THE HAMILTON PROJECT

Advancing Opportunity, Prosperity and Growth

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David Lewis

America's Traffic Congestion Problem: Toward a Framework for Nationwide Reform

THE BROOKINGS INSTITUTION

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Abstract

A large and growing burden on the nation's economy, traffic congestion arises for various reasons, and more than one mechanism is needed to combat it. It is most unlikely, however, that serious inroads to address the problem will be made without fundamental reform in the way consumers are charged for their use of congested highways. *Congestion prices* are tolls that reflect the economic costs of congestion, including productivity losses from traffic delays, increased accidents, higher emissions, and more. Congestion prices would help reduce these economic costs and guide transportation investment resources to their highest and best use—which would include a better balance between highway and transit investment. In addition, such prices would generate revenues to help finance new investment and compensate low-income people and others for whom toll payments are especially burdensome. Requiring federal, state, and local engagement, such reform is a necessary step in the development of an effective, efficient, and sustainable highway system for the twenty-first century.

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1.0. Introduction

Mobility, and the transportation infrastructure needed to enable it, is foundational to American culture and economic activity. In 1860, President Lincoln campaigned on the importance of "internal [infrastructure] improvements." Almost a century later, President Eisenhower spearheaded construction of the interstate highway system. To finance it, he created the Highway Trust Fund. The latter years of the twentieth century witnessed a continuous series of innovative legislative initiatives in Congress to facilitate mobility as a vital national priority. In 2005, President George W. Bush signed into law the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). With guaranteed funding for highways, highway safety, and public transportation totaling $244.1 billion, SAFETEA-LU represents the largest surface transportation investment in the nation's history. Two landmark bills preceded SAFETEA-LU: the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Transportation Equity Act for the 21st Century (TEA-21). Between them, these bills introduced important new safety programs, designated the national highway system to extend federal financial assistance to principal roads beyond interstate highways, extended the eligibility of dedicated Highway Trust Fund revenues to transit projects, and provided flexibility for states and localities to employ innovative methods of finance and congestion management.

Despite the nation's history of sustained investment to create and maintain what is the most extensive system of roads and bridges in the world, our mobility and economic productivity is being eroded by traffic congestion at an alarming rate. Suburbanization and urban sprawl continue apace (Lewis and Williams 1999). Public transit attracts less than 10 percent of total passenger trips (Transportation Research Board [TRB] 2006). Although the digital revolution enables twenty-first-century industry to adopt just-in-time production, distribution, and inventory management systems, the clogged twentieth century transportation system is not up to the task of enabling the fast and reliable just-in-time deliveries on which such systems depend in order to deliver enhanced productivity and competitiveness. Although some congestion is a blessing—an indicator of vibrant economic and social activity—beyond a certain point, the delay and uncertainty people and goods endure in traffic jams constitute net economic and social burdens.

Compounding the congestion problem is the reality that the nation's primary source of funds for infrastructure investment—taxes on gasoline—is dwindling. In the first quarter of 2008, the average state gasoline tax was $0.214 per gallon, plus $0.184 per gallon of federal tax, making the total tax $0.47 per gallon. For diesel, the average state tax was $0.292 per gallon, plus $0.244 per gallon federal tax, making the total tax $0.536 per gallon. For much of the twentieth century, gas taxes, with occasional modest increases, were sufficient to keep pace with infrastructure costs. But the advent of more fuel-efficient vehicles, inflation in the cost of infrastructure construction and maintenance, and resistance to higher taxes is changing that situation. Unless there is a sharp increase in gasoline tax rates, the Highway Trust Fund is projected to be bankrupt by the end of 2009. A recent federal commission reports that the gas tax would need to be increased by $0.25 to $0.41 per gallon in order to close the gap between projected infrastructure requirements and available funds (National Surface Transportation Policy and Revenue Study Commission 2007).

To focus discussion of America's congestion problem on the shortage of gas tax revenues, however, is to misdirect attention from the more fundamental issue. In the progressively more complex and dynamic twenty-first-century economy, America needs not just more infrastructure investment, but better investment, in the right amount, at the right locations, and in the right balance between roads and transit. The focus of this paper is on the need to reform the way we charge for the use of congested roads as a means of guiding infrastructure investment dollars to their highest and best use; this paper will not examine the way we pay for infrastructure.

Instituting congestion prices (tolls that reflect the true economic cost of using congested roads) would provide a powerful incentive to shift travel away from the peak hours, encourage greater use of mass transit, reduce pressure to expand highway capacity, and direct investment dollars to highway and public transit projects of the highest value. In fact, charging people the true cost of using congested roads would help raise the money needed to pay for such projects and could compensate low-income people who are disadvantaged by the advent of road charges. It would be a win-win-win proposition: better investment, the money to pay for it, and equitable treatment of disadvantaged groups.

