The ZocDoc Effect: How Does Online Information Impact Appointment Availability in Outpatient Care?

Patients in the healthcare market typically face uncertainty regarding the doctor’s quality, and may rely on imperfect signals to infer quality measures such as accuracy of diagnosis, bedside manner, and operational factors such as service time, waiting time, and appointment availability. Traditionally, patients have relied on word of mouth to resolve some of these information asymmetries. For example, patients may ask their peers to recommend a physician or ask their primary doctor to recommend a specialist. Patients may also gain information about best doctors lists published in the popular media. In the absence of other channels for discerning physician quality, online physician ratings are gaining popularity among patients. On the other hand, ever since the Affordable Care Act has been signed into law in 2010, the waiting times for doctor service have become longer as reported by National Public Radio (NPR) and Wall Street Journal (WSJ). In the outpatient physician services, we would expect the waiting time for the appointment to be a non-negligible part of the patient valuation of the doctor service. Therefore, on the one hand, doctors may want to increase service rate to serve more patients under the pay per patient reimbursement mechanism to maximize their total revenues. On the other hand, if the service time is too short, the patient valuation of the service may decrease. Thus, how to balance the patient valuation and productivity is a serious problem for healthcare providers. This paper, to our knowledge, is the first one that proposes a queueing model to explore how the online information, namely displayed appointment book and online ratings, affect both patients and doctors’ decisions.

To gain a sense of the rapidly growing healthcare online market, we take a look at some statistics. First, the public demand for this type of online information is accelerating: a recent survey found 61% of US adults have looked online for health information. Moreover, according to a recent report from Accenture, by the end of 2019, two thirds of U.S. health systems will offer self-scheduling tools for patients to book, change, or cancel their appointments online, generating $3.2 billion in added value or potential savings for U.S.
health systems. Despite the increasing popularity of these online rating websites, how the displayed information would affect the healthcare market, namely patients and doctors decisions, is unclear. We integrate and extend the advances in healthcare operations models, taking a step towards a more detailed understanding of patients and doctors’ behavior in the healthcare online markets.

The empirical results of Xu et al. (2015) indicate that patients care about waiting time and service time when choosing doctors in the healthcare online market. Following the insights derived from Xu et al. (2015), our work discusses specifically how in-clinic waiting time and displayed appointment service time affect patient appointment book joining decisions and doctor’s service decisions. We postulate that a shorter in-clinic service time decreases the doctor’s rating, because patients might consider the doctor to be rushed and inconsiderate. The impact of displaying the appointment book time includes two components: one is the appointment delay cost, and the other is the mismatch cost between the displayed service duration and the actual in-clinic service time. For the appointment delay cost, since now patients can observe the entire appointment book of the doctor, they can directly infer how much delay they will incur if they book with this particular doctor. For the mismatch cost, patients observe the displayed appointment duration, and can also implicitly infer the actual expected appointment duration, they may associate cost with having displayed appointment duration that is longer than actual in-clinic service duration.

Next, the doctor in this market attempts to maximize his utility determined by the expected intra-day in-clinic arrivals as well as the clinic congestion cost. We characterize the optimal strategy of the doctor, and show that when the potential market size is large, the optimal strategy falls into the partial market coverage regime; while when the market size is small, the optimal strategy falls into the full market coverage regime.

In the full market coverage regime, it is always optimal for the doctor to use an “open access” strategy, and the doctor would choose to use the highest possible in-clinic service rate. In the partial market coverage regime, there are two scenarios under which the optimal strategy of partial market coverage regime exist. In the first scenario, the doctor uses an
aggressive strategy to set higher appointment book service rate than the in-clinic service
rate, and again the doctor uses the full in-clinic service rate capacity. In the second scenario,
where the market size is larger than the first scenario, the doctor uses a conservative strat-
ey to set lower appointment book service rate than in-clinic service rate, and the doctor
would lower the in-clinic service rate. The results of the second scenario are mainly driven
by the mismatch cost and in-clinic congestion cost. When there’s no mismatch cost, we find
that the optimal strategy always exists and is characterized by the aggressive strategy.

Finally, we run a simulation study to check the robustness of our results and insights
from the analytical model. We focus on examining two major approximations in our ana-
lytical model: (i) steady-state distribution and Poisson arrivals of in-clinic system, and (ii)
patients’ choice towards nearest possible slots. In general, we show consistent results be-
tween the analytical solutions and simulation solutions for approximation (i). With respect
to approximation (ii), First, we find the pattern of the optimal in-clinic service rate will
increase first when the arrival rate increases, and then decrease to similar values as our ana-
lytical results. The optimal appointment book service rate is close to our analytical solution
when the arrival rate is small, however the value increases when the arrival rate gets larger
as compared to the decreasing pattern for our analytical results. In general, we find that
under random appointment choice assumption, the doctor would increase the appointment
book service rate to assign enough capacity to each single day due to the uncertainty of
patient choices, especially when the market size is large.

This paper makes two key contributions. First, to our knowledge, this study is the first
to incorporate online rating and displayed appointment book together into a queueing model
to study doctor’s optimal behavior. Moreover, the model is inspired by empirical evidence
(Xu et al. (2015)) which makes the model practically valid. Our model lays foundation for
future research in healthcare operations and online marketing. Second, our model provides
new insights into the nature of healthcare online market, and show the impact of online
information on doctor’s service decisions and service outcomes.
References