Pricing Service with Heterogeneous Quality and Customer Taste

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We consider a market with two types of service with one having a higher service value than the other. Customers are heterogeneous on service taste (or service reward). Such service system with two-dimensional heterogeneity is common in our real life but the pricing problem for such kind of system is never studied in the literature. Past studies consider either homogeneous service quality with heterogeneous customers or the other way around.

We assume that customers make their queueing decision in a decentralized way. Queues are unobservable. When customers make their queueing decision according to utility maximization, their decision is affected by the delay of the system, which, in turn, is affected by how other customers make such decision. We hence derive customer equilibrium queueing strategy. Since customers are heterogeneous on service taste, the equilibrium strategy turns out to be a threshold strategy which results in a value-based market segmentation.

We then study pricing strategy for a monopolist who provides both types of services to customers and compare the profit-maximizing prices with the socially optimal ones. To ensure the concavity of profit function, we introduce the concept of increasing virtual value function, which has been identified in the auction and mechanism design literature. Then, both the profit-maximizing and welfare-maximizing problems (denoted by System C and System S, respectively) can be represented by constrained optimization problems with customer equilibrium queueing equations as constrains. The optimal solution for such problems can be solved via Karush-Kuhn-Tucker conditions. For System S, we show that the price charged for each service always equals the marginal externality of joining. For System C, the price charged for each service is higher than the marginal externality of joining. With optimal prices posited by a decision maker, different market structures can be formed according to which servers being active: either high-end or low-end or both. In a plane with x-axis being server 1's service rate and y-axis being server 2's service rate, the region for each market structure is identified. See Figure 1 for illustration. We take system C as an example to explain: The region between the two green curves represents the market structure with both servers being active. The region between the lower green line and the x-axis represents the market structure with only server 1 being active. Similarly, the region between the upper green line and the y-axis represents the one with only server 2 being active. Our result demonstrates the existence of strategic deactivation—a centralized system, either System C or S, will strategically deactivate the slower server, no matter it is the high-end or low-end service, to eliminate the competition between two servers.

We finally study the price competition (denoted by System D) between a high-end service provider and a low-end one. We show that when the service reward has an increasing virtual value function, the pure-strategy Nash equilibrium exists and is unique. Comparison among the three systems shows that welfare maximization leads to the lowest price for each service. We also find that competition brings two main effects. One, it reduces the price for both types of services, compared with the profit-maximizing prices. Two, it sustains the variety of services. Specifically, while in some scenarios only one type of service is provided by a monopolist, both types of service are provided in a duopoly competition market, see Figure 1 for illustration. From the figure, we can see that the region for both servers being active in system D contains the one for system S, which, in turn, contains the one for system C. We also numerically show that System C tends to serve the smallest number of customers, while System S serves the largest.

Figure 1: The regions where both servers are used