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The effects of public transit supply on the demand for automobile travel[☆]

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ABSTRACT

Public transit is often advocated as a means to address traffic congestion within urban transportation networks. We estimate the effect of past public transit investment on the demand for automobile transportation by applying an instrumental variable approach that accounts for the potential endogeneity of public transit investment, and that distinguishes between the substitution effect and the equilibrium effect, to a panel dataset of 96 urban areas across the U.S. over the years 1991–2011. The results show that, owing to the countervailing effects of substitution and induced demand, the effects of increases in public transit supply on auto travel depend on the time horizon. In the short run, when accounting for the substitution effect only, we find that on average a 10% increase in transit capacity leads to a 0.7% reduction in auto travel. However, transit has no effect on auto travel in the medium run, as latent and induced demand offset the substitution effect. In the long run, when accounting for both substitution and induced demand, we find that on average a 10% increase in transit capacity is associated with a 0.4% increase in auto travel. We also find that public transit supply does not have a significant effect on auto travel when traffic congestion is below a threshold level. Additionally, we find that there is substantial heterogeneity across urban areas, with public transit having significantly different effects on auto travel demand in smaller, less densely populated regions with less-developed public transit networks than in larger, more densely populated regions with more extensive public transit networks.

1. Introduction

Anyone who has idled in traffic anxiously watching the clock is all too familiar with the costs of traffic congestion. Congestion is ubiquitous across urban roadways and is a persistent topic of policy debate. The external costs of congestion – which include increased operating costs for both private and freight vehicles, increased fuel usage and emissions, and, most

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significantly, the delay costs and uncertain travel times confronting motorists – are substantial and have been steadily increasing.[1] In 2011, these costs of traffic congestion alone have been estimated to have exceeded $121 billion in the U.S. (Schrank et al., 2012). Congestion has steadily increased in recent decades: from 1983 to 2001, for example, average car travel time increased by 30% and average transit travel time increased by 62.5% for a sample of large metropolitan statistical areas in the U.S. (Berechman, 2009).[2]

Congestion costs represent the majority of the external costs of automobile travel for urban commuters in the U.S.: of the combined per vehicle-mile costs of congestion, accidents, and environmental externalities for urban commuters in the U.S., congestion costs represent 71.7% of the short-run average variable social cost of auto travel and 74.3% of the short-run marginal variable social cost (Small and Verhoef, 2007).[3]

As one component of broader urban transportation policy, public transit is often advocated as a means to decrease traffic congestion and reduce emissions from automobiles. Additionally, large-scale public transit investments are often championed due to purported local and/or regional economic development benefits accompanying the construction and operation of the new transit system. In the U.S., in addition to annual transit operating expenses of $38 billion per year, recent expenditures on public transit capital have exceeded $18 billion per year (American Public Transportation Association, 2012).

Public transit investments should be evaluated on their contribution to overall net social welfare, taking into account the cost of the investment and any associated operating costs. While the broader question as to how public transit should be funded and its role in the U.S. urban transportation sector is important and has been addressed by others such as Viton (1981) and Winston and Shirley (1998), the congestion-reduction effect of public transit is a potentially important component of this overall evaluation process, and to date there has not been an empirical consensus on the magnitude of this effect.[4]

Although policymakers may wish to use public transit investment as a policy instrument to both reduce congestion and spur economic activity, these two objectives are often incompatible.[5] On the one hand, an increase in transit supply may cause some commuters to substitute transit travel for trips previously taken by automobile (the "substitution effect"), thereby decreasing auto travel. On the other hand, by reducing congestion, increasing accessibility, increasing economic activity, and/or attracting additional residents and workers to the area, transit investment may generate additional automobile trips that were previously not undertaken (the "induced demand effect"). The "equilibrium effect" accounts for both the substitution effect and the induced demand effect.

In this paper, we consider the effect of public transit supply on the volume of auto travel. Specifically, we address the following questions:

1. Have past public transit investments been effective in reducing the demand for automobile travel in the U.S.?
2. Is it possible to disentangle the substitution effect and the induced demand effect due to public transit supply?

Our measure of public transit supply is the public transit capacity in vehicle-revenue miles, where public transit includes commuter rail, light rail, heavy rail, hybrid rail, monorail, automated guideway, bus rapid transit, bus, and trolleybus. We empirically estimate the effect of past public transit investment on the demand for automobile transportation by applying an instrumental variable approach that accounts for the potential endogeneity of public transit investment, and that distinguishes between the substitution effect and the equilibrium effect, to a panel dataset of 96 urban areas across the U.S. over the years 1991–2011.

The results show that, owing to the countervailing effects of substitution and induced demand, the effects of increases in public transit supply on auto travel depend on the time horizon. In the short run, when accounting for the substitution effect only, we find that on average a 10% increase in transit capacity leads to a 0.7% reduction in auto travel. However, transit has no effect on auto travel in the medium run, as latent and induced demand offset the substitution effect. In the long run, when accounting for both substitution and induced demand, we find that on average a 10% increase in transit capacity is associated with a 0.4% increase in auto travel. We also find that public transit supply does not have a significant effect on auto travel when traffic congestion is below a threshold level.

Additionally, we find that there is substantial heterogeneity across urban areas. When accounting for the substitution

[1] Congestion can be particularly costly if individuals exhibit preferences for urgency owing to time constraints, schedule constraints, and possible penalties for being late (Bento et al., 2017).

[2] In addition, as we show in Section 3 using the population-weighted mean values across 96 large urban areas in the U.S., total hours of delay attributable to congestion increased by 55% over the period 1991 to 2011.

[3] Similarly, of the externalities associated with gasoline consumption that Lin and Prince (2009) analyze in their study of the optimal gasoline tax for the state of California, the congestion externality is the largest and should be taxed the most heavily, followed by oil security, accident externalities, local air pollution, and global climate change.

[4] Beaudoin et al. (2018) develop a theoretical model of optimal public transit investment to evaluate whether public transit investment has a role in reducing congestion in a second-best setting when a Pigouvian congestion tax cannot be levied on auto travel.

[5] For example, employment growth, a common public policy goal, can lead to a number of unwanted environmental, social, and economic costs – particularly in high growth communities – due to its impact on peak-hour traffic. Morrison and Lin Lawell (2016) find that for each additional 10 workers added per square kilometer, travel time increases by 0.171–0.244 min per one-way commute trip per commuter in the short run, which equates to $0.07 to $0.20 in travel time cost per commuter per day.