Transport Policy 71 (2018) 28–35

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Income and spatial distributional effects of a congestion tax: A hypothetical case of Oregon

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ARTICLE INFO

Keywords:
Congestion pricing
Oregon
Distributional effects

ABSTRACT

In US urban areas, traffic congestion remains a growing and costly problem. The Texas Transportation Institute estimated that in 2014 delays due to congestion caused an extra 7 billion extra hours in delay, leading to wasted fuel, increased environmental degradation, and high user costs. Previous studies have focused on the impacts to congestion via highway toll lanes and the income distributional effects of tolling. While tolling can be effective in reducing congestion levels, these tolls have been found to be at least as regressive as fuel taxes. Further, these studies do not investigate the impacts tolling has on rural households compared to urban households. This study presents a per-mile congestion tax as an alternative policy tool to congestion tolling. Using a Suits Index with the Oregon Households Activity Survey, we find a per-mile congestion charge to be progressive on income. This suggests that the administratively challenging toll revenue redistribution payments that would be necessary to make congestion tolling progressive would not be needed. At the same time, however, the Suits Index suggests that a per-mile congestion charge would be regressive with regards to rural households. Econometric models are estimated to further support and explain these outcomes. While rural households, in general, drive more during peak hours compared to urban households, we find that low-income rural households are less likely to drive during these periods than wealthier rural households.

1. Introduction

The Texas Transportation Institute's (TTI) Urban Mobility Report (UMR), estimated that in 2014, travel delays due to traffic congestion caused an extra 7 billion extra hours in delay, led to wasting more than 3 billion gallons of fuel, and cost a total of $160 billion, or $960 per commuter. Although there is some evidence that the UMR's valuation of congestion costs may be overestimated (Cortright, 2010), congestion delays remain a costly problem. Thus, congestion, and the delays attributed to congestion, is a negative externality. Through the use of the on-board technology intended for mileage-based user fees, this externality could be internalized by having a tax imposed on it to discourage the marginal user from adding to delays.

One policy intervention to curb congestion is the implementation of highway tolls with toll rates sensitive to time of day. Congestion tolls impose an additional user cost to drivers using certain routes during particular times of day. These have been found effective in reducing the level of congestion although they are regressive in nature. Remitting toll payments to lower income households and using tolls to fund public transit or improve public transportation infrastructure are some of the ways that may allow congestion tolling to be less regressive. However, the remittance of toll payments can be administratively challenging, and improvements to public transportation infrastructure are not guaranteed to solely benefit lower-income households. Furthermore, because congestion tolling only allows agencies to toll certain corridors, there may be unintended effects, such as increased traffic through lower functional classes of roadways or local roads by drivers who wish to bypass toll booths. This can impose safety hazards for other road users during peak travel periods. Additionally, drivers may simply choose to exit highways before reaching a toll booth (i.e., free riding). A mileage-based congestion fee, however, avoids these problems by assessing a fee on the number of miles driven rather than the route chosen by drivers.

Alternatively, one can apply existing technology currently used in mileage-based user fees trials (e.g., the Oregon trial includes more than 5000 participant households) and pay-by-mile vehicle insurance to record the number of miles travelled during times of day when congestion is high. In these instances, an on-board device (OBD) is installed in vehicles, which can read vehicle odometers and track the number of miles driven. Mileage-based user fees assess road users a fee for driving based on the amount they have driven irrespective of the time in which

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https://doi.org/10.1016/j.tranpol.2018.07.012
Received 13 June 2017; Received in revised form 26 June 2018; Accepted 27 July 2018
0967-070X/

the trip took place. However, OBDs can also be customized to report the time of day vehicles are in use. By merging the two policies, congestion tolling and mileage-based user fees, one can form a novel combination of the two—a per-mile congestion tax. This would allow departments of transportation to charge drivers a per-mile tax during peak travel periods rather than use congestion tolls. Similar to variable tolling, the mileage-based congestion fee structure can also have the flexibility to apply variable rates. For the purposes of this study, an additional flat per-mile fee is assessed on all households that have travelled by motor vehicle during morning and afternoon peak periods.

This study evaluates the equity concerns related to per-mile congestion taxes, as policymakers may be worried that low income households may bear a burden of a per-mile congestion tax that is disproportionately high compared with higher income households. In addition to examining the degree of income regressivity, this study also analyses spatial distributional effects, such as whether rural households would be shoulder more of the burden compared to households in urban areas. Oregon was chosen as a case study state because the data requirements for such a study was readily available via the Oregon Household Activity Survey. Furthermore, as Oregon was the first state to adopt the fuel tax and weight-mile taxing, the state has a history of trying novel means of highway finance. In addition to several rounds of pilot mileage-based user fee programs, Oregon DOT is currently conducting a state-wide trial program with over 5000 participants. This familiarity with per-mile charging could potentially signify a higher public acceptance to per-mile charging schemes in general. It must be noted that while Oregon's Department of Transportation (DOT) does not currently have any plans to implement a mileage-based congestion tax, the findings of this study have important implications should an agency pursue this approach with the goal of curbing congestion.

