

2013 Russell Ackoff Doctoral Student Fellowship Application

Project Title: Modeling Consumer Decision-Making Behaviors in Blind Queues and Retrial Queues

Applicant: Shiliang Cui, 4th Year Ph.D. Student at OPIM

Faculty Advisors: Xuanming Su and Senthil Veeraraghavan

Date: March 1, 2013

Introduction and Project Goal:

The goal of our project is to model consumer decision-making biases in queueing settings, and study their effect on consumer learning, revenues and welfare. Much of the Service Operations literature in queueing does not include psychological considerations in consumer decisions. Our research project seeks to fill this gap, by demonstrating such decision-making process significantly influences queue outcomes. In particular, we consider two distinct settings: First, we consider settings when consumers join queues with biased information – we call them *blind* queues. Second, we consider *retrial* queues based on the observation that consumers often postpone their decisions based on several considerations. Both of these decision making issues have not been considered in the queueing literature.

Much of the traditional operations literature on queues assumes that the service parameters (service time distributions, etc.) are common knowledge and fully known to consumers when making their decisions. While this is acceptable in the operations literature, in reality, it is likely that only the service firm knows its capacity, and the consumers may not be fully informed of the service capacity. In fact, it is even likely that consumers could be misinformed about a firm's service capacity. In such blind queues, consumers typically make their decisions based on the limited information and the biases they arrive with.

For instance, a customer might have visited a restaurant or an amusement park only once or twice. It is conceivable that his estimate of the service time will be strongly dependent on the bias formed based from previous service experience. In some cases, consumers might augment their information using feedback from external acquaintances, but even such information is likely to be a smaller sample than what is needed to know the full service distribution (which is often assumed to be known accurately in the literature).

Almost all queueing models have focused on consumers' join and balk¹ decisions – with customers not making forward looking decisions. In reality, when the queue is very long, consumers may not be willing to wait, rather they choose to retry later (as opposed to balking). For instance, consider a customer who arrives at the package pick-up service at a post office, or a customer who goes to have his parking permit renewed. Upon seeing the status of the queue, i.e., the number of consumers that are already in the queue, this customer can either decide to join the queue or to leave only to return back at a later more convenient time. In scenarios such as the post office and the parking permit renewal examples, and in many other real-life queues such as discretionary shopping decisions, postponing is a commonly used practice among consumers.

We will study revenues, consumer and social welfare under various *boundedly rational* and *irrational* consumer decisions. It is important to understand if the service firm is motivated to reveal its private service information to the customers to alleviate costs of biases, or just want to remain a blind queue. It is important to understand if retrials can make the consumers, the firm, and/or the society better off. Finally, we will study the effect of learning service/queue information through sampling on consumer decisions.

¹ Balk: Do not enter the queue, and never return. (We consider balking a restriction on how consumers make decisions in time-related events).

Planned Methodology:

We will pursue modeling work based on the classical queueing model by Naor (1969)² but extend it to include decision-making and psychology research in two ways. Naor studies a single-server system with an observable queue where rational consumers (who *know* the service parameters) make join or balk decisions. In contrast, we will model consumers with decision biases, who may have arbitrarily different (even misled) beliefs about the service rate. Under these beliefs, the consumers will make a decision to join the system, balk from it, or *postpone* at later time period with a retrial cost. This cost can be an external cost incurred by the customer, but not collected by the server (for e.g., costs associated with transportation back and forth, or a retrial “hassle” cost such as rescheduling other activities, which may cause irrational deviations) or an internal fee collected by the server (for e.g., a toll for entering the system, such as visit fees and copays in insurance services).

