Tolling the Freeway: Congestion Pricing and the Economics of Managing Traffic

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ABSTRACT

Highway congestion increases the cost of travel in most urban areas in the United States. This paper examines the economics of highway congestion pricing. Toll-free highways can be congested at certain times of the day. When additional drivers entering the freeway slow traffic, they impose an externality, or cost, on other highway users. A congestion toll that varies with the level of traffic can correct that congestion externality. The evidence indicates that congestion tolls reduce congestion and increase driving speeds. Some policymakers are concerned that congestion taxes are regressive. Many factors, such as the proximity of residential communities to jobs, can influence this outcome. Also, the way toll revenues are used determines the degree to which the tax is regressive or progressive. Research suggests that congestion tolls are no more regressive than the fuel tax that is currently used to finance highways. To encourage and facilitate the adoption of congestion pricing in the United States, Congress should pass legislation making congestion tolls legal on all interstate highways. Experience with congestion tolling improves the public's perception of tolling and increases drivers' willingness to accept highway tolls. One tactic that has been successful is following a congestion-pricing experiment with a referendum on whether the system should be made permanent.

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Highways and roads are not free; they must be paid for. Fuel taxes are the primary revenue source used to finance highway construction and maintenance. Although much of the debate related to highway infrastructure is focused on the condition of the system, congestion is a more pressing issue for most drivers.[1] The fuel tax is not the most effective way to deal with congestion.

Drivers on most highways in the United States do not pay access tolls. A lack of tolls leads to a "tragedy of the commons" problem, resulting in the overuse of scarce road space and congestion. Overly congested highways are inefficient because they waste people's time and can increase air pollution. Highway congestion cost the United States $160 billion in 2014.[2]

In response to urban congestion, politicians have focused on expanding highway capacity or building mass transit. Those approaches are popular with elected officials because construction companies and unions, in addition to voters, are willing to support politicians who back highway and mass transit construction. Although expanding highway capacity serves more drivers, congestion eventually returns as total traffic volume increases.[3] Moreover, in all but the most densely populated cities, mass transit has failed to reduce congestion.

Variable tolls offer a solution to highway congestion. The optimal toll is highest during peak driving times. Some users respond to the higher price by shifting less essential trips to off-peak times. Other drivers may car pool or use

1. A poll conducted by the University of Southern California's Dornsife College, the California Community Foundation, and the Los Angeles Times found that 55 percent of respondents viewed traffic and congestion as their biggest concerns above crime, personal finance, housing, and retirement. See Nita Lelyveld and Shelby Grad, "Traffic Still Tops Crime, Economy as Top L.A. Concern, Poll Finds," *Los Angeles Times*, October 7, 2015; Robert Krol, "America's Crumbling Infrastructure?," Expert Commentary, Mercatus Center at George Mason University, June 26, 2015.
2. David Schrank et al., *2015 Urban Mobility Scorecard* (College Station, TX: Texas A&M Transportation Institute and INRIX, 2015), 5.
3. Gilles Duranton and Matthew Turner, "The Fundamental Law of Road Congestion: Evidence from US Cities," *American Economic Review* 101, no. 6 (2011): 2616–52.

mass transit. As a result, congestion is reduced. Tolls can be placed on all lanes or just a few lanes. These toll lanes not only improve the efficiency of infrastructure use but also give elected officials information about the importance of additional highway capacity to drivers.

A major concern that has slowed the adoption of congestion pricing is the equity or distribution effects of the toll. Is a congestion toll regressive? To make sense of the regressivity issue, one must compare the effects of the congestion toll to the effects of the tax currently used to fund highway construction—that is, the fuel tax. Although the evidence is mixed, one can conclude that the congestion toll is no more regressive than the fuel tax. In addition, when toll revenues are used to improve public transit or to lower the sales or fuel tax, the regressivity is reduced or eliminated.

Congestion pricing has been used in major cities outside the United States and on a limited basis in the United States. Given the potential efficiencies associated with road pricing, the federal government should end the ban on tolls on existing interstate highways. Variable tolls could be part of a vehicle-miles-traveled (VMT) system of charges to finance highway construction and maintenance. When drivers become more familiar with congestion-pricing systems, their support grows. As traffic speeds increase and drive times are reduced, the benefits associated with tolls are observable, making the policy more acceptable to the public.

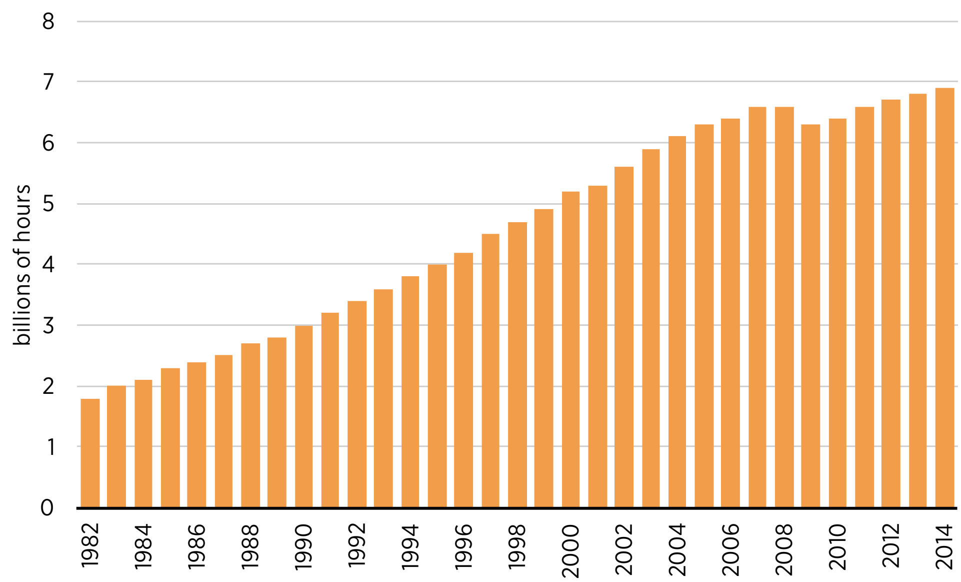
The next section of the paper examines congestion trends in the United States. Section 2 discusses the economics of congestion and equity issues. Section 3 reviews experiences with tolling in the United States and abroad. Section 4 presents policy options. The paper ends with a brief conclusion.

