Fondren Library Study Room Allocation

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Rice University contains a myriad of hidden markets that often match students to services, objects, or even other people without the use of any financial instruments. To the watchful eye, one can tease out the functioning of these markets and apply economic theory and empirical analysis to better understand how they can be improved to achieve goals such as efficiency, fairness, and simplicity. One such market is for study rooms at Fondren Library. Fondren offers 45 study rooms available for checkout to Rice ID holders for up to four hours at a time, with each ID holder allowed one reservation per day. The reservations can be made up to three days in advance, and these rooms vary in size, location, and time availability. There is an exception for the three largest study rooms, which can be reserved more than three days in advance. The current mechanism for allocating study rooms to students is a first-come first-served strategy: each student can reserve any room for up to four hours that is open within the next three days. Additionally, a student is allowed one reservation per day, and if a room remains unclaimed for 30 minutes after the time of the reservation, the reservation is released. During the semester, the library, as well as most study rooms, is open 24 hours Monday through Thursday, 12 a.m. to 10 p.m. on Friday, 9 a.m. to 7 p.m. on Saturday, and 12 p.m. to midnight on Sunday. However, these hours change during finals period, the last 10 days of the semester, so that the library and study rooms are open 24 hours a day for the entire 10-day period. As one could imagine, with several thousand undergraduate and graduate students, the market for study rooms can become thick, even congested, especially during final exam periods.

For our term paper, we decided to examine whether the current allocation mechanism for study rooms was effective during regular order
of the university and during finals period.

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Figure 1: Fondren Library Hours
These are the hours of operation of Fondren Library during the normal semester, outside of finals period.

To do this, we conducted a campus-wide survey\(^1\) of students about their opinions and experiences using the study room reservation system, which we compared to data on reservations from Fondren Library IT staff. While the survey could suffer from sample selection bias, we believe it is still informative of the views of many users of study rooms.

We broke up our survey into four sections, designed to determine the effectiveness of the study room allocation mechanism at different times of the year. The first section asked students about their experiences and strategic behavior during the regular semester, to establish a baseline against which we could compare behavior once the market thickened during finals period. We then asked students the same questions about their expected study room usage during finals period\(^1\) and asked several questions to assess students’ knowledge of the changes to reservation rules that take place during finals period. After reporting their own expected behavior, we asked students to assess their beliefs about other students’ strategies during finals period. This would allow us to understand their perceptions of other students’ behavior. Finally, we asked students to qualitatively report what they wished to maintain and hoped to change about the current study room reservation system.

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\(^1\) The survey was released on November 27th, 2018, four days before the beginning of the designated “Dead Days” period, and responses were received up until December 6th, two days into scheduled final examinations.
We compared this information to data we received from Fondren Library about the time, length, and frequency of study room reservations and use. We divided this data into two blocks, the first recording study room use from November 5th through 26th, representing three weeks of “regular semester use,” with the second encompassing all study room use during “Dead Days,” which lasted from December 1st through 4th. From this raw data, we compared study room use between these two periods by two different metrics: the duration of each reservation and the length of time between when the study room reservation was made and when the study room was used. While we also hoped to compare the length of study room reservations with length of use (determined by check-in and check-out times), Fondren Library personnel suggested this data would be unreliable. Instead, we considered self-reported and qualitative data from the student survey to determine whether students reserved study rooms for efficient lengths of time.

The data we gathered from Fondren reveals many insights about the nature of how students interact with the current market for study rooms. For example, Figure 2 shows the duration of reservations during finals period and the normal semester. We see that there is a shift in the duration of reservations towards longer reservations during finals period: the average duration increased from 2 hours and 53 minutes to 3 hours and 14 minutes, an increase of about 12%. Additionally, most of this increase is at the maximum reservation duration of four hours, which rises in frequency by a large margin. Furthermore, Figure 3 depicts how far in advance students reserve their rooms. Excluding outliers, which occur in the specialty rooms, students are allowed to reserve study rooms up to 72 hours in advance. Interestingly, the data shows that most of the reservations are made within a few hours of their starting times. A more striking result is the difference in reservation habits between the normal semester and finals period. During the normal semester, students seem less inclined to plan ahead for their study rooms, which is depicted in the top right graph showing that over a third of reservations are made within just three
hours of the starting time. However, that fraction drops to a quarter when looking at finals period, implying that students are reserving their rooms in advance at greater rates than during the normal semester. One potential reason is that during the normal semester the market for study rooms is thin, and students can find an available study room whenever they please. However, during finals period the market becomes more congested, and students have to plan ahead and strategize to be able to reserve study rooms.