To augment the motivation for state and local governments to implement congestion pricing, this paper recommends that Congress (through legislation) and the executive branch (through implementation of regulations) redesign the way in which federal highway grants are established for projects on certain new and existing roads. Under one version of this approach, designated projects to be undertaken without the coincident introduction of congestion pricing would be eligible for less than the highest federal financial match that would otherwise be allowable. Rather than diminish the allowable match, another version of this approach would offer a higher match, a premium, for designated types of projects implemented with congestion pricing. A different federal match would be in recognition of the extra burden of highway maintenance and congestion costs that untolled roads create by stimulating excess demand, delays, and environmental emissions during peak periods. States and localities could opt out of the congestion pricing incentive, but would need to weigh the advantages of doing so against incentivized federal funding as well as the loss of access to the significant revenues available from congestion pricing. This proposal also includes mechanisms by which to mitigate the effects of congestion pricing on low-income people.

2.0. The Problem

Research funded by the Federal Highway Administration (2005) and conducted by the Texas Transportation Institute (TTI) reports that urban traffic congestion in 2005 caused the average peak-period traveler to spend an extra thirty-eight hours of travel time and consume an additional twenty-six gallons of fuel a year, amounting to a cost of $710 per traveler (TTI 2007a). These statistics are part of a worsening trend. In all such places,

- trips take longer,
- congestion exists during more of the day,
- congestion affects weekend travel and rural areas,
- congestion affects more personal trips and freight shipments, and
- trip travel times are increasingly unreliable.

If current policies and trends continue, analysts foresee that by 2030 as many as eleven additional urban areas could reach or exceed today's level of congestion in Los Angeles, the nation's most congested urban area (Hartgen and Fields 2006). The average traveler in Los Angeles spends an estimated seventy-two hours a year stuck in traffic (TTI 2007a).[1]

Although population growth, inexpensive downtown parking, urban sprawl, and inadequate infrastructure investment are correctly cited as causes of congestion, the way we charge—or, rather, the way we do not charge—for the use of roads and bridges is in fact a central cause. To appreciate the point, consider the role that prices play in enabling the economy in general to function without persistent shortages and queues. The price of a good or a service signals to prospective consumers the true economic cost of using up the scarce resources required in supplying it (the capital, the labor, and so on). Based on personal tastes and preferences, and within the limits of their disposable income, consumers establish their willingness, or unwillingness, to pay the true cost by sizing up whether or not the benefits they will enjoy make paying the price worthwhile. If people are not willing to pay for all the washing machines available, for example, producers' resources are quickly shifted into the supply of other goods and services for which people are willing to pay.

In this way, prices guide consumers to make millions of individual cost-benefit decisions every day, and thereby bring about the allocation of resources that achieves, more or less, an efficiently functioning economy. In short, prices send cost signals to consumers who, through the benefit-cost choices they make of what to buy and what not to buy, signal back to producers how to deploy resources and avert persistent shortages, queues, and surpluses.

Apart from a handful of places around the country, there are no roadway prices to signal consumers about the real economic cost of their decisions to travel during congested times of day. It should be no surprise, therefore, that we witness an apparent shortage of road space yet little use of public transit. In deciding when and how to travel, people certainly take into account their private costs, such as gas, oil, insurance, and so on. They also consider the congestion they expect to encounter. Travelers do not, however, consider the costs their trips impose on *others* when they add to the congestion (Mohring 1999). These costs are external to people's trip-mak-

1. By many measures, Los Angeles faces the most severe traffic congestion in the nation. According to the most recent Urban Mobility Report from the TTI, drivers in the greater Los Angeles region lost about 490 million hours due to congestion delays in 2005. About 62 percent of the lane miles in greater Los Angeles were congested during the peak period, and about 86 percent of peak period travel occurred in congested conditions. TTI estimates the cost of congestion in the greater Los Angeles region—in terms of wasted time and wasted fuel—at about $9.3 billion dollars annually. This represents a more-than-fourfold increase from 1985, when the annual cost (in current dollars) was estimated to be $2.2 billion.

ing decisions; economists thus call them "external costs."

They include the economic value of time wasted in delayed and unreliable conditions, the extra gas and other vehicle operating costs of stop-and-go driving, and the environmental damage and related costs to human health. Although studies differ in relation to definitions and methods, recent estimates of external roadway costs vary from $0.13 per vehicle mile to $0.29 per vehicle mile (HDR|HLB Decision Economics 2005; see also Small and Vehoef 2007, Chapter 3). Compared with the private costs of driving (about $0.52 per vehicle mile based on AAA 2007), external costs thus exceed private costs by some 25 to 56 percent. If the price of any other good or service were set so far below its cost, it would surprise no one to find that its demand routinely outstripped its supply and that there would be very low demand for substitutes.