1. THE CONGESTION PROBLEM

Congestion in the United States has been increasing over time. Figures 1 and 2 provide data on congestion from 1982 to 2014. Figure 1 shows the trend in total time delays measured in billions of hours. With the exception of the Great Recession of 2008 and the slow recovery following it, traffic time delays have steadily increased over the period. To put this problem in perspective, the authors of the *2015 Urban Mobility Report* point out that a typical urban driver must allow 48 minutes during peak driving hours to take a trip that would be 20 minutes on a free-flowing highway.[4]

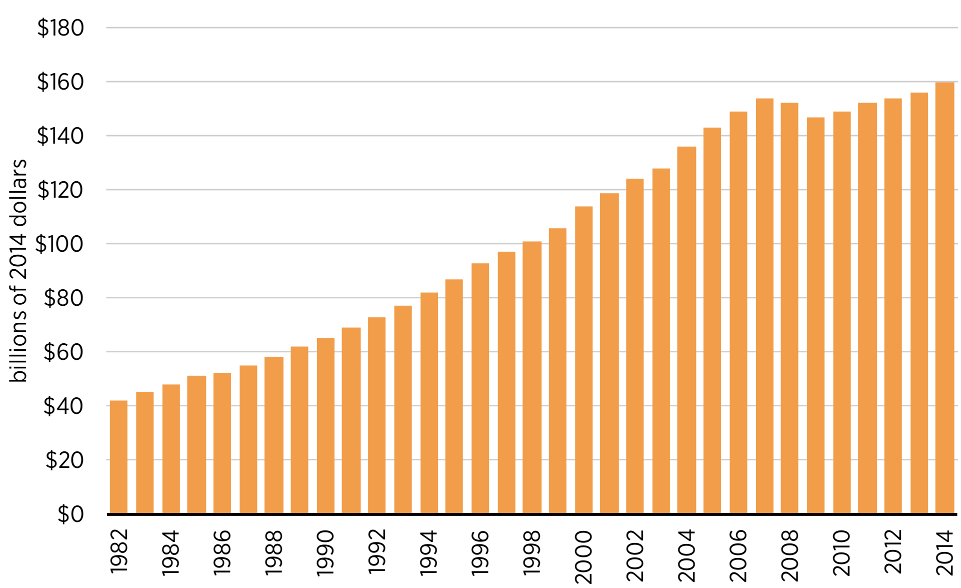
4. Schrank et al., *2015 Urban Mobility Scoreboard*, 1.

FIGURE 1. TOTAL TIME DELAYS, 1982–2014



Source: Based on David Schrank, Bill Eisele, Tim Lomax, and Jim Bak, *2015 Urban Mobility Scorecard* (College Station, TX: Texas A&M Transportation Institute and INRIX, 2015), exhibit 2.

FIGURE 2. COST OF CONGESTION, 1982–2014



Source: Based on David Schrank, Bill Eisele, Tim Lomax, and Jim Bak, *2015 Urban Mobility Scorecard* (College Station, TX: Texas A&M Transportation Institute and INRIX, 2015), exhibit 2.

These travel delays are costly. Figure 2 provides a different perspective—the cost of traffic delays in billions of 2014 dollars. The cost estimate includes the value of time delays plus the value of fuel wasted by vehicles sitting in traffic. The same pattern emerges; the cost of congestion has steadily increased from 1982 to 2014. Congestion is estimated to have cost the United States $160 billion in 2014, nearly a fourfold increase since 1982.[5] Clearly, US transportation policy has failed to put a dent in urban congestion.

Although highway congestion may be a sign of a healthy economy, high levels of congestion can have a negative impact on an area's economic activity. Economist Kent Hymel argues that congestion can influence economic activity, measured by employment growth, in two ways.[6] First, time delays raise shipping costs, which reduces business activity and the demand for labor. Second, higher commuting costs can increase a worker's reservation wage, making workers less likely to accept job offers, thus slowing the expansion of employment.[7] Hymel found that congestion in US cities, as measured by travel delays per capita, slows subsequent employment growth.[8] An earlier study by economist Marlon Boarnet found that congestion reduces county-level output in California.[9] Another study by economist John Fernald found that congestion reduces US industry–level output.[10]

2. CONSIDERATIONS FOR IMPROVING TRAFFIC FLOW

Most highways do not charge a variable toll (price) for access, and as a result, many urban highways are over used and highly congested. This congestion is especially heavy during rush hour drive times. Each time an additional vehicle enters a congested highway, the travel time for drivers in other vehicles increases. In this situation, drivers impose a cost (longer travel times) on other

5. For a discussion of the issues surrounding these estimates, see Todd Litman, "Congestion Costing Critique: Critical Evaluation of the *Urban Mobility Report*" (Victoria Transportation Policy Institute, Victoria, BC, December 18, 2014).
6. Kent Hymel, "Does Traffic Congestion Reduce Employment Growth," *Journal of Urban Economics* 65, no. 2 (2009): 127–35.
7. The *reservation wage* is the lowest wage rate an individual requires to accept a job offer. Higher travel costs tend to raise the reservation wage.
8. Matthias Sweet confirms Hymel's results in "Traffic Congestion's Economic Impacts: Evidence from US Metropolitan Regions," *Urban Studies* 51, no. 10 (2014): 2088–110.
9. Marlon Boarnet, "Services and the Productivity of Public Capital: The Case of Streets and Highways," *National Tax Journal* 50, no. 1 (1997): 39–57.
10. John Fernald, "Roads to Prosperity? Assessing the Link between Public Capital and Productivity," *American Economic Review* 89, no. 3 (1999): 619–38.

users of the highway. Economists call this cost a *negative externality*. This negative externality is an inefficient outcome that can be corrected with a tax.

The Economics of Congestion

An efficient tax is one set to equal the costs imposed on other users of the road. Economists call this cost the *external marginal cost* because it is the incremental cost an additional driver imposes on drivers already on the road. While most taxes distort decision making, resulting in a less efficient use of resources (lowering economic welfare), taxes directed at correcting externalities, such as congestion, improve efficiency and aggregate welfare.[11]

A highway is used efficiently when, for the last vehicle entering the highway, the social marginal benefit of using the highway equals the social marginal cost. The social marginal benefit has two parts—a private marginal benefit and an external marginal benefit. The private marginal benefit is what drivers and occupants are willing to pay to make the trip on the highway. In the case of a highway, I assume there is no external benefit.[12] Thus, for highways, the social and private marginal benefits are the same.

The social marginal cost also has two parts—a private cost and an external cost. The private marginal cost of using a road includes the value of the user's time (what drivers and occupants are willing to pay to save an hour of travel time, which is sometimes measured as a percentage of average wages), fuel costs, and vehicle wear and tear. When there is congestion, an additional vehicle imposes an additional cost (longer travel time) on other users of the highway (the external marginal cost). Using a highway has other social costs, such as air and noise pollution.[13]

When highways are congested and no variable toll is imposed, a driver considers only his or her costs (gasoline, travel time, and so on) to use the congested highway, ignoring the external marginal cost. Thus, the social marginal cost to use the highway exceeds the social marginal benefit for this driver,

11. Arthur C. Pigou, *The Economics of Welfare* (London: Macmillan, 1920).

12. An example of an external benefit is when people get vaccinated for the flu. The vaccinations reduce the chances that other people will get sick, so those other people also receive a benefit from the vaccination.

13. Externalities such as air and noise pollution can be corrected by setting the fuel tax at a level that reflects the damages they cause. See Ian W. H. Parry and Kenneth A. Small, "Does Britain or the United States Have the Right Gasoline Tax?," *American Economic Review* 95, no. 4 (2005): 1276–89. The toll could also be set at a level that reflects the damages from these externalities.

resulting in an inefficient overuse of the highway.[14] This inefficient overuse can be reduced by charging a tax (or toll) equal to the value of the externality. The right toll equates the social marginal cost to the social marginal benefit, resulting in more efficient use of highway resources.[15] Hence, the toll increases the welfare of society.[16] This approach can be applied to correct externalities ranging from congestion to air pollution.

