Why do cities use supply side strategies to mitigate traffic congestion externalities?

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Abstract

For traffic congestion arising from sprawl, planners prefer supply side strategies over the demand side strategies recommended by economists. Our model provides a rationale why: wealth-induced congestion increases a planner's social discount rate, which decreases future costs of supply side solutions.
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1. Introduction

Urban sprawl pushes the boundaries of development further out from city centers.[1] While urban growth and suburbanization are natural phenomena (Mieszkowski and Mills, 1993), described as an orderly market process (Brueckner and Fansler, 1983), sprawling development is nevertheless

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[1] The causes of urban growth are well documented. More people, more income, lower agricultural land rents, and changing transportation technologies along with the social problems of poverty, crime and poor schools have lead to the suburban growth so dominant in metropolitan regions across the US (see Brueckner and Fansler, 1983; Mieszkowski and Mills, 1993; Mills, 2000).

characterized by growth beyond what many people consider a socially desirable level (Brueckner, 2001). Due to the negative externalities arising from sprawling development, the flight from city to suburb to exurb to countryside continues to attract the attention of economists and environmental policy makers.[2] The theory of market failure helps explain urban sprawl. The market fails to price the social value of open space, a motorist fails to bear the social costs of congestion caused by his or her driving, and a real estate developer avoids the collective costs of public infrastructure needs caused by his or her projects (see Brueckner, 2000, 2001).

Economists have offered up a menu of tax and fee mechanisms to help correct these market failures. Researchers overwhelmingly recommend easing traffic congestion through demand side – not supply side – strategies. Optimal demand side solutions include encouraging motorists to drive during off-peak hours or to switch to public transportation, or to impose congestion tolls (e.g., Brueckner, 2000, 2001, Glaeser and Kahn, 2003). Supply side solutions like increasing highway capacity have been criticized for creating perverse incentives—theory and data suggest additional highway capacity provides only short-run congestion relief before induced travel causes traffic congestion to return to its original level again in the long-run (see Downs, 1992; Johnston and Ceerla, 1996; Hansen and Huang, 1997; Fulton et al., 2000; Noland, 2001; Boarnet and Chalermpong, 2001; Dutzik, 2002).

Despite economists' suggestions, local planners still prefer the supply side strategy of building more highway lanes to the optimal demand side strategies.[3] The open question is why? Herein we suggest one reason this can occur—we construct a model to show that wealth-induced congestion actually increases the social rate of discount of a local jurisdiction, which makes the supply side solution relatively more attractive. Our results imply that adding a road fee to the purchase of a car that is similar in nature to the impact fees charged to real estate developers could lead to a socially optimal level of traffic congestion and the optimal spatial growth of a city.

2. Traffic congestion and the social discount rate

Different strategies – demand side and supply side – are available to try to relieve traffic congestion in areas where sprawl is a problem. These two strategies differ the most in their intended, or effective, time horizon. Demand side strategies take a relatively long run view of congestion relief by changing consumers' demand for transportation. Providing incentives for and promoting strategies such as telecommuting and ride sharing do relieve congestion immediately, but are expected to shift demand in such a manner that congestion can be held in check for some length of time once those shifts are made. In contrast, supply side strategies are intended to meet the current demand immediately by increasing the supply of highway capacity. While highway construction takes time to plan and to finish, congestion

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[2] Some of these externalities include diminishing open space (U.S. General Accounting Office [GAO], 1999), traffic congestion (Black, 1996; Downs, 1999) and air and water pollution (Sierra Club, 1998).

[3] Public policy in recent years devotes at least as many public dollars of funding to supply side projects as to demand side projects. The state of Maryland, for example, plans to commit almost $6 billion to highway expansion projects and about $5.5 billion to transit services for the period 2001–2006 (Dutzik, 2002). The current federal surface transportation funding program, TEA-21, and the proposed SAFETEA program each appropriate over $200 billion for highways, highway safety, and public transit. In both appropriations bills, public transportation programs are set to receive about $50 billion of the total federal funding amounts with much of the remainder directed to highway programs.

relief is immediate once the construction is complete.[4] If the policy goal is to create long lasting solutions to traffic congestion problems, people prefer demand side to supply side solutions (Remak and Rosenbloom, 1976). In cost–benefit analysis, the implied time horizon of these two solutions suggests the social discount rate may impact planners' decisions.

We now examine more closely the relationship between sprawl, traffic congestion and the social discount rate. Increasing highway capacity generally creates immediate benefits for drivers as commuting times drop, but induced travel causes traffic congestion to return to its original level in the long run. A higher social discount rate makes this supply side solution more attractive as the problems caused by the induced travel do not appear until later when costs are discounted more heavily.[5] Alternatively, a lower social discount rate creates more reliance on demand side solutions to relieve traffic congestion—long-term benefits are valued heavily. These solutions include remedies that alter driver behavior or housing and job locations (Downs, 1992). Any exogenous change in the social discount rate can affect which congestion remedy is selected. For example, a higher social discount rate increases the attractiveness of supply side policies since future congestion costs resulting from induced travel are discounted more heavily—delaying congestion looks more attractive when the discount rate is sufficiently high.

Brueckner (2000, 2001) rightly notes that the failure of commuters to account for their contribution to traffic congestion leads to more private vehicle trips than is socially optimal, i.e., traffic congestion. This traffic congestion, however, has a second unintended consequence—the social discount rate also increases. As a result, planners find supply side policies like building more highway capacity more attractive, which in turn leads to excessive urban expansion since commuting costs are kept too low. The next section develops a model to show this result.

