For decades, companies have struggled with the seemingly competing forces of excellent customer service and best-in-class operational cost. The prevailing view dictated that customer satisfaction required a high price and aftermarket service was a necessary evil. Only recently have companies realized that they can run their service business as a profit center, making both their customers and their shareholders happy. The advantages of achieving excellence in service supply chain management include increased customer satisfaction and retention, product sales, and service contract revenue as well as higher margins. Given the higher emphasis of customers on after-sale support, the importance of excellence in service supply chain management—and the risks of not taking proper steps to improve performance in this area, are expected to further increase in the future.

This article describes a five-step process to help companies swiftly get on that road to service supply chain excellence:

**Step 1: Understand Your Service Supply Chain.** The service supply chain is defined as all processes and activities involved in the planning, movement, and repair of materials to enable after-sales support of the company’s products. As a first step, companies should move into viewing the service supply chain as a cross-functional core process. Currently, many companies tend to have the service supply chain subprocess owners report into different organizational functions, which typically suboptimizes performance.

**Step 2: Determine How to Measure Your Service Supply Chain.** There is no single metric that defines the service supply chain’s performance. This challenge is complicated by the multitude of operational models typically in play. It’s essential to choose the right metrics, that are aligned with the organization’s strategy and balance operational and financial measures, and measure them in the right way. Otherwise, performance is likely to be suboptimized.

**Step 3: Develop the Business Case for Improvement.** Enhanced service supply chain performance can drive higher business growth or lower...
Capacity and Quality Risk in Decentralized Supply Chains

by Özalp Özer

This article is a compilation of research by Professor Özalp Özer; Dr. Wei Wei, a Ph.D. graduate of Stanford who is now at Morgan Stanley; and Ph.D. student Murat Kaya. Their work explores the risks in the management of decentralized supply chains. For more information, please contact Prof. Özer at oozer@stanford.edu.

The coordination of information, as well as operations and logistics optimization, has become increasingly more difficult with recent increases in supply chain complexity. These higher levels of complexity are the result of dramatic changes in manufacturing and distribution, including globalization and outsourcing. As a result, independent firms manage different parts of today's global supply chains. Each firm in the supply chain sets strategic and operational goals to maximize its own profit by using local information such as cost structures, profit margins and forecasts. Even though advances in information technology enable firms to collect, process, and share information, firms may be reluctant to do so because of conflicting incentives. Aligning incentives improves firms' profits and sustains the use of information technology.

We attribute incentive problems to two major risk imbalances: capacity (inventory) risk and quality risk. Because of these imbalances, the adverse effects of capacity and quality risks are more severe for a decentralized supply chain than for a vertically integrated supply chain. Here, we introduce our ongoing research in designing contracts to eliminate or mitigate these adverse effects. We will typify a two level supply chain using a contract manufacturer (CM) and an original equipment manufacturer (OEM).

Capacity Risk

Forecasting demand is inherently difficult due to short product life cycles and long production leadtimes. Hence, supply chains face the risk of either excess capacity due to low demand realization (downside capacity risk) or lack of product availability due to high demand realization (upside capacity risk). In a decentralized supply chain, lack of proper capacity risk sharing exacerbates the cost of capacity risk. Specifically, to deliver on time, the CM secures capacity in advance of an OEM order. For such a supply chain, if consumer demand turns out to be high, both the CM and the OEM face upside capacity risk. However, if consumer demand turns out to be low, only the CM faces downside capacity risk.

Double Marginalization

The severity of capacity risk for each party depends on the contractual agreements. Under a wholesale price contract, for example, the OEM pays a wholesale price $w$ to the CM for each unit ordered and sells the product to the market at $s$ per unit. The CM secures capacity at a unit cost of $c$, which could represent an equivalent annual cost of capacity. Hence, the CM's marginal profit $(w-c)$ is less than the vertically integrated supply chain's marginal profit $(r-c)$. This difference is known as double marginalization. The CM, therefore, protects himself by securing less capacity than what would be optimal for a vertically integrated supply chain. The OEM may eliminate this adverse effect of decentralization by sharing the CM's upside capacity risk. Note that the CM's marginal cost is $c$, whereas the OEM's marginal cost is zero. Hence, the OEM can, for example, agree to pay back $p$ per unit of unused capacity. This would reduce the CM's marginal cost to $(c-p)$ and induce the CM to build a higher capacity, thus aligning incentives. We refer to this as a pay back contract.