In the case of congested highways, the size of the externality varies over the time of day. Because highways are most congested at peak driving times, the congestion externality is highest during those periods. Low-flow times have no external effect because an additional driver on an empty road does not slow other drivers. For improved highway efficiency, a variable toll should be charged to highway users. This toll would be highest during the peak driving times and lowest (or zero) in off-peak periods.[17]

A variable congestion toll could be part of a vehicle-miles-traveled (VMT) system. Under a basic VMT system, drivers would pay a flat toll for each mile driven on a highway. Alternatively, the toll could vary according to the level of congestion (time of day) or according to the damage imposed on the highway from use (weight per axle). GPS technology and vehicle transponders make the administrative costs of this type of system low, thus making the VMT approach technologically feasible.

Privacy concerns are a possible drawback to the VMT approach. Charging a variable toll requires that data be collected on vehicle location and time of day. The issue is deciding who controls this information. One solution is to develop technology that would store travel information in the car. Once a month, travel details could be sent to a private firm that would convert the data into a bill that could later be matched to an account for payment. After the monthly bill is paid, the travel data could be deleted. This type of system

14. I am focusing on a congestion externality that varies over time. If congestion were constant over time, it could also be corrected with a fixed fuel tax.
15. In practice, determining the optimal toll is difficult. Computer estimates can be made, or officials can determine the toll by trial and error.
16. This benefit to society does not mean that every user of the highway is better off. The distribution of the toll's costs and benefits among different individual highway users will be discussed in the next section of the paper.
17. See William Vickrey, "Pricing in Urban and Suburban Transport," *American Economic Review* 53, no. 2 (1963): 452–65; Kenneth A. Small and Erik Verhoef, *The Economics of Urban Transportation* (New York: Routledge, 2007); Ian W. H. Parry, "Pricing Urban Congestion," *Annual Review of Resource Economics* 1, no.1 (2009): 461–84; Alex Anas and Robin Lindsey, "Reducing Urban Road Transportation Externalities: Road Pricing in Theory and Practice," *Review of Environmental Economics and Policy* 5, no. 1 (2011): 66–88.

would produce an efficient billing process and, at least partially, ensure that travel details are protected.[18]

Starting July 2015, Oregon is testing a VMT system as an alternative to the fuel tax to fund highway construction and maintenance.[19] State officials will be able to see how this type of tolling system influences driving habits. The VMT system is likely to reduce total miles driven. Given the flat toll rate, it will probably reduce driving during both congested and noncongested times.[20] Since a variable rate toll is highest during peak travel times, a variable toll would have a bigger effect on congestion. If the flat rate system proves successful, introducing a variable rate toll later would be fairly easy.

The Oregon program is voluntary, and participants receive tax credits for fuel taxes paid. To reduce privacy concerns, the state passed laws that restrict how the collected data may be used and how long it is stored. The law has private companies, rather than the government, manage the program and store data to ensure privacy. Oregon state officials estimate the operating costs of the program to be $420,000 per year.[21]

What would it cost to set up and operate a VMT system nationally? Using the Netherlands' planned truck VMT system as a guide, the Federal Highway Administration estimates the capital cost of a national VMT system

"The right toll equates the social marginal cost to the social marginal benefit, resulting in more efficient use of highway resources. Hence, the toll increases the welfare of society."

18. See Tracy C. Miller, "Improving the Efficiency and Equity of Highway Funding and Management: The Role of VMT Charges" (Mercatus Working Paper no. 14-04, Mercatus Center at George Mason University, Arlington, VA, February 2014) for details on ways to handle privacy issues in a VMT system. See also Paul Sorensen, Liisa Ecola, and Martin Wachs, *Mileage-Based User Fees for Transportation Funding: A Primer for State and Local Decisionmakers* (Santa Monica, CA: RAND, 2012).
19. Jeff Reynolds, "Road User Fee Based on Mileage Goes for a Test Drive in Oregon," *Budget and Tax News*, September 2015, 4. California has passed legislation to establish a statewide pilot VMT by 2017. See "California Road Charge Pilot Program," California Department of Transportation, accessed April 18, 2016, http://www.dot.ca.gov/road_charge/.
20. Higher fuel taxes have the same problem. They may reduce total driving, but they are less effective in reducing congestion at peak hours.
21. Oregon Department of Transportation, *Road Usage Charge Pilot Program 2013 and Per-Mile Charge Policy in Oregon* (Salem: Oregon Department of Transportation, February 2014).

would be approximately $10 billion, and operating costs would be 5 percent of revenues.[22] Operating costs of the current fuel tax equal 1 percent of revenues. Economist Anthony Rufolo estimates the administrative costs of operating a basic VMT system would be approximately 17 percent of revenues.[23] Although these figures are only estimates, operating costs of a VMT system appear to be higher than those of the current fuel tax system. However, experience and better technologies could lower the VMT system's costs over time.

In addition to reducing congestion, variable tolls provide policymakers with information on the value drivers place on using a highway at a particular time of day. Highway users who value driving on the highway at peak times the most will continue to use the highway. However, users who place a low value on driving on the highway at peak times will choose alternative modes of transportation or shift travel times to off-peak hours. Congestion on the tolled highway will be reduced. One problem with congestion tolls is that traffic flows on secondary roads can increase. The size of this route shift would be influenced by the location of jobs relative to where people live, the size of the toll, and alterative transit options.

Equity Concern Associated with Congestion Pricing

A roadblock to congestion pricing is concern about equity. Congestion pricing has a number of potential equity issues. First, although total welfare is higher using congestion tolls, the effect is likely to vary across individuals. How do the costs and benefits differ among highway users? This equity issue often hinges on how the toll revenues are used. A second concern centers on tax regressivity. Do low-income drivers pay a larger percentage of their income on congestion tolls than high-income drivers? Is a toll more regressive than a fuel tax? Finally, the current system for financing highways is not equitable across states. The amount of federal funding that some states receive is less than the amount of fuel taxes state drivers pay.

Individual costs and benefits.

