Bike-sharing and Congestion

A resurgence of (public) bike-sharing systems (BSSs) has been witnessed around the world in the past decades. Although the idea of BSSs has been around for almost half a century, it is only recently that such systems have been strategized as sustainable transportation means worldwide. Although the explicit goals of the introduction of individual BSSs may be different, BSSs are associated with social, environmental, and health benefits, including but not limited to congestion and emission reductions, flexible mobility, consumer financial savings, and positive health outcomes (Midgley, 2011; Shaheen, Guzman, & Zhang, 2010). Despite above-mentioned benefits of BSS, there are at least two concerns about the effectiveness of the BBS functionality from previous studies. First, cycling itself rather than the BSS, in general, provides many of the benefits above (Handy, van Wee, & Kroesen, 2014; Pucher & Buehler, 2012). Although one of those objectives of BSSs is to promote cycling, such effect cannot be taken for granted. The improvement of bike lanes and the increase docking stations can also facilitate cycling activities. In other words, it may not be necessarily through the launch of BSSs to achieve such benefits. Second, the achievement of such benefits relies heavily on the effectiveness of BSSs. For instance, the benefits of mobility, financial savings, and health depend on the actual participation level of BSS users. The social and environmental benefits of congestion and emission reduction depend on the degree of modal shift from automobile to the real use of BSSs. In other words, the launch of BSSs may not be sufficient to achieve such positive outcomes.

Although a few previous studies examined the environmental benefits associated with the BSS (DeMaio, 2009), very few empirical studies examined the effect of congestion reduction related to the introduction of the BSSs across the US. In a recent study, Hamilton and Wichman (2017) found that BSSs can reduce congestion at neighborhood scale in Washington, D.C. Therefore, we aim to expand the scope of cities and provide a high-level assessment of the relationship between the launch of BSSs and congestion through a difference-in-differences (DID) model that examined the congestion over ten years (2005-2014) in 96 urban areas in the US.

Our data are mainly from four sources. First, congestion-related data were obtained from the Texas A&M Transportation Institute (https://tti.tamu.edu/), which combines speed data from INRIX (http://inrix.com/) and the volume and roadway inventory data from the Highway Performance Monitoring System from the US Federal Highway Administration (FHWA). It describes congestion in a consistent way, allowing for comparisons amongst different urban areas. INRIX provides real-time traffic data so that “real” rush hour speeds of fleets are measured, and overnight speeds are used to provide free-flow speeds. It provides (1) quarterly congestion statistics from 52 US urban areas from the fourth quarter of 2008 to the second quarter of 2015; (2) yearly congestion statistics from 100 US urban areas and San Juan, Puerto Rico, from 1982 to 2014. Second, socioeconomic profiles and urban travel characteristics across different urban areas were acquired from American Community Survey (ACS). Third, weather and climate data were obtained from the National Climatic Data Center, National Oceanic and Atmospheric Administration (NCDC-NOAA). Lastly, we manually consolidated information regarding the launch time of BSSs in the 100 US urban areas from the official website of BSSs and mass media. San Juan, PR was excluded to control for the potential political heterogeneity between Puerto Rico and the 50 US states. Our final sample includes 96 urban areas and from 2005 to 2014, which results in a total number of 960 observations.

A suite of control variables is obtained from three different data sources, including the UMS, the ACS, and the NCDC-NOAA. From the UMS, the total population in thousands (*Population*) is used to proxy for the size of the urban area. Second, the percentage of autocommuters (*Autocommuter*) is computed as the total number of autocommuters divided by the total population. Third, the average arterial street daily thousand miles of travel (*VMT*) is gathered. A arterial street often delivers traffic between different urban centers and from distributor roads (i.e., low-to-moderate-capacity roads which moves traffic from local streets to arterial roads) to freeways. *VMT* is populated as the average daily traffic of a section roadway multiplied by the length of that section of roadway. From the ACS, the median income in USD (*Income*) and median age (*Age*) were obtained to control for socioeconomic; the percentages of workers who use public transport (excluding taxi cabs) to work and bike to work (*Public_Transport*, and *Bicycle*, respectively) are added to control for urban travel behaviors. From the DCDC-NOAA, average precipitation (*Precipitation*) and temperature (*Temperature*) data were obtained to control for urban weather and climate factors. For the dependent variables, we have included the total annual excess fuel consumed in a thousand gallons (*AEFC*) from the Urban Mobility Scorecard (UMS).

The results indicate the entry of bike-sharing systems has mixed impacts on congestion. On the one hand, it mitigates the positive role of the population on congestion. Urban areas with the launch of BSSs, a one percent increase in total population will result in 0.0264% less congestion compared to those without BSSs. In other words, BSSs benefit larger cities more than they do to smaller ones regarding congestion reduction. On the other hand, it strengthens the positive role of median income to congestion. Specifically, with the presence of BSSs, a one percent increase in median income will lead to 0.1021% more congestion of the urban area compared to those without BSSs. In another word, richer cities get worse off by introducing BSSs regarding congestion. Also, we re-estimated Model 3 using only matched samples, which are derived from PSM. The results are consistent with those in Model 3, with the slightly different magnitude of the beta coefficients for the interaction terms. The preprocessing of data with PSM also increased the adjusted R^2 by 20% (from 0.519 to 0.625).

References

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