Time spent in traffic jams is the manifestation of roadway supply falling short of the demand for travel. Delay is an economic cost because it means less time available for productive work as well as for nonwork activities that people value. Moreover, unreliable conditions—wide day-to-day variation in the time needed to drive from Point A to Point B—lead people to guard against the risk of being late for work and appointments by leaving early. This time spent is at the expense of yet more time for productive work, as well as more time at home in the morning for family or other personal business.

For trucks, unreliable transit times are of special significance because of just-in-time penalties built into many delivery contracts. A pattern of late deliveries for the receivers of goods can lead them to bear the cost of holding extra inventories—"shock stocks"—to guard against the risk of material shortages in just-in-time production systems (Shirley and Winston 2004).

In 2005, autos and trucks lost an estimated 4.2 billion hours to traffic delays and to the effects of cushioning against the risk of being late. The monetary equivalent value of these losses, when combined with the 2.9 billion gallons of fuel wasted in stop-and-go conditions, amounted to an estimated $78 billion lost during that year.[2] Even with the exclusion of environmental costs, $78 billion equates to "105 million weeks of vacation and 58 fully loaded supertankers" (TTI 2007b).

While statistics on the nationwide effects of congestion are indicative of its importance as a problem of national strategic significance, the impacts of congestion on people and their well-being are felt locally. A recent analysis of traffic in New York City finds that, even after allowing for some congestion as part and parcel of a vibrant economy, congestion there has "passed the tipping point" (Partnership for New York City 2006), stripping the metropolitan economy of more than $13 billion a year, including about $6 billion in wasted time and workday productivity.

The study reports that shippers who rely on predictable pickups and deliveries in order to maintain low inventory costs (and to obtain value from their investments in just-in-time technologies and business processes) hold costly shock stocks that reduce productivity and competitiveness. Trucking firms, which incur financial penalties for late deliveries, cushion against the risk of such penalties by leaving earlier than they would under more reliable and predictable travel time conditions, thereby reducing their productivity and competitiveness.

Congestion imposes an economic burden on a wide range of industries. Those directly affected by con-

2. Economists assign monetary-equivalent value to time based on factors such as wage rates (which reflect the value of productive work done) and people's willingness to pay to save time for nonwork purposes, including commuting and leisure activities. Recent studies have revealed that the rate at which road users value *reliable* and *predictable* journey times actually exceeds the rate at which they value improvements in average journey times almost threefold (Small, Noland, Chu, and Lewis 1999).

TABLE 1

The Cost Burden of Congestion on Industry in the New York City Region (selected sectors)

Industry and type of congestion cost effect	CBD Manhattan	Rest of Manhattan	Bronx	Brooklyn	Queens	Richmond	Nassau
Retail industry							
Reduction in revenue, US$ millions/year	$99.5	$8.5	–$1.2	$7.0	$7.3	$4.7	$20.9
Increase in operational costs, US$ millions/year	$66.5	$7.8	$4.3	$15.6	$15.9	$4.8	$17.0
Reduction in employment, FTE/year	413	35	-5	29	30	19	87
Restaurants							
Reduction in revenue, US$ millions/year	$214.7	$7.4	–$12.3	–$22.0	–$14.5	–$1.0	$8.4
Increase in operational costs, US$ millions/year	$5.0	$0.3	$0.1	$0.3	$0.5	$0.1	$0.4
Reduction in employment, FTE/year	2,054	71	-117	-210	-139	-9	80
Arts & entertainment							
Reduction in revenue, US$ millions/year	$181.7	$0.5	–$11.6	–$23.3	–$21.7	–$3.0	$2.3
Reduction in employment, FTE/year	1,402	4	-89	-179	-167	-23	18
Health care & social services							
Reduction in revenue, US$ millions/year	$152.5	$26.3	$14.1	$44.7	$22.8	$7.7	$23.5
Reduction in employment, FTE/year	1,626	280	151	477	243	82	250
Construction							
Reduction in revenue, US$ millions/year	$280.6	$15.1	$28.8	$92.8	$203.9	$18.6	$78.5
Increase in operational costs, US$ millions/year	$34.1	$1.8	$3.5	$11.3	$24.8	$2.3	$9.5
Reduction in employment, FTE/year	1,142	61	117	378	830	76	320
Manufacturing							
Reduction in revenue, US$ millions/year	$488.3	$3.2	$24.6	$132.8	$159.2	$3.6	$91.7