After a toll is imposed, whether an individual benefits depends on (1) whether the individual continues to drive on the highway and (2) how the toll revenues are spent. Drivers who continue using the highway pay a toll, but they benefit from faster commutes. These drivers would benefit

22. National Surface Transportation Infrastructure Financing Commission, *Paying Our Way: A New Framework for Transportation Finance* (Washington, DC: Federal Highway Administration, 2009).
23. Anthony Rufolo, "Cost Estimates for Collecting Fees for Vehicle Miles Traveled," *Transportation Research Record: Journal of the Transportation Research Board* 2221 (2011): 39–45.

if the highway toll revenues were used to lower other taxes or to improve the highway. When the value of the time saved plus benefits from revenues exceeds the amount of tolls paid, the driver is better off. For these drivers, the net result depends on how much they value their time (and the amount of time saved), how the toll revenues are used, and how much the toll is.[24]

Drivers who stop using the highway because of the toll lose the benefits they derived from using the road before the toll. They now use a less preferred travel mode, travel less, or depart at less convenient times. They benefit from toll revenues that are used to reduce taxes, improve bus or rail transit systems, or expand alternate routes. When the value of the benefits derived from toll-funded programs exceeds the value lost from not using the road, drivers who use toll-free roads are better off. For this group of drivers, the net result depends on the value they place on using the toll-free road and the way toll revenues are used.[25]

The way revenues from tolls are spent plays an important role in determining the welfare effect of congestion pricing on individuals. The extent to which voters trust government officials to keep their promises plays a key role in public acceptance of urban congestion pricing. Taxpayers are aware that revenues are fungible; if toll revenues are spent as promised but other revenues are redirected, there may not be a net increase in funding.

Economist Kenneth A. Small simulated the welfare effects of a $0.15 per mile toll in the five-county Southern California region in 1990,[26] making specific assumptions about how the revenues would be used. First, he assumed that one-third of the revenues were used to compensate travelers by providing commuting allowances through employers. Second, he assumed that taxes that had been previously used to finance the transportation system—fuel taxes and license fees—were lowered to offset the toll. Third, he assumed that the remaining funds financed new transportation services. Small found that drivers who continued to drive on the highway and those who switched to carpooling or mass transit were better off with the toll. Among those who continued to drive after the toll, both high- and low-income drivers gained, but low-income drivers gained the least. This difference in benefits reflects differences in the time value of the groups. Small's work suggests that directing toll revenues to specific areas that benefit commuters creates a broad-based welfare gain,

24. Kenneth A. Small, "The Incidence of Congestion Tolls on Urban Highways," *Journal of Urban Economics* 13, no.1 (1983): 90–111.
25. See Small and Verhoef, *Economics of Urban Transportation*, or Arthur O'Sullivan, *Urban Economics* (New York: McGraw-Hill Education, 2007).
26. Kenneth A. Small, "Using Revenues from Congestion Pricing," *Transportation* 19, no. 4 (1992): 359–81.

which is a feature voter's may find attractive. Consumers already experience price rationing to manage congestion in the air travel market. Airline flights are more expensive during the preferred peak travel times, thereby reducing congestion.[27]

Tax regressivity. Many policymakers are concerned that congestion tolls may be regressive. A tax is regressive when the amount represents a larger percentage of income for a low-income individual than for a high-income individual. Regressivity is often viewed as an undesirable feature of a tax. The gasoline tax—currently the primary highway-funding source—may be regressive as well. The relevant issue is whether a congestion toll is more regressive or less regressive than a traditional fuel or sales tax.

The estimated regressivity of a particular tax is sensitive to how the analysis defines *income*. The gasoline tax appears to be regressive when taxes paid are compared to the taxpayer's current-year annual income. However, consumption depends on lifetime income, which is a better measure of an individual's economic circumstances. Economist James Poterba calculated the regressivity of gasoline taxes in the United States using annual income and lifetime income.[28] When lifetime income is used as the basis of comparison, rather than annual income, the gasoline tax appears less regressive. Poterba proxies lifetime income with total annual consumption. So instead of analyzing the tax as a share of income, he analyzes it as a share of total consumption.

Economists Howard Chernick and Andrew Reschovsky argue that using total consumption expenditures as a proxy for lifetime income may not be correct.[29] They point out that capital market imperfections constrain borrowing, thereby breaking the proportional link between consumption and lifetime income. They take an intermediate-run perspective and compare the fuel tax burden to average income over 5-year and 11-year periods.[30] Using this approach, Chernick and Reschovsky find that the gasoline tax is only modestly less regressive than when annual data are used. The reduction in regressivity is less than what Poterba finds in his study. Despite differences across their studies, all the researchers find that the gasoline tax is regressive.

27. I thank one of the reviewers for this point.
28. James M. Poterba, "Is the Gasoline Tax Regressive?," *Tax Policy and the Economy* 5 (1991): 145–64. Poterba measures lifetime income using total consumption expenditures. His justification for this strategy is the permanent income hypothesis, in which consumption is proportional to lifetime or permanent income.
29. Howard Chernick and Andrew Reschovsky, "Who Pays the Gasoline Tax?," *National Tax Journal* 50, no. 2 (1997): 233–59.
30. The 5-year and 11-year periods were dictated by the data used by Chernick and Reschovsky.

These same regressivity issues apply to congestion tolls. The overall degree to which a congestion toll is regressive or progressive also depends on where people (regardless of income level) live, work, go to school, and shop. Any transportation tax system influences housing prices and wages, which further complicates equity issues. If congestion pricing reduces air pollution because drivers can avoid being stuck idling on the highway, people living near highways may find that their welfare improves. A reduction in air pollution will raise the value of homes in highway-adjacent neighborhoods. If those neighborhoods include mostly low-income households, congestion tolling will be less regressive than traditional evaluation suggests.

A further complication is that *equity* can be defined in various ways when making welfare comparisons; regressivity is not the only relevant criterion. For highways, it is common to use the benefit-principle approach. Put simply, this approach means that those who benefit pay the toll. Alternatively, one could use vertical equity (comparing welfare effects between groups) as the basis for welfare comparisons. Depending on the circumstances, a congestion toll might do well from a benefit-principle standpoint but do poorly if evaluated on the basis of vertical equity.

When congestion tolls are in place, drivers with the highest time value gain the most. Because time value is positivity related to income, the congestion tax can be regressive. However, this regressivity is offset by the fact that high-income individuals may drive longer distances and pay more tolls. The relationship between income and driving would have to be large for the congestion toll to be progressive.[31]

It is difficult to draw a firm conclusion about the regressivity of congestion tolls because of their limited use as a way to manage highway financing and congestion. The limited studies that do exist have mixed evidence. For example, in the United Kingdom, the Transport Act 2000 gave local governments the power to use variable tolls to reduce highway congestion. Economists Georgina Santos and Laurent Rojey simulate the effect of congestion pricing in three UK cities—Cambridge, Bedford, and Northampton.[32] As one would expect, the distributional effect depends on where people (rich and poor) live and work and how toll revenues are spent. The available transportation options also play a role in determining the regressivity of the toll. In

31. Parry, "Pricing Urban Congestion"; Anas and Lindsey, "Reducing Urban Road Transportation Externalities"; Liisa Ecola and Thomas Light, *Equity and Congestion Pricing: A Review of the Evidence* (Santa Monica, CA: RAND, 2009).
32. Georgina Santos and Laurent Rojey, "Distributional Impacts of Road Pricing: The Truth behind the Myth," *Transportation* 31 (2004): 21–42.

"Congestion pricing is no more regressive than the fuel tax. . . . The key advantage of using congestion tolls is the greater efficiency the highway system gains, which is a benefit that these other taxes do not provide."

