On the benefits of real time pricing: evidence from high occupancy toll lanes in California

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In the tradition of Pigou (1920), economists have long advocated congestion pricing as the first-best solution to the unpriced externalities caused by excess traffic in major urban freeways. However, this first-best solution requires the largely impractical pricing of the entire freeway that varies by location, time of the day, and user type, reflecting the spatial and temporal heterogeneity of congestion (see Vickrey, 1969 for an early treatment). This contrasts sharply with the fact that the daily use of roads remains largely free. Congestion pricing continues to face major opposition, and concerns related to its distributional impacts have prevented policy makers to implement Pigouvian-style congestion pricing.

Over the years, the strategy of relying on HOV lanes as a tool to reduce congestion appears not to produce major results in terms of substantially reducing congestion in non-HOV lanes. Because of the difference in travel times in mainline lanes and HOV lanes, recently there have been proposals to transform HOV lanes into High Occupancy Toll (HOT) lanes, where solo drivers have the option to enter the HOV lanes, provided that they pay a toll collected via billing from an electronic transmitter. While there has been some theoretical literature on the welfare effects of converting HOV lanes into HOT lanes (Konishi & Mun, 2010), relatively little is known about the behavioral responses of drivers to pricing. Understanding these responses is crucial to inform the level and variability of the toll needed to achieve specific traffic goals, as well as to quantify the distributional impacts of these second-best approaches to traffic congestion (Verhoef & Small, 2004). The central question of this paper is whether real time pricing on a congestion road network, implemented in a technically feasible manner, can be welfare improving and what the corresponding distributional effects can be.

Beginning February 22nd, 2013, a pilot project was launched in Los Angeles that introduced dynamically priced tolls on HOT lanes in parts of the I-10 covering the route from Pomona to Downtown Los Angeles. The ExpressLanes project allows The tolls range from $.25 to $1.40 per mile and the price is locked in at the time of entry into the express lane and is based on HOV/HOT lane traffic levels to ensure a minimum speed of 45 miles per hour. In turn, carpoolers are allowed to continue to use the HOV lane and solo use of the mainline remains untolled.

In this paper, we take advantage of the introduction of this pilot project to study the behavioral responses of drivers to congestion pricing. A key component of our approach is to exploit the temporal (tolls change dynamically with congestion) and spatial (toll varies by entry and exit point) variation in the implementation of the ExpressLanes. The analysis controls for possible confounding factors through the use of a regression discontinuity (RD) design where travel time in the mainline and

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HOV lanes are compared before and after the start of the policy. To study these behavioral responses, we have assembled a rich dataset that includes real time vehicle speed and flow data by lane from the freeway performance measurement (PeMS) in LA and road characteristics. We consider all channels of adjustment in response to the policy including: changes in travel time in the HOV due to additional solo drivers that pay the toll to use the lane; changes in travel time in the mainline, depending on whether vehicles that move into the HOT lane get replaced by other vehicles or not; changes in travel time in competing routes and public transit usage.

Preliminary results suggest that the policy resulted in non-trivial behavioral adjustments of drivers in both the HOT and the mainline of the I-10. In the morning peak travel period (5am-9am), average travel time increased in the HOV lane by around 1 minute in the HOT lane (where a typical commute lasts about 10 minutes), and it had no effect on the mainline. It appears that the toll created incentives for individuals to shift lanes, while preserving a substantial travel time saving in the HOT lane. We validate these results using a series of standard robustness checks for sharp RD as well as comparison to a difference-in-difference estimator using a synthetic control group. While we find some increased uptake and change in the elasticity of demand after initial implantation, the benefits of the program seem to be bounded from below by the short-run effect.

We also explore the distributional impacts of the policy. Building off of Small, Winston & Yan’s (2005) analysis of HOT on SR-91 in Orange County, we are able to recover implied lower bound estimates of the value of time and reliability for HOT users without the strict distributional assumptions imposed by the random coefficients approach of their paper. Based on our preliminary estimates, it appears that drivers who moved into the HOT lane as well as mainline drivers at peak periods may have benefited from the policy. In contrast carpoolers experienced modest welfare losses. Using the toll paid as a lower bound estimate of the welfare improvement to solo drivers, we find that the negative carpool congestion effect is almost always outweighed by the benefit to solo drivers and that this result is robust to considerations for schedule delay adjustments and changes in overall reliability. On the whole, we are able to demonstrate that even with a dynamic toll that deviates substantially from both a first- and second-best price schedule, substantial welfare improvements are possible from charging for access to a carpool lane.