![Finals Period duration of reservations](image1)

![Normal Semester duration of reservations](image2)

Figure 2: Duration of Reservations
These graphs display the frequency histogram of the duration of reservation times during finals and the normal semester.
ervations calculated from the start to end time of the reservation. The left graph is the frequency histogram during finals period, while the right graph is during the normal semester. There are 1069 reservations for the finals period with an average duration of 3:14 and a standard deviation of 0:59. There are 3796 reservations for the Normal Semester with an average duration of 2:53 and a standard deviation of 1:06.

The data in Figure 3 provides an interesting comparison to the survey results, because while nearly 43% of respondents report that they reserve study rooms at least a day in advance, we can see that this is clearly not the case as 76.7% of reservations during the normal semester were made within 24 hours of the start time of the reservation. However, there is a shift in both survey results and Fondren data for the finals period, where 61% of respondents reported that they planned to reserve study rooms at least a day in advance, and instead 63.7% of reservations were made within 24 hours of the start time. Thus, we can see that while survey results may not exactly reflect the Fondren data, trends in both data sets are correlated. Additionally, this difference between finals period and the normal semester is consistent with the claim that students are planning and strategizing more during finals period than during the normal semester. This claim is supported by another question in the survey asking whether students agree with the statement that they “plan more when reserving a study room during finals period than [...] during the regular semester,” the average response to which was “Slightly Agree” (3.759)².

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² Answers were solicited on a scale from “Strongly Disagree” to “Strongly Agree,” which were converted to numbers between 1 and 5 for ease of analysis, with 1 representing “Strongly Disagree” and 5 representing “Strongly Agree.”
Figure 3: Advance Reservations
These graphs were calculated by finding the difference in time between the start of the reservation and the time the reservation was created. The top blue graphs are during the normal semester, which had 3796 reservations, while the bottom orange graphs are during the finals period, which had 1096 reservations.
We also might note that, even if the majority of reservations during finals period are made within 24 hours of start time, this may not reflect demand for study rooms at peak hours. The average response to the assertion that “Other students want to use study rooms at the same time I do” was between “Slightly Agree” and “Strongly Agree” (4.356). This is surprising, especially given the flexibility of most students’ schedules during finals period. Agreement with the assertion may also be a response to greater general demand for study rooms during finals period, rather than students observing higher demand at the times which they also prefer. Nevertheless, the statistic that the majority of reservations are made within a day of start time does not necessarily suggest that there is always relatively low demand for study rooms, and any proposed mechanism should take into account differences in demand between different times of the day.

Moving between regular semester use and use of study rooms during finals period, we hope to evaluate whether changing strategies based on perceptions of scarcity led to inefficiencies in the market. While the market for study rooms clearly thickens during finals period, this thickening does not signal a malfunctioning market in and of itself, nor a market in need of redesign. It should, however, broadly indicate whether students feel the current market for study rooms meets their needs. Students responding to the survey question, “In past finals periods, I have been able to reserve study rooms when I wanted them,” answered, on average, slightly below “Neither Agree nor Disagree” (2.75). While this reported difficulty may suffer from sample selection bias, it nevertheless indicates that many students feel they are being underserved by an important university resource. Perhaps because of this, the average student responses to “I believe the current study room allocation mechanism is fair” and “I believe the current study room allocation mechanism efficiently pairs students with study rooms” were midway between “Neither Agree nor Disagree” and “Slightly Agree” (3.603 and 3.321, respectively), which suggests a low level of faith in the current allocation mechanism,
especially during finals period.

Evaluating the possible reasons for these perceptions informs our design of a potential replacement market. The average student response to “I know when I will need a study room in advance” fell between “Neither Agree nor Disagree” and “Slightly Agree” (3.237), with responses slightly positively correlated (.0966) with student perceptions about the fairness of the current mechanism. Because study rooms fill up faster during finals period, students unable to predict when they might need a study room are less likely to access study rooms at the times they prefer. Based on this existing gap in the market, between students who reserve rooms ahead of time and those lacking the information to do so, we decided against implementing a central clearinghouse or top trading cycles system, which would require students to report their preferences ahead of time. Similarly, we noticed that the existing market for study rooms does not optimally allocate study rooms by size. Even amongst the study rooms which fall under standard reservation rules, the size of the rooms vary from one to eight chairs. If rooms intended for use by groups are being used by individuals when there are still groups demanding rooms, we could improve outcomes by better distinguishing between different-sized rooms within the market. While this adjustment would not improve Pareto efficiency, it would increase the number of individuals able to use study rooms during finals period, which we believe to be a desirable outcome.