Santos and Rojey's analysis, the toll revenues are allocated to finance infrastructure and public transportation. A portion of the revenue compensates those whom the toll harms the most. Because those factors varied between towns, the regressivity also varied. In Cambridge, the toll turned out to be regressive; in Northhampton, it was neutral, and in Bedford, progressive. Santos and Rojey conclude that, on average, the rich pay the toll and the poor do not, which suggests that the poor reduce their amount of driving.

Analysts Jonas Eliasson and Lars-Göran Mattsson examine the equity effects of congestion pricing in Stockholm, Sweden, in 2005.[33] Because the revenues were used to improve public transportation, Eliasson and Mattsson find the pricing to be progressive. Scholars Anders Karlström and Joel P. Franklin also examine the Stockholm plan for congestion pricing.[34] They do not find any clear pattern between income and the burden of the toll. They also find no effect on income inequality.

Research shows that fuel taxes are regressive. Studies that examine this issue for congestion tolls are mixed. However, the net welfare effect on different groups depends on the way the revenues are used. For example, if congestion tax revenues are used to cut income taxes, the toll is more regressive. If the revenues are instead used to improve bus services, the toll is more progressive. More research on congestion-pricing experiences is needed to draw a firm conclusion about congestion tolling's level of regressivity. The research reported here suggests that congestion pricing is no more regressive than the fuel tax, which is already the primary source of funding for highways in the United States.[35] The key advantage of using congestion tolls is the

33. Jonas Eliasson and Lars-Göran Mattsson, "Equity Effects of Congestion Pricing Quantitative Methodology and a Case Study for Stockholm," *Transportation Research Part A* 40, no. 7 (2006): 602–20.
34. Anders Karlström and Joel P. Franklin, "Behavioral Adjustment and Equity Effects of Congestion Pricing: Analysis of Morning Commutes during the Stockholm Trial," *Transportation Research Part A* 43, no. 3 (2009): 283–96.
35. Ecola and Light, *Equity and Congestion Pricing*, 36.

greater efficiency the highway system gains, which is a benefit that these other taxes do not provide.[36]

State equity. Another equity issue under the current fuel tax funding system is whether the revenues raised are distributed equitably among the states. The revenues from the federal fuel tax are distributed to states using a formula set by Congress. Although state minimum allocations are mandated, the distribution of remaining funds is based on factors such as existing miles of highways and roads, but not on congestion. The issue is whether a state receives a funding level that is equal to, less than, or greater than the amount of taxes paid.

Economist Ronald Utt finds wide disparities among states in terms of transportation funds received compared with fuel taxes paid during the 1956–2005 period. Utt finds that 28 states received more funds than they paid in fuel taxes. The remaining states received fewer funds than the amount of fuel taxes paid.[37]

Political scientists Pengyu Zhu and Jeffrey Brown investigate the redistribution of federal highway aid during the 1974–2008 period and examine some of the factors that affected the dollar allocations.[38] They find that a disproportionate allocation of funds went to states with higher per capita income, fewer highway miles, low highway usage, less urban populations, and better political representation. It appears that urban congestion, a pressing transportation problem, does not affect the allocation of funds. Instead, political factors influence the allocation of transportation dollars.[39] Zhu and Brown find that states represented by a senator who chaired the US Senate Committee on Appropriations received $98 more per capita than states without that kind of representation.

Such results indicate that the current funding system does not direct funds in a manner that would reduce highway congestion. Even though the allocation system is based on a formula, political factors drive transportation funding. A way to reduce this problem would be to shift more funding

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36. Douglas Lee, "Impacts of Pricing on Income Classes," in *TRB Conference Proceedings 34: International Perspectives on Road Pricing*, ed. Transportation Research Board (Washington, DC: National Academies, 2003), 49–50.
37. Ronald D. Utt, "Restoring Regional Equity to the Federal Highway Trust Fund" (Backgrounder 2074, Heritage Foundation, Washington, DC, October 2007), 1–6.
38. Pengyu Zhu and Jeffrey R. Brown, "Donor States and Donee States: Investigating Geographic Redistribution of the US Federal-Aid Highway Program, 1974–2008," *Transportation* 40, no. 1 (2013): 203–27.
39. See Robert Krol, "Political Incentives and Transportation Funding" (Mercatus Research, Mercatus Center at George Mason University, Arlington, VA, July 2015), for a detailed discussion about the way political factors influence transportation funding.

responsibility from the federal government to the states. Shifting more of the funding responsibility to lower levels of government would better align highway benefits with costs, resulting in more efficient use of highway funds.[40] Also, federal law could be changed to allow states to use congestion tolling, if they wished, on all highways.

3. EXPERIENCES AND OUTCOMES

To provide a greater understanding of how congestion pricing can be implemented, this section examines experiences with tolling in the United States and abroad. In the United States, federal, state, and local programs have used variable tolls on highways and sections of interstate highways since the 1990s. These variable tolls include high occupancy toll (HOT) lanes on some interstates in California, Texas, and other states. Express lanes along a freeway in Orange County, California, have also used congestion pricing. Cities outside the United States have applied variable tolls when highway users enter the central business district of major cities. This section will review the experiences of Singapore, London, Stockholm, and Southern California (Interstate 15 [I-15] in San Diego and State Route 91 [SR-91] in Orange County). In most places, congestion declined and highway speeds increased following the imposition of congestion tolls.

Cordon or Zone Toll Systems

An early adoption of road pricing occurred in Singapore.[41] Singapore is an island nation that has experienced rapid economic growth. As income rose, vehicle ownership increased, resulting in significant congestion.[42] Beginning in 1975, vehicles entering the restricted zone of the central business district during the morning rush hour were charged a toll. This toll was a fixed amount per day (S$3 per day), and it allowed cars multiple entries during the day. A license was displayed and manually checked by individuals stationed at entry

40. Ibid.
41. See Sock-Yong Phang and Rex S. Toh, "Road Congestion Pricing in Singapore: 1975 to 2003," *Transportation Journal* 43, no. 2 (2004): 16–25; Gopinath Menon, "Congestion Pricing: The Singapore Experience," in *Street Smart*, ed. Gabriel Roth (Piscataway, NJ: Transaction Publishers and Independent Institute, 2006): 117–40.
42. Singapore also limited growth in highway use by maintaining a vehicle quota system. Individuals interested in buying a new car would bid for a certificate that would allow the purchase of the vehicle. See Menon, "Congestion Pricing," 119–20 for details.

points to the zone. Carpools, school buses, and emergency vehicles were exempt from the toll.[43]

The objective of the toll was to reduce the flow of traffic to non–rush hour levels. The government estimated that meeting this objective would require a 30 percent decline in traffic. At first, traffic volume during the morning rush hour decreased by almost 45 percent, and the average speed nearly doubled. However, traffic volume increased significantly just before and after the rush hour period. Officials expected a similar drop off during the evening rush hours, but the reduction did not occur. The result was an underuse of highways during the morning rush hours and a shift of traffic to off-peak times and alternate routes. By 1988, the traffic flow was down by 31 percent, exceeding the government's initial goal of 30 percent. Over time, use of buses and rapid transit significantly increased. In 1975, 46 percent of all trips into the zone were made by bus. By 1998, 67 percent of all trips into the zone were made by bus or rapid transit.