We will then apply our modeling framework to the following specific belief structures:

- Quantal Response Errors: Consumers in queues may make “errors” in their estimate of the true service rate due to cognitive limitations following Quantal Choice Theory (Luce, 1959)³, which argues that decision makers do not always choose the “correct” alternative, but alternatives with smaller errors are chosen with a higher probability than the alternatives that are worse.
- Learning by Sampling Past Experiences: Consumers could use their past service experience as samples to learn more about the service rate. This sampling helps consumers to arrive at their beliefs and eventually make their decisions. Consumers may not be able to sample properly due to limited cognitive attention to the sequence of events, or due to system environment. For example, emergency room queues, where consumers can sample, but unlikely to sample accurately due to the state of their mind.
- Limited Memories/Cognitive Costs: Consumers may come across information (for e.g., reviews on bulletin boards or websites), but may not recall all observed information due to cognitive limitations. When subjected to an increasing amount of information, a consumer may remember only a limited amount of information.
- Availability Bias: Under availability bias, consumers remember unusual experiences saliently, in forming their beliefs. Thus, consumers recall poor longer-than-usual service times more vividly. When consumers update their beliefs, longer (worse) service times affect updating more significantly according to the Prospect Theory (Kahneman and Tversky, 1979)⁴. This hurts server revenues.

Conclusion and Needs of the Funding:

To conclude this application, I believe that the project proposed is an important missing piece in the current queueing literature. The findings of the project will have wide implications in service operations such as congestion models and health care settings. We sincerely believe that the project goals are consistent with the mission and interest of the Russell Ackoff Doctoral Student Fellowship. Finally, the support from this grant will make it possible for me to present my research findings at two key conferences during upcoming job market year. I sincerely thank the committee for the opportunity to be considered for the 2013 Russell Ackoff Doctoral Student Fellowship. Please see page 3 for the breakdown of the anticipated expenses.

² Naor, P. (1969). The regulation of queue size by levying tolls. *Econometrica*, 15-24.

³ Luce, R. (1959). *Individual Choice Behavior*. Wiley, New York.

⁴ Tversky, A. and D. Kahneman (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology* 5 (1), 207-233.

Anticipated Expenses (\$3,750):

As entering job market in my fifth year, I would like to attend the 2013 POMS, MSOM and INFORMS conferences. I have received funding from the Wharton Doctoral Office to attend the POMS conference. I sincerely hope that the Russell Ackoff Doctoral Student Fellowship can support me to present my research work on consumer decision-making in queues, at the other two conferences. The total amount I would like to request is \$3,750. Since my work is based on modeling and does not involve data collection, the entire budget will be spent on attending conferences. Please find below the anticipated expenses based on estimates and the previous 2012 conferences.

- 2013 Manufacturing & Service Operations Management (MSOM) Society Meeting
 - INSEAD, Fontainebleau, France, July 28-30, 2013
 - Round-trip airfare b/t Philadelphia and Paris: \$1,400
 - Round-trip transportation fee b/t Paris and Fontainebleau: \$300
 - Hotel expenses: \$125/per night * 4 nights = \$500
 - Conference registration: \$150 including
 - Early registration for student to attend MSOM: \$100
 - Early registration for student to attend the SIG conference: \$50
 - Obtaining Schengen Visa at Washington, D.C.: \$150 including
 - Visa fee for short-term stay in France: \$80
 - Round-trip transportation fee b/t Philadelphia and the Consulate at D.C.: \$70
 - **Subtotal: \$2,500**

- INFORMS Annual Meeting 2013
 - Minneapolis, Minnesota, October 6-9, 2013
 - Round-trip airfare b/t Philadelphia and Minneapolis: \$400
 - Hotel expenses: \$150/per night * 4 nights = \$600
 - Conference registration for student non-member: \$250
 - **Subtotal: \$1,250**

Current Sources of Available Funding:

- Wharton Doctoral Office Travel Grant (\$500): Only to be used to present research at the 2013 Production & Operation Management Society (POMS) Meeting, May 3-6, 2013 in Denver, CO.

Advisor Signature (Senthil Veeraraghavan):

Dear Howard, Bob and Erwann,

Shiliang is a 4th year doctoral student jointly advised by Morris Cohen and me on his dissertation. As a part of his dissertation papers, Xuanming, Shiliang and I have been looking at integrating decision biases into Service Operations, very much in the spirit of Russell Ackoff. We are excited about the work, and look forward to sharing our research progress and working papers. Shiliang's work will bring in a fresh perspective to Service Operations Research, and the grant will help him attend key conferences to present his findings. Hence, I wholeheartedly support Shiliang's application for the Ackoff grant.

Sincerely,



Senthil Veeraraghavan