Supply Chain Expansion and Integration

The past two decades have witnessed a radical movement from vertically integrated supply chains towards globally decentralized supply chains. With the advancements of information technologies and reduced barriers in global trade, supply chains are expanding in a way that retailers can buy products from a larger collection of suppliers, and suppliers can sell to a larger group of retailers at different regions of the world (Netessine 2009). All these factors transformed local supply chains in which only a handful of firms transact into integrated supply chains in which a multitude of firms transact and compete. This paper examines the impact of the supply chain expansion and integration on supply chain performance.

Various factors fuel supply chain expansion and integration. Information technologies such as standard electronic business interfaces (SEBIs) enable supply chains to expand quickly and at low cost: Suppliers can easily sell to new retailers at different regions, and retailers can easily buy from new suppliers. Supply chain expansion or integration is also fueled by disappearing boundaries between countries after the formation of economic unions such as the European Union (in short, EU). When two countries join an economic union, transaction costs between supply chains in these countries decrease substantially because of reduced tariffs (taxes on imports or exports) and other trade barriers. Reduced transaction costs often induce local supply chains to form an integrated supply chain. For example, since Turkey entered the EU Customs Union in 1995, Turkish-specialty-food (e.g., sausage and pastrami) suppliers such as Aytac and Baktat have expanded their sales to retailers all over Europe, starting to compete with other Europe-based suppliers, such as Egeturk based in Germany and Gima based in the United Kingdom (in short, UK). More generally, after it is established in 1993, the EU Single Market Programme facilitated the integration of wholesale markets and supply chains throughout Europe (EU 2016). We may also see the opposite of integration, i.e., disintegration after the recent decision of the UK to leave the EU, popularly known as “Brexit.” After Brexit, if the UK leaves the EU Single Market along with the EU, supply chains that span both the UK and Europe may disintegrate. How this disintegration will affect the UK and EU is an important open question.

In this paper, we examine the impact of the supply chain expansion and integration on supply
chains’ performance when multiple suppliers and multiple retailers compete under uncertain demand. In particular, we aim to answer the following research questions: (Q1) How does the supply chain expansion to include more suppliers or more retailers affect the profit and efficiency of the supply chain? (Q2) How does the integration of two local supply chains affect the total profit of each local supply chain as well as the combined profit of the integrated supply chain?

To answer these questions, we propose an imperfect competition model based on a market game mechanism. In our model of a two-tier supply chain, multiple suppliers compete to sell a certain product to multiple retailers through a wholesale market. Suppliers make production decisions, retailers make ordering decisions, and a wholesale-market price is determined so as to equate the total production quantity to the total order quantity (i.e., clear the market). Our competition model captures a fundamental concept in economics: In an imperfectly competitive market, a finite number of firms compete, and hence each individual supplier or retailer influences the market price, causing a two-sided market friction. This fundamental concept has been either overlooked or only partially implemented by the competition models frequently used in the operations literature. For example, the Bertrand (price) competition model and the Cournot (quantity) competition model (at best) capture the impact of each supplier’s production decision on the wholesale-market price leading to a one-sided market friction, yet they overlook the impact of each retailer’s ordering decision on the wholesale-market price. This is because these models assume that each individual retailer is too small to influence the wholesale-market price. Corbett and Karmarkar (2001) improve the Cournot model by considering a finite number of influential suppliers and retailers, which is more suitable to supply chains in practice. However, they assume that retailers make ordering decisions given the wholesale-market price; i.e., retailers act as if they were price takers in the wholesale market. We improve Corbett and Karmarkar (2001) model further by developing a market-game model in which suppliers and retailers make production and ordering decisions, respectively, considering their impact on the wholesale market, so our model captures the intrinsic two-sided market friction. This novel feature in our model plays a crucial role in studying supply chain expansion and integration through the inclusion of suppliers, retailers, or both.

The analysis of our market-game model yields the following novel results. First, we show that
unlike the findings in the literature, the supply chain profit increases as the supply chain expands to include more suppliers or more retailers. The intuition is as follows. Due to the two-sided market friction, a retailer who faces demand uncertainty orders less than the quantity that balances her costs of under-stocking and over-stocking. When a supply chain expands to include more suppliers or more retailers, the two-sided market friction diminishes, and hence retailers order more. This ultimately improves the profit and efficiency of the supply chain. This result suggests encouraging expansion, for example, by using SEBIs or reducing trade barriers. Second, the integration of two local supply chains can improve profits of individual firms in the integrated supply chain although they compete with more firms. Moreover, the profit of the integrated supply chain is higher than the sum of total profits of local supply chains prior to integration. This result suggests, ceteris paribus, that the total profit of supply chains in the EU may have increased with the EU Single Market, and that Brexit may have a negative impact on supply chains in the EU. Third, we show that whether each local supply chain benefits from integration depends on ratios of suppliers to retailers in these supply chains. Specifically, when ratios of suppliers to retailers are similar in two local supply chains, their integration raises the total profit of firms in each local supply chain. In contrast, integration may reduce the total profit of firms in a supply chain with a smaller ratio of suppliers to retailers (than the other one) because suppliers lose profits after the integration, and although retailers gain profits (due to a lower wholesale price), retailers’ profit gains do not offset suppliers’ profit losses. By the same reasoning, a supply chain with a smaller ratio of suppliers to retailers may benefit from disintegration. This finding suggests that the UK, which has a smaller ratio of suppliers to retailers than the EU, could enjoy greater supply chain profits on aggregate after disintegrating from the EU although supply chains in the EU may lose profits.

References