3. A model

Consider a simple economy for jurisdiction J as given by $Y=C+I+\tau$, where Y, C, and I represent output, consumption and investment. Within the public arena, policy planners in J devote some resources, τ, to traffic congestion relief. Income growth in J drives our model. Define $F(D, X, t)$ as a function expressing the ratio of traffic congestion to the level of income, where $D = \frac{\tau}{Y}$ is the level of congestion relief spending as a portion of income, X is a vector of other variables affecting traffic congestion and t represents time. Assume $F' \equiv \frac{\partial F}{\partial D} < 0$ and $F'' \equiv \frac{\partial^2 F}{\partial D^2} > 0$, so as the spending on congestion relief as a portion of income rises, the level of congestion per unit of income drops. The level of congestion in J at any time t is

$$S = YF\left(\frac{\tau}{Y}, t\right). \tag{1}$$

We implicitly differentiate Eq. (1) with respect to Y, yielding

$$S' = F + YF'\left(\frac{Y\tau' - \tau}{Y^2}\right). \tag{2}$$

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[4] Planners usually have enough information to address potentially major traffic congestion problems before they actually occur.

[5] Johnston and Ceerla (1996) suggest a time span of no more than 40 years before the congestion relief provided by additional highway capacity is exhausted and congestion returns to its original level.

Solving for τ' in (2) gives

$$\tau' = \left(\frac{\tau}{Y}\right) - \left(\frac{F}{F'}\right) + \left(\frac{S'}{F'}\right). \tag{3}$$

Treating the automobile as a normal good, income growth in jurisdiction J leads to increased automobile ownership and increased traffic congestion (see Hsieh and Hsing, 2002; Glaeser and Kahn, 2003), such that $S' = \frac{\partial S}{\partial Y} > 0$. Since $\frac{S'}{F'} < 0$, expression (3) indicates the change in the fraction of income spent on congestion relief is smaller when traffic congestion increases relative to when congestion is held constant. The intuition behind this result is that smaller portions of J's output gains that accompany the increasing level of traffic congestion are earmarked towards maintaining a constant level of congestion in J. When congestion is held constant, $\tau' = \left(\frac{\tau}{Y}\right) - \left(\frac{F}{F'}\right)$. This is the specific case Weitzman (1994) examined in his social discount rate model. We allow traffic congestion to increase with income and track its impact on the social discount rate in the following derivation of the social discount rate.

Assume a two-period model in which a small decrease in consumption, δ, is taken at time t. This amount δ is invested in further capital formation and with a private interest rate, i, output at time $t+1$ increases by

$$\Delta Y = i \cdot \delta. \tag{4}$$

Express the change in the level of income devoted to congestion relief from time t to time $t+1$ as

$$\Delta \tau = \tau' \cdot i \cdot \delta. \tag{5}$$

The social rate of return on consumption is defined as the extra consumption available in time $t+1$ after decreasing consumption in time t by a small amount δ. Derive the social discount rate, r, as

$$r = \lim_{\delta \to 0} \frac{\Delta Y - \Delta \tau}{\delta}. \tag{6}$$

Substituting Eqs. (4) and (5) into (6) yields

$$r = i \cdot \left[1 - D\left(1 + \frac{1}{E}\right) - \frac{S'}{F'}\right], \tag{7}$$

where $E = -\frac{DF'}{F}$. The variable E is interpreted as the elasticity of traffic congestion improvement with respect to spending on reducing traffic congestion (see Weitzman, 1994). E indicates the percentage rate at which the level of traffic congestion declines due to a 1% increase in spending on congestion relief projects.

Since $\frac{S'}{F'} < 0$, Eq. (7) shows that, as congestion increases with income growth and wealth, the planner's social discount rate increases relative to our benchmark case (in which congestion does not increase with income growth and wealth).[6] Following the suburban growth literature that stresses the importance of car ownership, we link car ownership with congestion and show that increased car ownership caused by income growth leads to a higher social discount rate. Given the costs of increased congestion today, planners will accept greater future costs to achieve immediate congestion relief. In our framework,

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[6] The benchmark case is set for $S' = 0$, which is the case considered by Weitzman (1994). We replicate his result by substituting $S' = 0$ into our general formulation of the social discount rate in (7).

therefore, the higher social discount rate leads to a greater reliance by social planners on supply side projects like highway lane building rather than demand side programs.

4. Conclusions and policy implications

Economists advocate demand side strategies (e.g., carpooling) to reduce traffic congestion; policy makers, however, still prefer supply side strategies that increase future costs from the induced travel associated with increasing highway capacity. Herein we offer a rational choice explanation why this could occur—wealth-induced congestion can increase the social rate of discount of policy makers in a local jurisdiction, which reduces the future costs of the supply side solution, making them relatively more attractive. Because car ownership creates the external impact on the social discount rate, our model suggests policy makers should discourage car ownership to reduce sprawling development.[7] This could possibly occur through a road impact fee, similar to the impact fee suggested for real estate developers (see Brueckner, 1997, 2000, 2001). By limiting the number of cars purchased, a road impact fee would be another demand side solution. In developing this model, the failure of the market mechanism to fully account for the impact of increased traffic congestion on the social discount rate is noted. Future research can be expected to probe the specific magnitude of this impact on policy and to determine the shape of a traffic congestion function so proper policy can be implemented.

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[7] Raphael and Stoll (2001) and Glaeser and Kahn (2003) recognize the importance of car purchases in urban spatial growth patterns by asking whether it is appropriate to subsidize car purchases for poor families that desire to move to the suburbs.

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