Service Revenue Management When Customers Prefer Crowds

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Motivation: For many types of services, customers receive greater utility when they participate in larger groups. The most notable examples are drawn from entertainment industries where customers enjoy increased social interaction. For instance, an online video game may not be much "fun" if there is only a single player. As a result, when multiple service options are offered, one option may attract more customers which in turn may attract even more customers leading to a potential *snowball* effect where one of the service options may become universally preferred. For the service provider presenting multiple server options this unequal load may be detrimental: the increased load on the preferred server often results in congestion and lowers revenue. For instance, in the video game example, games with more players will take longer to complete and if the provider is charging customers on a per game basis this will reduce revenues. This is a potential issue whenever customers are charged à la carte and are free to select from a menu of service options. The service provider would gain increased revenue from a more equitable distribution of customers between service options.

The degree of differentiation between offered services is often a decision variable for service managers. In the video game example, the provider might present beginner and advanced game options. In a casino, the lower limits on bets at particular tables are changed at a moments notice. By increasing the degree of differentiation between offered services, idiosyncratic preferences on the part of customers may inhibit crowding around a particular service option. In this paper we study when and how service differentiation can be used as a managerial tool to improve the distribution of customers and increase revenue when customers prefer to crowd.

We study an analytical model of a monopoly service provider who can operate two possibly differentiated servers. We find criteria describing when service differentiation can be used to reduce congestion from crowding—there are reasonable problem parameters where any partitioning of customers to multiple servers is unstable. We also identify the optimal service differentiation and how it depends on market and operational problem parameters.

We observe that as the preference for crowding is increased, the optimal service differentiation will transition through three distinct regions where optimal differentiation is high only in the intermediate region.

The presence of customer preferences that lead to crowding around particular products and services dates back to Veblen [1899]. There are a number of more recent economic studies of competitive settings including Becker [1991] which observes how such preferences can cause demand inequality for similar restaurants. Our model of a monopoly service provider is influenced by the analyses of a competitive setting in Grilo et al. [2001]. To the best of our knowledge, our paper is the first to study this setting from a revenue management perspective.

Model: Our model features a monopoly service provider who may operate up to two servers. The level of differentiation is determined by the difference between each servers *service-type* parameter. While prices and system wide demand are fixed, the provider can change the degree of differentiation by selecting service-type parameters from the 0-1 interval for each service option. Servers also vary in their *efficiency*, which determines the marginal revenue from serving a customer when they have minimal demand. As customer demand on each server increases the marginal revenue decreases linearly according to a *congestion* parameter. The customers' types are drawn from the 0-1 interval and describe their idiosyncratic preference for service options. The customer's utility for receipt of service from a particular server has two additive components: a *service utility* which is higher when customer and server types are more similar and a *crowd utility* which increases as the number of customers using the server grows at a rate determined by a *crowding* parameter. Each customer chooses the server which maximizes her utility and the service provider selects the level of differentiation which results in a stable assignment of customers (ie. an arbitrarily small deviation of customers will not change other customers decisions) and, of these stable assignments, maximizes expected revenue.

Results and Significance: The optimal server positioning is driven by two effects:

1. Parameters that reinforce crowding require additional differentiation to optimally partition customers.

2. Parameters that reinforce crowding shrink the space of stable customer partitionings requiring the provider to settle for *second best* solutions.

For instance, if the crowding parameter is increased, relative utility for the more crowded server will increase, leading some customers to switch servers. The service provider may be able to maintain the current partitioning by increasing differentiation but at some point, the level of differentiation will be maximized and this particular partitioning will no longer be stable for any pair of server types. When the crowding parameter is large enough a single server with maximum efficiency will provide higher stable revenue than any pair of servers. This results in the following transitions:

1. At low incentives to crowd, the first best partitioning of customers can be implemented with minimal differentiation.

2. At moderate incentives to crowd, only a second best solution can be implemented and requires high levels of differentiation.

3. At high incentives to crowd, it is most profitable to operate only the most efficient server.

We introduce a novel motive for a monopolist to differentiate services which is of interest to a variety of service industries where customers benefit from receiving the service with their cohort.

References

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