

Essays on the Economics of Urban Transportation

Extended Abstract

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Traffic gridlock affects large cities everywhere, and especially those in developing countries. In a certain sense, congestion is a good sign: it suggests a strong economy and highlights how cities connect people. Naturally, these benefits diminish when travel becomes slow and unreliable. Congestion may be especially inefficient due to externalities: a car slows down everyone else on the road, generates pollution and noise, and the driver likely does not take these social costs into account. This tension suggests that driving is not inherently good or bad, and that ideal policies should reduce the social cost of driving, without unintended negative consequences due to non-compliance or excessive costs to commuters.

This thesis includes three papers exploring urban traffic congestion and the interplay between urban commuting and economic activity in developing countries. The first paper studies the impact of peak-hour road congestion pricing on commuter welfare, using a field experiment and GPS-based data collection in Bangalore, India. Commuters value time spent commuting highly and are moderately flexible to change departure time. However, welfare gains from optimal congestion pricing are predicted to be low, due primarily to a small road traffic externality. The second paper studies the impact of a high occupancy vehicle (HOV) policy in Jakarta, Indonesia, on road traffic congestion measured using data from Google Maps. The lifting of the “3-in-1” policy led to large increases in traffic congestion throughout the city. The third paper uses cell phone transaction data in Colombo, Sri Lanka and Dhaka, Bangladesh, to construct and validate detailed urban commuting flows, and to then infer urban locations with high labor productivity.

Quantifying the benefits and costs of driving is challenging because it requires understanding and measuring how people change their travel behavior in response to any policy (across modes, time and routes), and how this affects other participants. A distinguished theoretical literature spanning transport economics, civil engineering and computer science studies exactly this kind of interactions. However, two additional components are necessary to make progress

and bring these models into the real world: quality travel data, which traditionally is especially rare in developing countries, and policy experiments that induce changes in how people travel.

For the projects in this thesis, I have assembled and studied three newly available types of data to measure traffic congestion and urban travel behavior in developing countries. In each project, the data allowed to make progress on a policy-relevant question.

To monitor traffic congestion levels within a city, in the second paper (co-authored with Rema Hanna and Ben Olken) I set up a simple system to automatically collect live travel time data from Google Maps. For each route in a chosen set, data is queried continuously for several days or months. I used this data to study what happened when Jakarta suddenly removed a driving restriction policy, which required cars to have three passengers during peak-hours and on certain major roads. After the policy ended, there was a remarkably large, sudden and lasting increase in congestion. This was a surprising result; the prevailing view was that drivers had found ways to bypass this policy, for instance by paying a small fee to “passengers for hire,” who usually waited near restricted roads. The strong response shows that imperfect policies can be effective, even after being around for 20 years.

This project also served as an implicit “validation” of data quality. Google Maps traffic congestion data is available uniformly within and across many large cities across the world, and is easily accessible, a vast improvement over previous, laborious methods to monitor road speeds. This holds tremendous potential to understand the extent and variation in traffic congestion, as well as the impact on traffic congestion of various traffic, transportation and urban policies.

The welfare impact of a given policy requires going beyond the aggregate impact on speed to measure costs and benefits to individuals. In the first paper, I study the peak-hour congestion equilibrium and the impact of congestion charges. In theory, charging is economists’ favorite tool, yet we know little in practice. My project has three main components. I collected rich data on more than 100,000 trips from 2,000 commuters in Bangalore, using a custom-built smartphone app that passively logs GPS locations. Secondly, I show that the key economic parameters are commuters’ value of time spent driving, and the costs of deviating from their ideal trip timings (schedule costs). Guided by the model, I designed and implemented two realistic congestion charge policies in a field experiment, and measured how commuters in the sample responded to each policy.

The experimental results reveal that in the presence of charges, some commuters opt to advance morning trips, delay evening trips, or change routes. Structural estimates show that for the morning commute, the value of time spent driving is roughly four times higher than the cost of arriving early, indicating significant schedule flexibility. To fully understand the peak-hour traffic congestion equilibrium, we also need to know the shape of the road technology externality. Surprisingly, I show that in Bangalore there is only a *moderate* effect of road traffic volume on higher travel times. Moreover, the effect is linear, even for high traffic volumes. Putting together estimated demand and road technology, I show using simulations that the welfare gains from optimal congestion charges are small, despite larger travel time benefits. This surprising conclusion stems from the scheduling costs of pushing commuters away from the peak-hour, and the size and shape of the externality.

To measure urban commuting patterns for much larger samples, in the third paper (co-authored with Yuhei Miyauchi) I use cell phone transaction data in Colombo and Dhaka, and construct commuting matrices based on where people are during the day. We then use the rich commuting flow data to infer how areas within the city differ in productivity. To do this, we use a model of commuting and workplace choice to “invert” commuting flows into the attractiveness of each destinations, which we interpret the location’s productivity. We validate this procedure at every step, using a large transportation survey conducted in Dhaka, and find that both commuting flows and the model-predicted income measure are strongly correlated with their survey counterparts. We show two applications of how this data can be used to monitor cities at a fine level across space and time.

Improving urban transportation is a high policy priority in many cities, yet policy makers typically lack resources for rigorous impact measurement. One feature of the Jakarta study described above was that data collection was set up with only several days’ notice, and interim results were provided to the government within days. This type of collaboration may help governments better understand the impact of the policy “experiments” they routinely run as part of operations, and running such evaluations would become even easier with advance collaboration between researchers and governments. Indeed, with advance planning, policy experiments can be designed to extract even more useful information. For example, Jakarta is advancing towards implementing Electronic Road Pricing, and its experience may serve as an example for many other cities.

Now is an exciting time to study cities and urban transportation in developing countries. Newly available data and policy experiments make it possible to tap into the in-depth theoretical literature on urban and transportation issues, and connect it to the real world. This thesis aims to focus on this triple intersection: collecting data, testing and quantifying mathematical theories, and applying these tools to understand the impacts of policies that aim to manage negative externalities and improve rapidly growing cities.