Singapore's highway pricing system evolved over the years. To smooth out traffic flows over the day and week, Singapore began charging lower tolls just before and after the peak driving times. By 1994, the tolls were extended to the entire business day. To familiarize drivers with tolling, Singapore added a toll on the heavily traveled East Coast Parkway. Once again, traffic volume dropped and speeds doubled.

The tolling system reduced congestion, increased average highway speeds, and resulted in a shift toward public transportation. However, a number of problems emerged. First, finding the optimal toll took considerable trial and error. Often, tolls were too high during rush hour, resulting in an inefficient use of the road. Second, as the system became more complex, manual administration became more difficult. Third, drivers often shifted their commute to times just before and after the peak hours, causing congestion during those periods. Finally and most important, the license allowed multiple trips each day, thus muting the congestion reduction.

In 1998, Singapore transitioned to a fully electronic road-pricing system. Transponders were installed, free of charge, in all cars. Tolls were automatically paid using a debit card. Most important, tolls were charged for each entry into the zone to increase the efficiency of the system. Tolls were set to vary by time, location, and vehicle type. Emergency vehicles remained exempt. After some experimentation, the tolls were reduced. Tolls ranged

43. To avoid paying the toll, some drivers would pick up hitchhikers at bus stops just outside the zone. The toll exemption required four or more passengers.

“In February 2003, London introduced a toll system for entering or parking a vehicle on a public highway in the busiest part of the city’s downtown area. . . . By 2005, average speeds had increased 17 percent, and time spent in traffic jams had decreased 30 percent.”

from S$0.50 to S$2.50 during peak hours, compared with S$3.00 under the old system.

In Singapore, 98 percent of vehicles used the electronic system. Traffic volume dropped by 10 to 15 percent relative to the old system. A 23 percent decline in multiple trips caused this decrease in volume. Drivers benefited from the reduction in congestion and the shorter travel times. To offset the costs of the system, the government reduced vehicle registration fees and other road taxes. The government also invested heavily in public transit. Because of this investment, Singapore commuters considered the program to be fair.[44]

In February 2003, London introduced a toll system for entering or parking a vehicle on a public highway in the busiest part of the city’s downtown area. The toll was set at a fixed £5 charge per day. In 2005, it was increased to £8 from 7:00 a.m. to 6:30 p.m. on all business days. Buses, taxis, motorcycles, bicycles, vehicles driven by people with disabilities, alternate fuel vehicles, fire engines, and emergency vehicles were exempt from the toll. All toll revenues were earmarked for public transit for the first 10 years (later extended another 10 years), with 80 percent of the revenues spent on improving bus service. This use of funds generated political support and reduced equity concerns for voters. City officials’ justification for using a flat rate toll was that average travel speeds in the area were about the same all day long; there was no peak congestion problem to solve. The tolls were prepaid and enforced using a license plate recognition system.[45]

The effect of the congestion charge was significant. The number of cars, vans, and trucks entering the zone declined 27 percent in the first year. Approximately 50 percent of drivers switched to public transportation, 25 percent drove around the zone, 10 percent started using taxis or bikes, and 10 percent reduced the number of trips

44. Menon, “Congestion Pricing,” 136–37.
45. See Jonathan Leape, “The London Congestion Charge,” *Journal of Economic Perspectives* 20, no. 4 (2006): 157–76.

or shifted trip times. By 2005, average speeds had increased 17 percent, and time spent in traffic jams had decreased 30 percent. In addition, the reliability of projected trip times improved, making trip planning easier. Transport for London estimated that benefits exceeded costs by £67 million per year (in 2005 prices).[46]

Stockholm established a trial cordon variable–toll system for an inner-city zone during the first half of 2006. The tolls varied from Skr 10 to Skr 20 depending on the time of day. No tolls were charged in the evening, on weekends, or on holidays. Taxis, buses, and eco-fuel cars were exempt from the toll. The city also added 16 new bus routes, expanded railroad capacity, increased the frequency of rail departures, and increased park-and-ride capacity near public transport stations.[47]

Traffic simulations estimated traffic volume would decline by 10 to 15 percent. The actual decline was 22 percent. Interestingly, traffic declines also occurred outside the cordon zone, so the expected increase in congestion in those areas did not materialize. This higher-than-projected decline in volume was likely the result of the structure of the public transportation system and the spatial distribution of residential neighborhoods relative to employment. About one-half of the decline was caused by fewer trips to work and school. Most of the individuals in this group shifted from driving to using public transportation. The other half of the decline was mostly attributable to a reduction in discretionary trips. A benefit-cost analysis estimated an annual excess of SKr 650 million if the program were made permanent. Citizens of Stockholm viewed the trial as a success. In September 2006, voters approved a referendum to make the toll system permanent beginning in August 2007.[48]

46. Transport for London, *Central London Congestion Charging: Impacts Monitoring, Fourth Annual Report* (London: Transport for London, 2006). Estimates of positive net benefits can also be found in Georgina Santos, Gordon Fraser, and David Newbery, "Road Pricing: Lessons from London," *Economic Policy* 21, no. 46 (2006): 263–310.
47. See Jonas Eliasson, Lars Hultkrantz, Lena Nerghagen, and Lena Smidfeld, "The Stockholm Congestion-Charging Trial: 2006 Overview of Effects," *Transportation Research Part A* 43, no. 3 (2009): 240–50. The second largest city in Gothenberg, Sweden, followed Stockholm's lead and also instituted a trial and referendum approach to a cordon central city variable toll system, which began operating in 2013. In that case, traffic volume declined 12 percent following the imposition of congestion tolls. See Maria Börjesson and Ida Kristoffersson, "The Gothenburg Congestion Charge: Effects, Design, and Politics," *Transportation Research Part A* 75 (2015): 134–46.
48. The environment also improved as a result of the toll system. Carbon dioxide declined 14 percent, nitrogen oxide fell 8.5 percent, and particulates were 10 to 14 percent lower. See Eliasson et al., "Stockholm Congestion-Charging Trial," 245.