Increase in operational costs, US$ millions/year	$59.3	$0.4	$3.0	$16.1	$19.3	$0.4	$11.1
Reduction in employment, FTE/year	2,081	14	105	566	678	15	391
Wholesale							
Increase in costs, US$ millions/year	$688.1	$4.0	$17.0	$61.8	$70.0	$2.9	$52.4
Total revenue/loss US$ millions/year[a]	$1,623.5	$61.7	$43.8	$236.4	$362.9	$32.0	$230.7
Increase in operating costs, US$ millions/year[a]	$852.9	$14.4	$27.8	$105.0	$130.5	$10.5	$90.4
Total jobs lost[a]	8,717	466	161	1,060	1,475	160	1,145

Source: Partnership for New York City 2006.
Notes: CBD = central business district; FTE = full-time equivalent jobs. Revenue and employment numbers with a negative sign indicate situations in which congestion causes revenues or employment to increase due to the redistribution of traffic.
a. Totals reflect more sectors than shown in the table.

gestion include the retail trades, restaurants, health care and social services, construction, manufacturing, wholesale trade, taxis, financial and professional services, the services and repair industry, and for-hire trucking. Table 1 summarizes the estimated cost burdens borne by a selection of these sectors. The impact of congestion on the retail, restaurant, entertainment, and other consumption-based trades, for example, stems partly from a reduction in trips for consumption purposes. By increasing the cost of traveling to such destinations, congestion deters some consumers from using those services and causes others to use them less often than they otherwise would. As a result, retailers earn less revenue and employ fewer workers. Congestion also adds to the logistics costs of retailers by reducing the reliability of delivery times for merchandise and supplies. This adds to costs by inhibiting the adoption of inventory-saving and other productivity-enhancing strategies. Congestion imposes costs on the financial and professional services industries, due (inter alia) to the time spent by employees in highly congested conditions when traveling to business meetings. Frequently, professional workers will guard against the risk of being late or missing a meeting altogether by allowing extra time in their travel schedules. Less congestion would make additional time available for productive work in the office. In sum, the New York study finds that traffic jams in the region add millions of dollars to production and distribution costs and erode the economy of nearly fifty-five thousand jobs.

2.1. Why Are Congestion Prices Rare on American Roads?

Congestion prices—tolls that vary by time of day to reflect the costs travelers impose on each other when electing to use a congested roadway—are rare in America; they apply to less than 1 percent of congested U.S. roadways. Congestion pricing is not rare for lack of know-how or technology. Indeed, different approaches and technologies have been developed for a wide range of different circumstances. As shown in Box 1, tolls can be applied over an entire geographic network, on particular roads only, or on particular lanes.

Nor is congestion pricing rare for lack of successful examples. Consider the SR-91 express lanes facility in California. Opened in 1988, it is a four-lane, ten-mile toll road built in the median of the Riverside Freeway on the line between Orange and Riverside counties, and the Costa Mesa Freeway (SR-55). Users of SR-91 express lanes pay tolls from prepaid accounts using a transponder—a pocket-sized radio transmission device mounted to the inside of the vehicle's windshield. This electronic toll collection technology eliminates the need for travelers to stop and pay tolls at traditional tollbooths, thus helping facilitate the flow of traffic on tolled lanes. One-way tolls for the ten-mile stretch vary from $1.20 during off-peak periods to as much as $10.00 for travel during the busiest times of day.

As shown in Figure 1, SR-91 results are impressive, with the priced lanes generating considerably higher speeds than the free lanes.

BOX 1

Types of Congestion Prices Available to States and Localities

Areawide charges: Charges based on congestion level on all congested roads within a geographic area. Some believe this approach to be the most effective means of reducing congestion and vehicle emissions.

Variable charges on particular roadways: Tolls administered to both roads and bridges, including rush hour fees on facilities that currently are toll free. Examples include 407 ETR (Toronto), Sanibel Bridge (Lee County, Florida), New Jersey Turnpike, and the Port Authority of New York and New Jersey interstate crossings.

Variably priced lanes and managed lanes: Variable tolls implemented on separated lanes within a highway, such as express toll lanes or high-occupancy toll (HOT) lanes. Examples include Interstate 15 (I-15), State Route 91 (SR-91), and I-680 (under development) in southern California; I-10 Katy Freeway (Houston); I-394 (Minneapolis); I-25 (Denver); and SR-167 (Washington state, four-year pilot).