The remainder of this article is structured as follows. The next section reviews the literature on congestion taxes and previous studies on the equity effects of congestion tolling and describes the data used in this analysis. After that, section three explains the charge structure of the per-mile congestion tax in greater detail and the analysis methods used. Results and their analyses follow. The final section concludes and suggests avenues of further research.

2. Material and methods

Transportation economists have long proposed congestion taxes as a means to reduce peak hour delays by allocating scarce roadway capacity to the highest valued users (Pigou, 1920; Vickrey, 1969; Walters, 1961). Research in the determinants of congestion have typically relied on economic models, including closed general equilibrium models of central business districts (Anas and Xu, 1999; Moon and Park, 2002), statistical models (Marshall, 2015), or other economic models of a city (Broersma and Oosterhaven, 2009; Hymel, 2009; Wheaton, 2004). However, they have largely focused on commuters driving into a monocentric central business district (CBD) that contains jobs and other services (Solow, 1973; Vickrey, 1969). More recently, Broersma and Oosterhaven (2009) find that although agglomeration can lead to increased productivity in urban areas in the Netherlands, congestion increases as a result of increased traffic to and from the a CBD; this in turn can impede further growth.

In addition to theory-based research in congestion determinants, research has also been conducted on congestion taxation. Although economists widely support Pigou (1920) idea of using tolls on public roads to alleviate congestion, many disagreements over implementation-related details persist (Lindsey, 2006). These disagreements have included what the optimal rate should be, what to do with excess revenues, whether or not roads should be privatized, and other implementation related topics (Buchanan, 1956; Edelson, 1971; Knight, 1924; Lave et al., 1995; Mills, 1981; Small et al., 1989). One policy recommendation by Anas and Xu (1999) is for planners to relax local zoning restrictions on locations of businesses rather than trying to tax their way out of congestion. Accordingly, Wheaton (2004) examines commuting and congestion in cities with mixed land use and finds that, similar to Anas and Xu (1999), the level of congestion depends largely on the degree to which agglomeration occurs.

Apart from the effects that congestion-tolling schemes have on levels of congestion, economists have also examined the equity effects of such policies. While it can be evaluated in many ways, including income, geographical, modal, to name a few (Ungemah, 2007), this study focuses primarily on the income and spatial aspects of equity. Prior research suggests that tolling in general is regressive on income (Small, 1983; Giuliano, 1994; Krol, 2016). Small (1983) found that the lowest income group would have the largest absolute losses in terms of financial cost and value of time savings if peak expressway tolls were enacted. This is due to high-income drivers benefiting more because they have a higher value of time than the increase in financial cost of driving.

In order to give motorists the choice of opting out of tolls, highways may have a limited number of high occupancy tolled (HOT) lanes. As expected, HOT lane usage has been found to be positively correlated with income, but these studies lacked the sample size to compare users by income groups (Sullivan, 2002; Burris and Hannay, 2004). The transaction costs associated with highway tolling also seem to favour high-income motorists. Parkany (2005), for instance, noted that income is positively associated with owning toll transponders and frequency of using toll lanes due to low-income households being less likely to have credit card accounts than higher income households.

In order to offset tolls' negative impacts on low-income motorists, several revenue redistribution schemes have been proposed. Theoretically, direct repayment to low-income households, in full or in part, can alleviate the regressivity of tolls (Franklin, 2007). Practically, this can be challenging administratively to do so. The revenues from tolls could be used to finance or subsidize projects such as improving public transit access and infrastructure that benefit low income households more than higher income households (Schaller, 2010). Alternatively, King et al. (2007) suggest that congestion pricing's revenues should simply be earmarked for cities and urban residents rather than allocated towards public transit and road improvements as a means of generating the political support for the policy. Another method of increasing equity would be to distribute tradable transportation rations a la Coase (2013) in addition to pricing transportation (Viegas, 2001). Levine and Garb (2002) argue that congestion pricing needs to make other modes more affordable at the same time as making auto trips more expensive in order to ensure that accessibility is not diminished, as that could threaten the economic vitality of congested areas in addition to promoting inequity.

The majority of previous studies on the equity of tolls have focused on its income dimension. Far fewer studies have also considered the geographic, or spatial, aspect of equity with respect to tolls. Ungemah (2007) notes that the geographic equity is primarily focused on the decision of tolling one facility instead of another and considers it primarily a public relations challenge. In the context of this paper, however, spatial equity examines how a statewide congestion tax affects rural and urban drivers.

The effects to congestion levels by programs that have implemented congestion pricing have also been studied. However, due to technological limitations, these programs typically implement congestion tolling or cordons rather than per-mile congestion fees for all vehicles traveling at peak hours (Cottingham et al., 2007; Schindler, 2007; Sorensen and Taylor, 2005). Some notable examples of cordon-based and toll-based congestion charging include the London congestion charge, Singapore's Electronic Road Pricing system, and the Stockholm cordon charge (de Palma and Lindsey, 2011). Using data from four European cities, Eliasson (2016) find evidence that congestion tolling is regressive in nature: while high-income groups pay more in tolls, low-income groups pay a larger percentage of their income in tolls.

Furthermore, simulations of road pricing programs in Paris have