Can We Use Students to Predict Choices in the Field?
A Study of Simulated Drives with the Possibility of Congestion

By: Vinayak Dixit, Rami Harb, Jimmy Martinez, Elisabeth Rutström (In Alphabetical Order)
Presenter: Elisabeth Rutström Email: erutstrom@gmail.com

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ABSTRACT:

When studying behavior relating to congestion pricing it can be useful to use convenience samples, such as students, rather than incur the full cost of recruiting participants from the full population. It is unclear, however, to what extent behavior observed in students would generalize to the population at large, if for no other reasons than that students have a more limited range of demographic characteristics than the full population. We test the extent to which students behave differently from participants recruited from the full population in an experiment conducted using driving simulators. We estimate preferences over risk of congestion and the costs associated with time delays and test whether such students' preferences are different from those of the general population. We recruit commuters in Atlanta (GA) and Orlando (FL), and students at Georgia State University. All participants make route choices in a driving simulator. The simulator models two routes: one that has a risk of congestion and time delays, and the other that has a reliable driving time, but where a toll is charged. The drivers know the likelihood that the risky route causes delays, and they have some prior experience with what that delay can be. We vary the toll across drives and participants in order to identify their preferences. If risk attitudes do not vary across students and regular drivers then it may be possible to perform a low cost risk attitude elicitation on students and simply predict to the field driving population.

Traffic congestion is an increasingly problematic issue in the global urban landscape and pricing solutions are becoming popular amongst traffic planners. The effects of these pricing solutions vary, however, and there is a need to better understand how drivers react. Transportation planners and engineers alike have identified that drivers' risk attitudes have a significant effect on their route and departure time choices. Knowledge about these risk attitudes therefore has the potential of improving traffic planning. When studying behavior relating to congestion pricing it can be useful to use convenience samples, such as students, rather than incur the full cost of recruiting participants from the full population.

We study to what extent student population behave differently from participants recruited from the full population in an experiment conducted using driving simulators. To make the comparison, we sample from actual driving populations in Atlanta (GA) and in Orlando (FL), and also sample from the student population in Georgia State University.

We utilize methods from experimental economics to elicit risk attitudes through controlled incentivized experiments in driving simulators with monetary consequences. Our driving context is a binary route choice between a route where there is a chance it can become congested, and a route that is guaranteed not to be congested. We provide participants with actual monetary consequences to their route choices in that choosing a route that is congested can lead to reduced earnings. The individuals have to make a choice according to their risk preferences because taking the non-congested route results in a monetary earning that can be lower or higher than the reward in the other route depending on the randomly determined congestion conditions.

Two simulation scenarios were developed for these experiments, both in the downtown area of the simulated world. Figure 1 shows a map of the downtown area, with the relevant streets marked in. The two scenarios differ only in one aspect: whether a school bus pulls up on 9th Avenue from C Street or not. When it does, and subjects are informed of the chances of this happening, it slows down the queue of vehicles traveling ahead of the participant vehicle on 9th Avenue.

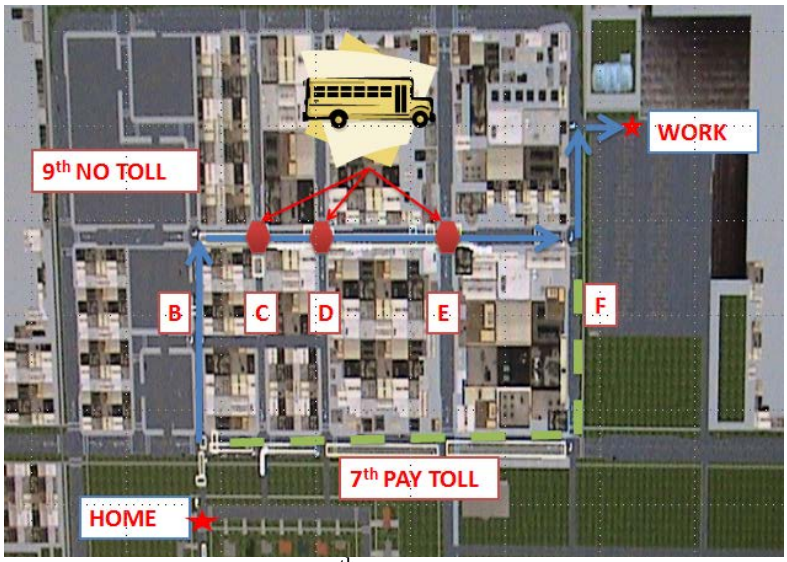

Figure 1: Downtown network with bus on 9th Avenue

In both scenarios, the driver's car is initially parked on B Street just south of the intersection with 6th Avenue (labeled home for illustration). The task is to drive from this point to the parking lot outside of a warehouse on F Street just north of 9th Avenue (labeled work for illustration). As the driver reaches the intersection 7th Avenue and B Street the traffic light always turns red. This is to allow the driver some time to make the choice between turning right to get on 7th Avenue or continuing straight to take 9th Avenue. The drive takes 2 to 4 minutes, depending on which route they take and which scenario they are in. The driver can choose to take either 7th Avenue or 9th Avenue between B Street and F Street. No other options are allowed. Apart from the occasional random car that is modeled as a default in any scenario, some additional vehicles have been added to the simulation. This is partly to assist the driver in following the rules, such as speed limits, and partly for added realism.

Each participant drives six times in the simulator.[1] The first three drives are practice drives and the second three drives are paid tasks. Following the practice drives, subjects took a demographics questionnaire and then completed three drives for incentivized monetary payoffs. Participants were compensated at the end of the sessions with a show-up fee and the money earned in each of the three simulated drives.

The driving tasks given to subjects are designed to elicit risk attitudes in the context of simulated drives. For this purpose the task was designed to mimic a standard risky choice task that is frequently used in the experimental economics literature where a participant is presented with a series of pairwise choices between prospects that differ in risk. In our experiment, each route choice had different possible outcomes and probabilities of winning a monetary amount. In this sense the routes and the monetary rewards to subjects were designed to resemble lotteries that are normally used in economic experiments. These features allowed us to apply the tools that experimental economics has developed to identify risk attitudes but in the context of simulated drives.

We estimate risk attitudes with a structural estimation approach. We study the Expected Utility model and the Rank-Dependent Utility model as possible latent choice models and their ability to explain the data. We allow for several utility function specifications and probability weighting functions, as well as for model specifications that allow controlling for behavioral errors arising from different cognitive abilities in experimental task. As a robustness check we also collect data from the same subjects about binary decisions over abstract lotteries with monetary consequences. This allows us to investigate if any similarities or differences in risk attitudes between students and field drivers elicited from the simulated drives are also present in other contexts. If risk attitudes do not vary across students and regular drivers then it may be possible to perform a low cost risk attitude elicitation on students and simply predict to the field driving population. This could lead to dramatic cost savings for traffic planners. Further, if risk attitudes do not vary across regions for field drivers, planners may not need to do full scale elicitation in all regions where congestion pricing is being considered.

[1] The driving simulator is PatrolSim by MPRI, a division of L3 communications. The software is installed on laptop computers (Asus G73JH-A1 and G73AW-A1) under a Windows XP operating system. The computers are equipped with a Momo steering wheel and pedal kit for automatic transmission driving.