Price Quoting Strategies of a Tier-Two Supplier

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In this paper we consider a two-tier supply chain, where the tier-two supplier quotes prices for a key component that she provides to several tier-one suppliers, who then compete on cost in an OEM’s sourcing auction. A tier-one supplier purchases the component at the quoted price only if he wins the contract (assuming the OEM’s contract is awarded as a whole). We are interested in the tier-two supplier’s optimal price-quoting strategy that maximizes her expected profit. Multi-tier supply chains are widespread, but to the best of our knowledge, our paper is the first in the sourcing literature to focus on a tier-two supplier’s strategies.

The most commonly seen price-quoting format of a tier-two supplier is fixed-price quotes: Based on her knowledge of the tier-one suppliers’ costs, she gives a fixed-price quote to each of her potential customers. We assume that she can give non-identical quotes to different tier-one suppliers (because no transaction takes place at the time of quoting, doing so does not pose a legal concern). To find the optimal fixed-price quotes, we use the following basic model: Two tier-one suppliers TO1 and TO2 are the only two participants in an OEM’s open-descending sourcing auction which starts at an announced reserve price r. The contract can only be awarded as a whole. Both tier-one suppliers have to depend on one tier-two supplier, TT, for a key component. Before the auction, TT gives each TO a price quote for the key component; the prices quoted to the TO’s can be different. If one TO wins the contract, TT will supply the component to this TO at the quoted price. If neither TO could meet the reserve price, TT has no business. The production cost of each TO (excluding the purchasing cost of the key component) is his private knowledge, but the distribution of the cost (assumed connected and bounded) is public information. Based on her prior belief about the two TO’s cost distributions, TT seeks to quote prices to the two TO’s to maximize her expected profit.

The basic trade-off in our problem is between payoff and chance of winning: Quoting a low price leads to limited payoff, while quoting a high price reduces the chance that the recipient of the quote will win the contract, along with the chance that TT receives the payoff. When there is only one tier-one supplier asking for a quote, we can easily find the optimal quote that balances this trade-off. However, quoting prices for two tier-one suppliers leads to increased complexity in decision making. For example, increasing the quote for one TO not only decreases his chance of winning, but also increases the other TO’s chance of winning, even when the other TO still receives the same quote. Thus, independently balancing the trade-off for each TO may not be optimal; all quotes have to be simultaneously determined. Technically, this is a multi-dimensional optimization problem, and is generally very difficult. We are however able to provide interesting structural results regarding the optimal fixed-price quotes.

Since a TO’s cost distribution is bounded, there always exists a quote low enough to guarantee that this TO will certainly meet the reserve price r. If a quoting strategy (a pair of quotes in our model) includes one such quote, we call it a secure quoting strategy. We call it this because with this strategy, TT is certain that at least one of the two TO’s can meet the reserve price. All other strategies are called risky strategies; with risky strategies there is a positive probability that TT will eventually have no business (meaning neither TO can meet the reserve price). Our paper shows the following structure of the optimal quoting strategy:
• Suppose we increase the cost distributions of both TO’s by adding the same constant amount to the costs. Then there is a threshold at which TT’s optimal strategy switches from being secure to being risky. Call it $T_1$.

• Suppose the two TO’s have identical cost distributions, and we increase the cost distributions of both TO’s by adding the same constant amount to the costs. Then there is another threshold at which the optimal strategy switches from asymmetric (non-identical quotes for the TO’s) to symmetric (identical quotes for the TO’s). Call it $T_2$. $T_1$ is smaller than $T_2$.

Intuitively, the structure can be described as follows: Assume we increase both TO’s cost distributions at the same time from sufficiently low values. The optimal quoting strategy starts out secure, then switches to risky at $T_1$ and never switches back. If the two TO’s have identical cost distributions, then at $T_1$ the risky strategy is asymmetric, it switches to symmetric at $T_2$, and it never switches back.

