

# **Queue Now or Queue Later: An Empirical Study of Callers' Redial Behaviors**

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Queues are an inherent outcome of many service systems. Because waiting in queue is typically perceived as negative, customers may choose either to not enter a queue if the length is too long (balk) or exit a queue prior to receiving service (renege). Balking and reneging have been extensively studied both analytically and empirically in both visible and invisible queues. However, models of queueing systems which only account for balking and reneging may ignore the impact of customers who choose to return to queue later. For example, amusement park customers often traverse the park searching for an attraction to ride. Upon observing a long queue for an attraction, some customers may balk but choose to return later when the queue is shorter. Another example is customer support in a call center. Callers waiting in a phone queue may choose to renege in order to redial at a more convenient time.

Managers of queueing systems with customers who return after balking or reneging may be interested in answering two sets of questions. First, after voluntarily exiting, how often do customers return to queue? What factors influence customers' decisions of whether to return? What is the process that customers use to decide whether to continue waiting, return later, or abandon their service request indefinitely? Second, how do returning customers affect the performance measures of the queueing system? For example, what is the impact of returning customers on waiting times and renege rates? Furthermore, how will managerial decisions such as employee staffing change if customers return to queue? In this paper, we answer these questions empirically by formulating and estimating the parameters of a structural model of callers' redial decisions in a commercial banking call center. Our model demonstrates how callers determine both how long to wait before reneging and whether to return later. We also use our model to demonstrate how the performance measures of this call center are affected by caller redialing and show that managers who ignore redialing will systematically understaff relative to their service level targets.

We study callers' redial behaviors using data from the credit/debit card servicing group of a

commercial banking call center. Using a unique identifier for each caller, we are able to determine whether callers chose to redial after exiting the queue. We find that 49 percent of callers who leave their queues prior to receiving service redial within 72 hours; however, this figure varies depending on callers' history with the call center such as their contact frequency and previous redialing decisions. We exploit this variation in caller history to conduct an empirical analysis of redial behaviors.

We examine what factors affect callers' decisions of whether and when to redial. We observe that callers' past history with the call center affects their future redial behaviors. For example, we find that callers who contact the call center more frequently are more likely to redial after reneging. We also find that callers who have previously redialed are more likely to redial in the future. While our examination of what factors affect caller's redial decisions is informative, we desire deeper insights regarding why callers choose to continue waiting, abandon or redial. Thus, we formulate and estimate the parameters of a structural model of callers' redial behaviors. We model callers as utility maximizing agents who periodically choose among the options of continuing to wait, abandoning, and redialing.

Callers may behave differently in queue due either to their past experiences with the call center or to permanent differences in their underlying preferences. For example, the positive correlation between past and future redialing could stem from one of two reasons. First, callers who redial once may find redialing in the future to be easier and are thus more likely to do so in the future. Second, certain callers may have an inherently higher propensity to redial. In both cases, we would observe the positive correlations between past and future redialing. To separate out the effects of caller history and permanent caller heterogeneity, we use a latent segment framework. We assume that callers belong to one of a finite number of segments and that callers within each segment are homogeneous with respect to their structural parameters. We are thus able to account for permanent unobserved heterogeneity and draw insights into how callers across segments determine whether to continue waiting, abandon or redial.

We recover the parameters of our structural model for each service group using maximum likelihood estimation (MLE). We observe that callers' utility of waiting varies significantly based on their segment, and current time spent waiting in queue. For example, we show that callers' expected utility of waiting is highest immediately after joining the queue but drops to its lowest

point within thirty seconds of waiting. This finding indicates that callers are initially patient, but quickly lose their patience as they wait. We also find that callers incur a high cost relative to their service reward when they choose to redial. This result implies that the process of dialing the call center and navigating through the menu options is costly for callers. Finally, we observe that callers' history impacts their redial decisions. For example, in one caller segment, callers who have redialed in the past have a 16% higher probability of choosing to redial in the future.

Finally, we demonstrate the effects of caller redialing on the performance measures of the call center under study. To do this, we perform two sets of counterfactual scenarios. We first use our redial model to project the waiting times and renege rates under various staffing levels. We then use the same arrival rate, service time and staffing assumptions, but project the performance using a model which does not consider redialing. Our projections show that waiting times and renege rates are higher when callers redial, and that the performance gap increases as staff decreases. For example, under the lowest level of staffing in our scenarios, the average caller waiting time is 249 seconds in the presence of redialing and 143 seconds when callers do not redial. We show that this gap is caused by the increase in the effective arrival rate due to caller redialing. This substantial difference in the performance projections under the two scenarios show that managers who ignore customers returning to queue may make misinformed staffing decisions.

This paper has three main contributions. First, we take a data-driven approach to study individual callers' redial behaviors. Though redialing has been analytically studied extensively, to the best of our knowledge, ours is the first empirical study of this caller behavior. Second, we add to the recent stream of structural models of caller behaviors by including the option of redialing to the callers' choice set. This addition allows us to draw conclusions about how callers choose both how long they are willing to wait and whether to redial. Finally, we demonstrate that caller redialing can have a substantial impact on the performance of a queuing system and that managers should consider redialing when determining staffing policies. The result of our work is a model which provides valuable insights into caller redial behaviors and demonstrates the managerial importance of accounting for redialing.