After a thorough analysis of Fondren study room data and the survey results, we believe that there are ways to improve the Fondren Library study room allocation market consistent with the values of efficiency, fairness, and simplicity. Our suggestions to improve the study room allocation market are as follows: designing a time-slot/room-size waitlist, allowing multiple reservations per day summing to 4 hours, and requiring at least one partner in order to book a room with more than 2 chairs in advance. Furthermore, we recommend that these policies be implemented only during finals period, when the market becomes thick enough to warrant a change in the mechanism. Looking at data from during the
semester, it is clear that study rooms are not as scarce as they are during finals period, so there is no need to complicate the current system during the semester. Additionally, a strong majority of students correctly answered questions designed to test their knowledge of the rules of the existing market. This suggests that Rice students have the capacity to learn new rules to the market, even during finals period, and potentially change their behavior based on new rules.

Our recommendation to include a waitlist stems from the fact that many students renege on their reservations or do not stay in the study room for the entire duration of their reservation. Currently, the room is placed back into the market, but there is often not enough time for people to realize there is an opening. We propose allowing students to “waitlist” a time slot and desired room size that they are interested in, which will allow them to be notified via email or text if any rooms become available within that particular specification. While we considered allowing students to waitlist individual rooms, we felt that grouping by time and room size would help thicken the market while still allowing for discrimination between group and individual studying. Students would be allowed to join one waitlist at a time, with a maximum time slot of four hours. This recommendation would improve study room efficiency by minimizing the time that study rooms remain empty as well as giving students another opportunity to utilize study rooms when they actually need them. Finally, this suggestion should not complicate the process because students are already familiar with the ability to waitlist from their experience with course schedule assignment.

Our second recommendation is to remove the restriction that limits students to only one reservation per day, and instead allow them to make as many reservations as they desire with the constraint that the total duration of these reservations cannot exceed 4 hours per day. We believe that this will allow students greater flexibility in their study habits, since many students surveyed stated that a lack of access to study rooms at the times they prefer adversely affects their studying. However, a limit of
four hours per day, which is consistent with the current limit, will prevent any one individual or group from utilizing a study room beyond what is perceived to be “fair.” Additionally, several students noted consistently unused time slots between reservations. Under the existing market, there is little incentive to reserve these rooms, which would require a student to waste their single reservation on a room available for less than four hours. Changing the rules of the market to allow for several reservations in a day would encourage efficient use of these gaps between reserved time slots. If students were able to reserve multiple times a day, they might also consider saving some of their allotted time for another possible reservation rather than reserving their full four hours.

With more time and resources to investigate the market, we would likely look into whether four hours a day is an appropriate amount of time for most students to have access to study rooms during finals period and whether students use the entirety of their reservation to study. While the average response to the question “I usually stay for the entire duration of my reservation” was “Slightly Agree,” (4.055) this may indicate that students are staying in study rooms when they no longer need to study. Having a waitlist system should provide students with social incentives to vacate study rooms they no longer need, if they know they could be used by other students. Consequently, this recommendation will improve the efficiency, flexibility, and fairness of the allocation mechanism.

Our third recommendation would constitute the biggest change to the current system. We propose a new requirement that would prevent students from reserving rooms with more than two chairs, unless they reserve it with at least one partner. This would be done by entering the partner’s email while making the reservation. Then, the partner(s) would receive an email by which they could approve or reject the reservation. The time of the study room would be split evenly between students’ allotments, which would be feasible under our proposed change to a multi-reservation time-capped system. This new system would be in place
between 72 and 12 hours before the start time of the reservation, at which point the system would revert back to the original set of rules, freeing all unreserved rooms for reservation by parties of any size. This change would encourage parties to make their reservations in advance and improve efficiency by encouraging more students to reserve study rooms according to their size needs. Furthermore, we believe this change will not alienate students who prefer to study alone for several reasons. First, these students still have unrestricted access to smaller rooms for the entire three-day reservation period. Second, all students would have unrestricted access to all non-specialty study rooms within 12 hours of the starting time of the reservation. Because Fondren data shows that currently nearly 44% of students reserve study rooms within 12 hours of the starting time, the proposed change should not cause a large shock to users’ habits. Third, our survey results indicate that nearly 80% of study room users do not study alone, which implies that there should be enough single-student study rooms for the small minority of individual users. Thus, we believe that this recommendation will improve the efficiency of study room allocation without sacrificing the simplicity of the user experience.

In conclusion, we believe these changes to the existing study room allocation market will improve perceived fairness and lead to more efficient study room allocation outcomes. While there is only so much a change in the design of the market can do to ease the high demand for study rooms during finals periods, we believe the rule changes we propose will make the most of limited study room resources and create a market for study rooms that is fair, simple, and efficient.