medical care and corresponding demand for drugs. In addition to this horizontal competition, the providers are also engaged in vertical competition with the supplier, from whom they purchase drugs and common equipment items in response to the wholesale price offered. The provider uses these supplies when treating patients in its clinic. The items range from simple disposable items, such as gloves, tongue depressors, needles, paper towels and linens, to diverse medications and medical devices such as injectable steroids, Botox, intrathecal pumps, antiseptics, antipyretics, antiepileptics, and antiemetics for ambulatory general and pediatric clinics. The larger the scale of the clinic, the greater the investment in the clinic's inventory and the wider the spectrum of the items stored. Dental clinics, for example, are known for especially expensive and diverse inventories of restorative materials, periodontal and root canal drugs, and anesthetics. A typical, middle-scale dental clinic includes three–four doctors, four–five assistants and a couple of secretaries. The clinic treats 200–300 patients per month, which implies from 500 to 1000 patient visits a month (most of the patients are on repeat visits) and about $400–$600 revenue per patient. These activities necessitate a monthly purchase, ranging from $15,000 to $20,000 of materials and medications for treating the patients, most of whom are with private insurances.

We show that, because of operational costs, the consistent evolutionarily stable conjecture does not necessarily imply the presence of full cooperation between the two providers. Moreover, when the evolutionarily stable level of cooperation increases, the providers and the drug supplier do not necessarily improve their profits. In fact, the overall supply chain performance may deteriorate. This implies that significant cooperation between the healthcare providers can be detrimental to their own profits and to the profit of the entire supply chain.

Although competition is not always encouraged or permitted in healthcare and therefore our set-up might not necessarily reflect all healthcare systems, the approach we suggest captures the behavior of many healthcare providers who do compete. It provides a means for obtaining analytical results for better understanding the economic efficiency of the system and factors affecting it. These factors possibly shed light on some of the reasons why healthcare providers might be reluctant to cooperate.

The remainder of this paper is organized as follows. Section 2 formalizes the competition among the providers for patients via insurance reimbursement contracts, provider operations (equipment/material/drug purchase, inventory handling and customer service), and providers' conjectures about the behavior of their competitors. In Section 3, we determine conjectural equilibrium with respect to the providers' market shares and inventory policies. The effect of the providers' consolidation on the equilibrium is then studied in Section 4. In Section 5 the consistent and evolutionarily stable conjecture is determined. Section 6 extends our discussion to study the effect of a wholesale price contract on the competition and supply chain performance. Our conclusions and implications are summarized in Section 7.

2. Problem formulation

Consider two healthcare providers, whom we distinguish with index $j = 1, 2$ (all notations are presented in Table 1). These two providers are situated in close proximity, thereby competing with each other for patients. The patients in the area constitute a primary random demand, D^t, per given period $t = 0, 1, 2 \ldots$. Depending on the type of insurance, patients can either be referred to only one of the providers by their primary physicians or freely choose between the two providers. For example, in the US, patients with an HMO (Health Maintenance Organizations) health plan can only see a healthcare provider within the HMO's network, while patients with a PPO (Preferred Provider Organization) plan have