This is the central result for optimal fixed price quotes. The explanation of this result is as follows. The supply chain TT-TOi’s maximal total profit equals the reserve price $r$ less TOi’s own production cost. When TO’s costs are low, the profit potential for TT is high. In this case TT cannot risk losing the contract, so she uses a secure strategy to lock in the business with one TO, despite a low payoff. (We can also show that she will take chance and quote higher for the other TO, because having one TO securing business is enough.) When the profit potential becomes lower, the value of securing the business diminishes. Thus at a point she switches to a risky strategy to take a chance on both TO’s. If the two TO’s have identical cost distributions, she will eventually use a symmetric risky strategy, as in such a case symmetric quotes can maximize the payoff for bearing any fixed amount of risk. In short, the profit potential determines what strategy to use: High profit potential leads to secure strategies, while low profit potential leads to risky strategies. We further analyze a special case with uniform cost distributions, and characterize the optimal strategy in closed-form. The results in this special case support our general findings and insights.

So far we have assumed that TT can quote different prices for the TO’s. Doing so often favors one TO over the other, so it requires TT to have substantial supply chain power. When TT does not have this power, she may be restricted to giving identical quotes to the TO’s. Thus we also analyze the fixed-price quotes model with this restriction; we call this the one-price quote format. We show that characterizing the optimal one-price quote is similar to characterizing the optimal quote with only one TO. In particular, we find that when the two TO’s have identical cost distributions and TT is restricted to giving a one-price quote, a secure strategy is never optimal. It is also obvious that the optimal one-price quote generates no higher expected profit than the optimal fixed-price quotes.

On the other hand, there are cases where TT has overwhelming supply chain power (e.g. Intel versus computer assemblers, until some of Intel’s supply chain power was reduced by regulatory authorities). In these cases, TT may ask TO’s to report their production costs (excluding the cost
of the key component from TT), and determine her quotes for the component based on the reports she receives. Of course, the TO’s cost information is private, and TT has to forego some profit in her quoting rules due to the TO’s information rent. To find TT’s the optimal quoting rules, we apply mechanism design theory to this problem: TT maximizes her expected profit by announcing an optimal price-quoting rule mapping the TO’s reports into quotes for them, in a way that accounts for the TO’s incentives to misreport their private production costs. We find that the optimal mechanism effectively “auctions” TT’s component supply between the TO’s based on their production costs. In addition, the optimal mechanism “eliminates” the inefficient TO from the OEM’s auction by quoting a prohibitively high price for him, so as to maximize the supply chain profit with the efficient TO. By definition, when implementable, the optimal mechanism generates the highest possible expected profit for TT, which is of course as high as that generated by the optimal fixed-price quotes. However, since in any optimal mechanism one TO will always be eliminated, TT has to have absolute supply chain power to overcome the TO’s likely opposition. In addition, the mechanism tends to be complex and unintuitive. While the optimal mechanism is important as a benchmark, all these issues mean that implementing the optimal mechanism in real life can be difficult.

Finally, we generalize the assumption that only two TO’s participate in the OEM’s auction and both depend on TT for the component, to allow any number of participants who may or may not depend on TT (for example, 4 out of 10 auction participants depend on TT for the component, while the rest have their own supply or production capability). We are able to extend most of our results under this setting, including: The threshold result which states that the optimal fixed-price quote switches from secure to risky; the optimal one-price quote characterization and non-existence of an optimal secure strategy for TO’s with identical cost distributions; and (a more general version of) the optimal quoting mechanism.

To summarize our paper, we study the price-quoting strategies of a tier-two supplier, particularly when she quotes prices to multiple tier-one suppliers. For fixed-price quotes, we identify secure and risky strategies and show that the optimal strategy switches from risky to secure as the profit potential increases. We also study two alternative price quoting formats – the one-price quote and the optimal quoting mechanism – which may become prevalent when TT has low and high supply chain power, respectively. We believe our results have the potential to help suppliers in practice make more profitable price-quoting decisions, and will spur further research into this important but little-studied area of sourcing.