Express and HOT Lanes

In the United States, congestion pricing has been used at the state and local levels for highways that are not part of the Interstate Highway System. Federal involvement in congestion pricing began in 1991 as part of the highway-funding bill. In 1998, the federal government set up the "Value Pricing Pilot Program," which provided state and local governments 80 percent federal matching funds to develop and manage road-pricing projects. Projects included (1) converting underused toll-free high-occupancy vehicle (HOV) lanes to HOT lanes that manage the lanes' traffic flow using a variable toll, (2) constructing and tolling additional lanes, and (3) adding variable tolls on bridges and tunnels.[49]

Southern California opened express and HOT lanes in the 1990s. The SR-91 express lanes were a private, for-profit highway project that began operating in December 1995. Four tolled express lanes were built in the SR-91 median for a 10-mile segment at a cost of $134 million. The California Private Transportation Company had a 35-year lease, after which the lanes would be returned to the state. The company was responsible for traffic management and driver assistance. Highway maintenance and law enforcement remained a state responsibility.[50]

The tolls varied from $1.00 to $5.50 depending on traffic flows. The goal was to maintain free-flowing traffic in the lanes. A constraint was imposed on the tolls that was based on the maximum limit on the project's rate of return. Carpools were exempt from the toll. Before the express lanes opened, delays on the highway increased travel time by 45 to 60 minutes for the roughly 10-mile trip. Once the express lanes opened, travel times were cut in half on the toll-free lanes, indicating a benefit to nonpaying drivers. However, these speed gains did not last, as regional economic development added vehicles to the highway. The express lanes remained free flowing during this period. Variable tolls were able to keep the lanes congestion free. A government agency bought the express lanes in 2003 for $207.5 million.[51]

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49. See Patrick DeCorla-Souza, "Recent US Experience: Pilot Projects," in *Road Pricing: Theory and Evidence*, ed. Georgina Santos (New York: Elsevier, 2004): 179–206. Other places in the United States where HOT lanes have been used include Denver, Colorado; Miami, Florida; and Minneapolis, Minnesota, to name a few.

50. Edward C. Sullivan, "HOT Lanes in Southern California," in *Street Smart*, ed. Gabriel Roth (Piscataway, NJ: Transaction Publishers and Independent Institute, 2006): 189–224.

51. The project became controversial when the state wanted to make highway improvements on nearby roads. The agreement between the state and California Private Transportation Company had a noncompete clause that limited construction to safety improvements. This friction led to the sale in 2003. See ibid. These problems might be avoided with better guidelines as to when competing highways may be improved. Thresholds for congestion and accident levels could be established to trigger construction on competing highways.

Two eight-mile HOV lanes were opened on I-15, north of San Diego, California, in 1988.[52] The lanes were underused as HOV lanes. Area governments, with the help of the Federal Highway Administration's Value Pricing Pilot Program, gradually allowed single-occupant vehicles to use the excess capacity of the lanes. At first, this program imposed a monthly fee to use the lanes, but it eventually evolved into a dynamic toll system. Eventually, drivers paid a toll for each trip. Toll values were reset every six minutes. Tolls typically varied between $0.75 and $4.00 per trip. The maximum toll change was $0.50 for each six-minute period. There was also an hour-by-hour schedule that showed drivers the maximum possible toll. Single-driver vehicles were required to pay tolls electronically from prepaid accounts. The variable tolls kept the HOT lanes free flowing at all times. The toll revenues exceeded operation costs. Consistent with the SR-91 experience, congestion on the nonpaying lanes initially declined but later increased as economic development occurred in the area.

In both of the I-15 and SR-91 examples, express and HOT lane use was highest when travel time savings were greatest. Higher-income individuals tended to use the toll lanes disproportionately. These two experiences found drivers to be fairly responsive to tolls charges. Variable tolls were able to keep the HOT and express lanes congestion free. Surveys found that these highway projects were supported by clear majorities of users and nonusers alike.[53] Drivers like having the option to use the toll lanes during rush hour drive times.

Economists Kenneth A. Small, Clifford Winston, and Jia Yan estimate the welfare effects of adding the express lanes on SR-91 in California.[54] SR-91 has variable tolls on the express lanes and has no tolls on the original highway lanes. This kind of lane pricing takes advantage of the fact that people value time savings differently. From an economic efficiency perspective, placing variable tolls on all lanes maximizes economic efficiency. However, this type of tolling system has associated equity concerns. In their study, Small, Winston, and Yan calculate and compare the net welfare gain of full tolling of SR-91 with that of the current system.

Although charging variable tolls on all lanes provides the greatest net welfare gain, the welfare gain of the current system captures an estimated 75 percent of the gains, and the average driver is better off. For drivers who choose

52. The extra lanes were reversible. From 5:45 a.m. to 9:15 a.m., traffic flowed southbound. Between 3:00 p.m. to 7:00 p.m., traffic flowed northbound. The lanes were closed on weekends and holidays.
53. Sullivan, "HOT Lanes in Southern California," 214–16.
54. Kenneth A. Small, Clifford Winston, and Jia Yan, "Differentiated Road Pricing, Express Lanes, and Carpools: Exploiting Heterogeneous Preferences in Policy Design," in *Brookings-Wharton Papers on Urban Affairs*, ed. Brookings Institution (Washington, DC: Brookings Institution, 2006), 53–96.

to pay the toll, clearly the value of time saved from the higher speeds outweighs the value of the toll paid, making them better off. Drivers on the toll-free lanes are better off because congestion is reduced.[55] Given political opposition to full congestion pricing, express lanes or HOT lanes provide an attractive option. People perceive them to be fair because there are toll-free lane options, yet most of the efficiency gains are captured.

Washington, DC, has restricted HOV lanes on segments of its highway system within the district and the adjacent suburbs. Because only carpools may use the lanes, the lanes tend to be underused, which is inefficient. Some portions of the HOV lanes have now been converted into HOT lanes. Economists Elena Safirova, Kenneth Gillingham, Ian Parry, Peter Nelson, Winston Harrington, and David Mason investigate the potential welfare gains from these types of changes in the area.[56] They compare the welfare gains from tolling all lanes with the gains from converting the HOV lanes to HOT lanes. For the full-tolling case, they estimate the toll for the converted HOV lanes to be $0.22 per mile and that for the other lanes to be $0.07 per mile. The net welfare gains from full tolling are also compared with the gains associated with converting the restrictive HOV lanes to HOT lanes and charging $0.20 per mile during peak periods.

As did Small, Winston, and Yan, Safirova and her colleagues find the net welfare gains from HOV lane conversion captured approximately 80 percent of the gains in the full-tolling case. They also find that households from all income quartiles benefited from the HOV conversion policy. This finding was not the case for the full-tolling policy, where average households from each income quartile were made worse off. These estimates assume that toll revenues are not redistributed. Generally, higher-income households gained more because of the higher value they place on their time. The actual net gains going to each household could be larger depending on how the toll revenues are be spent.

The experiences in the United States and abroad indicate that drivers have a strong and significant response to congestion tolls, which results in less congestion and faster speeds on tolled highways. The efficiency gains associated with HOT lanes compare favorably with the tolling of the entire highway. Because HOT lanes still leave drivers with a toll-free option, drivers view HOT lanes as a fairer option.

55. Area economic development could lead to more traffic volume, reducing these benefits over time.
56. Elena Safirova et al., "Welfare and Distributional Effects of Road Pricing Schemes for Metropolitan Washington, DC," *Research in Transportation Economics* 9 (2004): 179–206.

4. POLICY LESSONS

Currently, state and local governments are not allowed to impose tolls on existing interstate highways. However, they may petition the federal government to allow tolling on new highway lanes. State and local governments can pass legislation that allows tolls on highways that are not part of the Interstate Highway System. Reforms in the 1990s allowed state and local officials to institute pilot tolling programs on new lanes, convert HOV lanes to HOT lanes, and add tolls to bridges and tunnels.[57]

A first step toward reform must be to give state and local governments the option to impose tolls on all interstate highways. This option would give state and local officials the flexibility to use tolls on HOT lanes or on an entire highway. Allowing tolls on all interstate highways would also make it easier for local governments to use tolls on designated cordon zones in central business areas that have existing highways as the primary entry points.