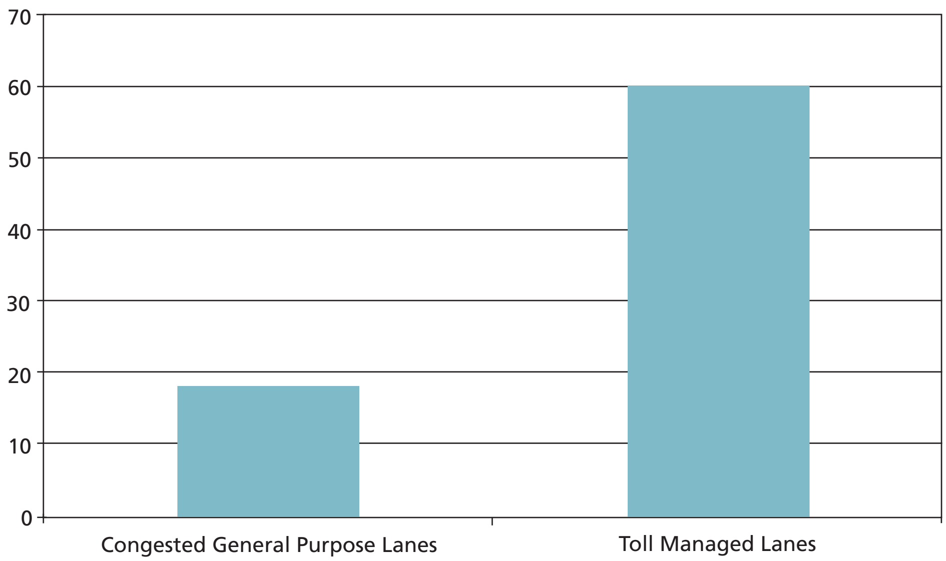
Cordon charges: Charges to drive within or into a congested area within a city. Examples include London (England), Stockholm (Sweden), Singapore, Oslo, Trondheim, Bergen (Norway), San Francisco (California; study), and New York (New York; proposal).

Zonal charges: Similar to cordon charging, but with adjacent charging zones. Examples include trials in Trondheim (Norway), Helsinki (Finland), and Copenhagen (Denmark).

FIGURE 1

Recent Traffic Statistics for the SR-91 Express Lane Facility

Average Traffic Speed on SR-91, Peak Hours Eastbound, Friday Afternoons 2004



Source: Environmental Defense 2007.

London (England) provides another example. A fee introduced in 2003 requires motorists to pay £8.00 (about $16.00) to drive into central London on weekdays between 7:30 a.m. and 6:30 p.m. Some vehicles are exempt, including licensed taxis, motorcycles, vehicles used by people with disabilities, certain alternative fuel vehicles, buses, and emergency vehicles. Since introduction of this fee, automobile traffic in central London has declined by a reported 20 percent, average traffic speeds have increased 37 percent, and peak period congestion delays are down 30 percent for autos and 50 percent for buses. Importantly, net revenues (more than $100 million a year) from congestion prices in London are used to finance increased public transit capacity. Reports indicate that people who change their travel patterns due to the fee have transferred to public transit (Litman 2006).[3] Other people change their routes to avoid central London, travel outside the charging period, or use taxis. Stockholm (Sweden) has since introduced a similar fee, with similar results.

Congestion pricing in the United States is not rare for lack of funding to study it, experiment with it, or implement it: Congress first set up a program to assist localities with local congestion pricing initiatives in 1991. In addition, under the Urban Partnerships Program established in 2006, the federal government makes more than $1 billion available to localities for congestion management initiatives. Although the number of lane miles on which congestion pricing has been introduced remains proportionately very small, especially on existing roads as distinct from newly constructed roads, more than forty congestion pricing programs have been undertaken since 1991 with the support of federal funds.

3. The share of total trips made by car fell from 12 to 10 percent between 2003 and 2005.

2.2. A Political Impasse at the State and Local Levels

So why is congestion pricing rare? An important reason is political impasse at the state and local levels, especially when it comes to introducing congestion pricing on existing roads as opposed to the construction of new capacity. Voters dislike new taxes. Congestion prices are not taxes; they are prices that mirror real economic costs. But explaining the difference to voters is challenging. Compounding this confusion is the public perception that congestion prices constitute a double tax since existing roads have indeed been paid for with tax dollars. Importantly, there also is concern about the risk of making poor households poorer, perhaps even driving some low-income households into poverty due to the economic burden congestion tolls could place on them and the smaller market area over which poor householders could afford the costs of travel to jobs.