Forecast Information Asymmetry

Forecast manipulation is widespread in many industries, from apparel to high technology. PC and electronics manufacturers often submit "phantom orders" to induce their suppliers to secure more capacity. In 2001 Solectron, a major electronics CM, had $4.7 Billion in excess component capacity due to inflated forecasts provided by OEMs. Anticipating such forecast inflation, the CM may discount the forecast provided earlier. Unfortunately, this caution can also lead to huge losses. In 1997, Boeing's suppliers were not able to fulfill Boeing's large orders because they did not believe Boeing's optimistic forecasts.

Structured Agreements

Through our private conversations with executives from several industries, we confirmed that the unit cost of capacity and the degree of forecast information asymmetry are two primary drivers of capacity risk. Figure 1 maps the level of these drivers for industries. For example, in the semiconductor industry, compared to the OEM, the CM knows almost nothing about...
the product’s potential in the marketplace.

We characterize two types of contracts that enable credible forecast information sharing. The first contract type is a capacity reservation contract, which essentially holds the OEM accountable for her forecast information by requiring a fee for reserving capacity. The CM provides this contract as a menu of fees for corresponding capacity level that the OEM may reserve. The optimal reservation price has the characteristics of a quantity discount. The second contract is an advance purchase agreement, which provides an option to the OEM to place firm orders at an advance purchase price before the CM secures capacity. This agreement credibly signals the OEM’s forecast and induces the CM to secure the necessary capacity.

Depending on the per unit cost of capacity and the degree of forecast information asymmetry, OEM and CM can choose among structured agreements that enable a mutually beneficial partnership as summarized in Figure 2.

For example, when forecast information between the parties is highly imbalanced, and per unit cost of component capacity is low, then our analysis shows that the advanced purchase contract generates higher profits for both parties.

Quality Risks
Controlling quality of a product in a decentralized supply chain is a challenge. OEMs face the risk of lower quality than in a vertically integrated supply chain. We define quality as the product attributes for which customers prefer more to less. The classical quality literature narrowly defines quality as the percentage of products that are not defective. Today, OEMs are outsourcing more advance functions such as strategic sourcing, design, and even research and development. The OEMs can use inspection techniques to measure yield and, hence, can enforce a certain yield in the contract. However, when CMs undertake more advanced tasks, measuring either the CMs’ quality effort or their cost to achieve the desired quality level is difficult. This difficulty precludes the OEM from enforcing the desired quality level with a legal contract.

Not being able to foresee all possible contingencies and time to market pressures are two other reasons that make quality difficult to measure. Quality requirements may be better understood after the CM builds a prototype, but this step typically occurs after an outsourcing agreement is signed. According to a Toshiba manager, if Toshiba waited until they were absolutely sure of every final detail and then wrote a complete contract, they would be 6 to 12 months late to the marketplace. Therefore, establishing strategic relationship management systems between OEM and CM is probably a good idea in addition to structured and legally binding agreements. This strategic relationship may encourage, for example, implementation of quality programs such as TQM or Six Sigma.

We refer to the adverse effect of inefficiencies caused by immeasurability of both quality effort level and the quality cost as the quality risk.

In our research, we design procurement contracts that improve CM-OEM profits by inducing the CM to exert effort to produce better quality products when parties cannot explicitly contract on quality. With the help of our study, we characterize the value of being able to contract on quality. We also quantify the value of obtaining information on the CM’s quality cost for supply chains in which parties can contract on quality at the expense of writing long contracts and of conducting extensive testing, inspection and negotiation. Our models shed light on the value of such activities.

We also study the effect of the OEM’s product-pricing policy on the resulting quality of the product. In our correspondence with executives from the telecommunications and semiconductor industries, we were surprised by their two opposing product-pricing strategies. The telecom executive advocated setting market price for his final product in the contract terms with his contract manufacturer. The semiconductor executive advocated pricing the product after receiving components from the CM. Each manager claimed his practice would induce the CM to produce a higher quality component. One of our aims is to shed light on such opposing strategies.

We hope that this article provokes more thought and instigates action to efficiently manage capacity and quality risk in decentralized supply chains. We are interested in hearing about and working on related problems that practitioners are facing today.