Tolling of trucks should be another step considered for reform. Trucks move the vast majority of goods in the US economy. Transportation analyst Robert Poole has suggested truck-only toll (TOT) lanes as a way to reduce congestion, finance highway expansion, and significantly improve the movement of goods within and between cities.[58] The tolls could be used to build and maintain TOT lanes. TOT lanes can improve access to ports and distribution centers in urban areas. Long-distance TOT lanes between cities would allow for longer trucking vehicles than are currently allowed on interstate highways. These lanes would significantly improve the movement of goods in the economy. Politically, it would be better if truckers were not forced to drive in TOT lanes and pay tolls. However, once the policy was in place, truck companies would have an incentive to use TOT lanes because the lanes

"A first step toward reform must be to give state and local governments the option to impose tolls on all interstate highways."

57. An exemption from these rules allows Missouri, North Carolina, and Virginia to use toll revenues to rebuild portions of interstate highways. However, these states have not used that option.
58. Robert W. Poole Jr., "The Case for Truck-Only Toll Lanes," *Public Works Management and Policy* 11, no. 4 (2007): 244–49.

would increase speed, improve the reliability of deliveries, and allow for larger shipping payloads, thereby reducing cost and raising profits for the truckers.

Over time, increased vehicle fuel efficiency has reduced the revenues generated from the fuel tax. Some policymakers and analysts have suggested a VMT tax as a supplemental or replacement revenue source for highway construction and maintenance. A congestion tax can be thought of as a special type of VMT tax—one that would vary by the time of day and the level of congestion, rather than impose a flat mileage toll. A flat VMT tax set at a high enough rate would reduce traffic volume on highways. But a congestion toll would be an even more efficient way to use existing highway infrastructure. As research and experience shows, use of HOT lanes leads to reductions in congestion. Furthermore, HOT lanes capture a significant proportion of the efficiency gains of full tolling, yet they are more politically acceptable. Equity concerns are mitigated by findings showing that variable congestion tolls are no more regressive than is the current fuel tax. If toll revenues are spent on public transportation or used for tax reductions, the regressivity can be reduced or eliminated.

The idea of congestion pricing is unpopular. However, survey evidence indicates that support for congestion pricing increases after implementation.[59] As people become more familiar with how congestion pricing works and observe the benefits of less congestion, public support grows. Support for the London toll increased from 39 percent to 54 percent following the introduction of the city toll.[60] Drivers in Southern California generally viewed the express and HOT lanes favorably once the new lanes operated for a period of time.[61] Reducing congestion should improve the environment, and this eco-friendly benefit can be a selling point when policymakers propose tolling programs.

Two reforms might encourage toll adoption in the United States. First, the toll should be offset by a reduction in the gasoline tax. Survey data show this reduction is one of the preferred uses of toll revenues in the United States. However, to address equity concerns, reductions in other regressive taxes, such as the sales tax, should also be considered. Using toll revenues to improve highways and public transportation can also increase support for

59. See Carl Hamilton et al., "Determinants of Congestion Pricing Acceptability" (Working Paper 2014-11, Centre for Transport Studies, Stockholm, Sweden); Martin Gaunt, Tom Rye, and Simon Allen, "Public Acceptability of Road User Charging: The Case of Edinburgh and the 2005 Referendum," *Transport Reviews* 27, no. 1 (2007): 85–102; Maria Börjesson et al., "Factors Driving Public Support for Road Congestion Reduction Policies: Congestion Charging, Free Public Transport, and More Roads in Stockholm, Helsinki, and Lyon," *Transportation Research Part A* 78 (2015): 452–62.

60. See Leape, "London Congestion Charge," 169–70.

61. See Sullivan, "HOT Lanes in Southern California," 214–16.

tolling. Second, because survey data suggest congestion tolling becomes more acceptable after it is implemented, a temporary toll should be considered. Once drivers experience the system and understand its costs and benefits, they may be more inclined to support a permanent toll.

As discussed earlier, residents in Stockholm participated in a seven-month trial. Stockholm policymakers followed the trial with a referendum to make the congestion toll system permanent, and the referendum was passed. Although it is always dangerous to generalize findings from one case, implementing a similar approach in the United States might increase the chances of the country adopting congestion pricing.[62]

5. CONCLUSION

Highway congestion in the United States continues to worsen despite efforts to build more roads and expand mass transit. Cordon toll systems and HOT lanes in the United States show that tolls reduce congestion and increase traffic speeds. Tolls provide policymakers with information about the value of a route to drivers, leading to more efficient use of transportation funds. Equity concerns have been a barrier to the expansion of congestion pricing to manage highways. Research suggests congestion tolls are no more regressive than the fuel taxes currently used to fund highway construction and maintenance. Toll revenues can be used to offset any adverse effects the tolls might have on individual groups.

The key reform needed to ease urban congestion is for the federal government to allow state and local governments to levy tolls on all interstate highways. Although surveys show that drivers generally do not support congestion pricing, attitudes tend to change once drivers experience the lower congestion that results from tolling.

Changes in technology have greatly reduced the transaction costs associated with tolling. It is no longer necessary to construct toll booths and require vehicles to stop to pay tolls. Transponders with prepaid accounts can be installed in cars. For cars without transponders, pictures of the car's license plate are used to identify the driver entering the toll road or zone, and then the driver is billed by mail. GPS also makes tracking vehicles far easier and

62. Björn Hårsman and John M. Quigley, "Political and Public Acceptability of Congestion Pricing: Ideology and Self-Interest," *Journal of Policy Analysis and Management* 29, no. 4 (2010): 854–74; Börjesson et al., "Factors Driving Public Support for Road Congestion Reduction Policies."

cheaper than in the past. Drivers may insist on systems to keep driver information secure and ensure privacy.

Increasing the role of the private sector to expand the highway system would facilitate experimentation with and adoption of congestion pricing in the United States. Before the 20th century, private investment in highways was common in the United States. Over time, government price regulation reduced the profitability and eventually resulted in government takeovers. If governments in the United States were to allow greater private sector highway development, congestion pricing could be used to finance capital costs, improve management, and raise traffic flows. An excellent example of this approach is the Dulles Greenway in Virginia.[63]

One option that might improve the chances of public support for congestion tolling is to first use it on a temporary basis. Then, after the trial period, citizens would vote on making the system permanent. Drivers more easily accept a congestion toll once they become familiar with its operation and benefits. Congestion tolls increase public welfare and lead to more efficient use of limited highway space. Because we cannot build our way out of congestion and because mass transit has failed to pull drivers off the roads, it is time to consider tolls as a way to solve urban congestion problems.

63. Daniel Klein and John Majewski, "America's Toll Heritage: The Achievements of Private Initiative in the Nineteenth Century," in *Street Smart*, ed. Gabriel Roth (Piscataway, NJ: Transaction Publishers and Independent Institute, 2006), 277–303.

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