Though understandable, these concerns, as this paper goes on to show, are either inaccurate or resolvable through a range of policy approaches. And despite the political impasse, there is significant evidence of emerging (latent) political support and consensus with regard to congestion pricing. Latent support, on its own, appears insufficient however to overcome significant grassroots opposition. In New York City, a mayoral plan to introduce congestion pricing for vehicles entering Manhattan won City Council approval. It did however face an uphill battle to gain grassroots political consensus and ultimately failed to obtain the necessary approval from the state legislature.[4] An analysis of public opinion surveys conducted in November 2007 finds that a majority of surveys (56 percent) show support for tolling and road pricing. Opposition was encountered in 31 percent of the surveys. Mixed results (i.e., neither majority support nor opposition) occurred in 13 percent of them (Zmud 2007). These results show that "in many parts of the U.S., a wide gap exists between elected officials' perceptions of what the public thinks about tolling and road pricing and what public opinion actually is" (Peters 2008, 3). In London and Stockholm, broad-based support has indeed been achieved, albeit after the politically unpopular decision to implement congestion pricing had been taken and people saw the results for themselves.

That the nation's transportation infrastructure is in trouble is not in doubt; nor is there much doubt that failure to charge congestion tolls is a significant source of the problem. We know, too, that charging congestion prices is feasible, that it would help optimize the use of existing transportation facilities in the short run, and that it would provide information vital to optimizing the characteristics of such facilities in the long run (Mohring 1999). The optimization of investment would occur as the prices of tolls signal which roadways have the highest level of demand.

It seems almost certain that, with congestion pricing in place, fewer trips would be made by car during busy periods, more people would use public transit, and the allocation of investment resources between highways and transit would better reflect the true transportation needs and preferences of travelers relative to the costs of satisfying those needs. It is time for the federal government to step in to help break the state and local political impasses that stand between congestion pricing and the realization of an efficient, sustainable, and affordable surface transportation system for the twenty-first century.

4. To understand the difficulty in obtaining grassroots support for this proposal, see: Editorial, "Reducing the cost of congestion," *New York Times*, December 10, 2006; Editorial, "Let NYC study pay-to-drive plan," Newsday.com, December 8, 2006; "Clearing the air on traffic problem," *Crain's New York Business*, December 10, 2006.

3.0. A Proposal for Congestion Pricing

3.1. Federal Reform

Notwithstanding the apparent political risk taken to introduce congestion pricing in London and Stockholm, making politically unpopular decisions in the hope that broad-based support will follow is rare in the development of transportation policy. Nevertheless, the evidence and analysis outlined above indicates the latent political acceptability of congestion pricing. A key to overcoming the political impasse at the state and local levels of government lies in policy innovation at the federal level. To be sure, Congress and the executive branch have already displayed significant leadership with innovative programs designed to promote and encourage local experimentation with, and implementation of, congestion pricing. The next step is for Congress to create powerful incentives that make the adoption of congestion pricing widely compelling at the local level.

Congress's ability to establish such incentives exists by virtue of the federal-state relationship with regard to highway infrastructure investment. Although the execution and administration of transportation policy, planning, and investment in the United States belongs with state and local governments, the federal government plays a significant financial role. The interstate highway system and many other primary roads have been built and maintained with 90 percent federal and 10 percent state and local funds. The significant federal financial role in transportation brings with it a great deal of leverage over policy and planning at the state and local levels. In return for federal highway dollars, the federal government mandates planning requirements, environmental impact analyses, safety standards, restrictions on the size and weight of trucks that are allowed to use the roadways, and a range of other conditions that Congress and the executive branch deem to be in the national interest.

Against this background, the main policy attributes of the existing federal approach to congestion pricing are permissive and facilitating, but certainly not mandatory. One option going forward would thus be to add congestion pricing to the range of mandatory requirements for state and local receipt of federal financial assistance. A mandatory approach would be clear and straightforward to administer but would run counter to the trend in federal policy of seeking to grant flexibility to states and localities to innovate and choose across the widest possible array of technological, planning, financial, and procurement mechanisms.

3.1.1 Proposal: Congestion Pricing Financial Incentive Program

An alternative to mandatory application of the congestion pricing approach would be to redesign the way federal highway grants are established to create a choice and an incentive for localities to introduce congestion pricing in association with projects in highly congested urban areas and congested intercity routes. Under this approach, construction and major reconstruction projects with designated attributes would be eligible for less than the otherwise highest allowable federal match if they are to be undertaken without the coincident introduction of congestion pricing. The reduction in allowable match would be determined by a method or formula that recognizes the external congestion costs that untolled roads create by stimulating excess demand and corresponding increases in delay, vehicle operating expenses, and environmental and accident costs. One practical way in which to establish such a formula would draw on analytical evidence regarding the extent to which congestion pricing, by diminishing demand, reduces the cost of highway maintenance and expansion. For example, according to model-based scenario analyses by the Federal Highway Administration (2006), applying congestion tolls to all congested roads in the national highway system could reduce the cost to maintain the system by about 27 percent (U.S. Department of Transportation [DOT] 2006). Taking this percentage as a hypothetical estimate (the DOT emphasizes the very preliminary nature of the estimate) of the amount by which the absence of congestion pricing increases the burden of highway infrastructure investment on federal resources, the federal matching ratio would be reduced proportionately: an 80 percent match would be reduced to about 58 percent, a 75 percent match to 55 percent, and so on. States and localities would still be free to choose the lower match and the option of not instituting congestion pricing, but would need to weigh the advantages of abstaining against the reduction in federal funds, as well as the loss of access to the revenues from congestion pricing.

An alternative to creating an incentive by reducing the base federal matching ratio for projects without congestion pricing would be to institute a higher match instead. This might be viewed as less disruptive to the present equity characteristics of the federal program. An approach that lies between these two alternatives is also possible, of course.

In addition to the incentive outlined above, this proposal calls for Congress to direct the DOT and the IRS cooperatively to design a model template for a progressive refundable mobility tax credit (PRMT) program for states and localities to adopt in conjunction with congestion pricing. Since the allocation of toll revenue between tax credits, direct rebates, and infrastructure investment must be determined and administered locally to align with local circumstances and preferences, the model template would be a guide to states and localities for them to implement as they see fit. As such, the PRMT template design would provide wide local latitude with regard to the choice of income thresholds, program qualifications, and other program parameters. At the same time, however, the PRMT model would provide states and localities sufficient technical and administrative specificity, and any necessary federal authorities, to facilitate full-scale implementation. In following this recommendation, Congress can help ensure that states and localities have the means to put in place administrative machinery through which to help protect low-income individuals and other disadvantaged groups. The PRMT would be financed from a portion of toll revenues and thus would be fiscally neutral.

A considerable amount of work is needed to translate the hypothetical approach given above into a practical basis for policy. As discussed next, Congress should direct the DOT to establish the exact method or formula by which differential matching ratios are to be established. The DOT would also determine the class of projects to which the incentive plan will apply. The Internal Revenue Service (IRS), in collaboration with the DOT, would be directed to develop the model PRMT. Congress would remove federal prohibitions on the application of congestion pricing to existing roadways.[5]

3.1.2 Enactment: Congestion Pricing Financial Incentive Program

Due for reauthorization in 2009, SAFETEA-LU (see §1 above) is the principal legislative mechanism through which Congress establishes national transportation law. As part of the reauthorization process, Congress should establish that

- by 2020, a federal financial congestion pricing incentive program is in place for a designated

5. Importantly, such a prohibition presently applies to the interstate highway system. Some steps in the direction of removing such restrictions have been taken already. The Interstate Highway System Construction Toll Pilot Program authorizes up to three facilities on the interstate system to toll for the purpose of financing the construction of new interstate highways. A state or an interstate compact of states may submit a single candidate project under this program. Each applicant must demonstrate that financing the construction of the facility with the collection of tolls is the most efficient and economical way to advance the project. The state must agree not to enter into a non-compete agreement with a private party, under which the state would be prevented from improving or expanding the capacity of public roads in the vicinity of the toll facility to address conditions resulting from traffic diverted to nearby roads from the toll facility. There is no special funding authorized for this program. Interstate maintenance funds may not be used on a facility for which tolls are being collected under this program.

category of highway projects associated with both new and existing capacity; and that

- by 2015, the DOT will have established regulations and guidelines enabling states and localities to begin planning for 2020 implementation; and

- by 2015, the IRS will have designed the program template for a PRMT, and put in place the necessary authorities to enable its implementation by states and localities.

3.2. Regulatory Direction to the DOT and the IRS

In enacting the congestion pricing incentive program, Congress would direct the DOT to promulgate by September 2013 a Notice of Proposed Rulemaking establishing the specific planning and implementation requirements for the Congestion Pricing Financial Incentive Program. As a means of indicating congressional intent, federal agencies would be directed to address seven matters through regulatory and administrative action.

1. The DOT would define the method or formula by which differential matching ratios are to be established. The DOT would also define the manner in which incentive program funding relates to specific projects within the Statewide Transportation Improvement Plans (STIP) that provide the basis for federal funding approvals. It is not contemplated here, for example, that matching funds for the entire STIP would hinge on the treatment of projects that pertain only to congested roads.

2. The DOT would define the attributes of project applications that would deem them to be subject to the financial incentive program. Attributes to be considered would include the extent of existing congestion, and the extent to which the applicant road or (roads) would provide independent utility as a congestion-priced facility.

3. The DOT would also establish principles and guidelines regarding the level of congestion tolls with due regard for both the economic cost of congestion and the effect of such tolls on the diversion of traffic to unpriced roads. The DOT should enable and encourage project applicants to set balanced rates, with due regard for evidence that tolls set to mirror the full cost of congestion can risk diverting so much traffic to unpriced routes that the aggregate economic costs of travel over the entire network would be greater than those roads with no tolls.[6]

4. The DOT would ensure both that states and localities provide reasonable alternatives to priced roads, and that they apply a stipulated minimum or reasoned percentage of the revenues from congestion pricing to monetary reimbursement for disadvantaged groups and investment in public transit. Others point out that the demand for transit, which is likely to rise significantly in some localities with the advent of congestion pricing, will automatically reveal the appropriate extent of new investment and generate sufficient revenues to finance it. The DOT rulemaking needs to strike a balance between such approaches, while leaving maximum feasible flexibility for local choice and innovation (see §5, this paper).

5. The DOT would also provide a framework within which states and localities are to adopt common technology platforms for toll collection to ensure regional and national interoperability in the use of congestion-priced highways. Similarly, automobile and truck manufacturers should be given rules by which to make provisions for all new automobiles and trucks sold after January

6. Mohring (1999), for example, reports that congestion tolls on expressways in the Twin Cities would need to be set at about 25 percent of the full economic cost of congestion to ensure that spillover traffic would not cancel the efficiency gains of congestion pricing. He also reports that "Singapore overdid it: Congestion outside the cordon was so great that, despite free flow within it, travel times per bus or auto trip to central area destinations did not change" (194).This problem has not been experienced in the case of London's cordon pricing program (see §2.1, this paper).

2015 to be equipped with onboard electronic devices compatible with the common platforms to be employed at the state and local levels.

6. For roads financed with a combination of federal and private sector financing (i.e., public-private partnerships), the DOT regulations would stipulate the requirement that sufficient revenues be reserved for compensation programs and that, where revenues from congestion pricing lead to private sector profits that exceed economic rates of return, such excess revenues are to be made available for public reinvestment.

7. The IRS and the DOT would collaboratively develop the detailed model template for PRMT, including the means by which to set income threshold provisions, eligibility qualifications, administrative procedures, and federal authorities to enable states and localities to implement a program with local discretion as to actual income cut-offs and other program criteria.

3.3. General Applicability of the Proposal

Although we cannot forecast the take-up of the proposed congestion-pricing financial-incentive program, we can examine its scope of application under book-end conditions. If the proposal were to lead to congestion pricing on all roads with congestion above a 70 percent volume-to-capacity ratio, pricing would apply to 15.3 percent of all road mileage (including interstates, other freeways, arterials, and collectors) and cover 41.1 percent of all vehicle miles traveled (at 2005 traffic levels). The more-detailed perspective on road mileage in Table 2 and on travel in Table 3 indicates a similar pattern. Just 22.3 percent of the interstate highway system's road mileage is seriously congested (with the volume-to-capacity ratio exceeding 95 percent), but these roads handle nearly 40 percent of vehicle miles traveled on the interstate system (see final column of Table 3).

3.4. State and Local Reform

The federal financial incentive program outlined above provides for a federal policy framework and regulatory foundation, but leaves much to be done at the state and local levels. Importantly, there is no need to defer the implementation of congestion pricing programs to the 2020 deadline, especially on congested roads that are not part of the federal system. In addition,

- states with legislative prohibitions against the implementation of tolls that might wish to take advantage of the incentive program need to take steps to remove such prohibitions;

- states and localities need to begin now to evaluate alternative congestion pricing mechanisms and to establish those of relevance and best value to their various local and regional circumstances, taking full advantage of federal programs designed to assist in that endeavor;

- states and localities need to begin now to engage the general public, stakeholder groups, and community opinion leaders regarding the nature of congestion pricing and the kind of opportunities and issues entailed in the federal incentive program; and

- states and localities need to begin now to assess the range of ways and means by which to help mitigate the negative effects of congestion pricing on disadvantaged groups, partly through the development of a PMRT (see §5).

TABLE 2

Road Mileage by Level of Congestion (as Measured by Volume-to-Capacity Ratio for Urban Roads), 2005

Road type	Percentage of road length mile in road category by VC				Percent of total road miles by functional category	Percent of congested road miles
	Less than 0.71	0.71–0.79	0.80–0.95	Greater than 0.95		
Interstate	48.1	10.8	18.8	22.3	5.3	17.1
Other freeways	63.0	8.0	13.5	15.5	3.6	8.2
Other principal arterials	81.3	6.3	7.5	4.9	20.9	24.4
Minor arterials	86.3	4.2	4.5	5.0	34.4	29.5
Collector	90.7	2.3	2.8	4.1	35.9	20.8

Source: Author's calculation using Federal Highway Administration 2005.

TABLE 3

Share of Travel (Measured in Vehicle Miles) on Urban Roadways, Categorized by Volume-to-Capacity Ratio

Road type	Percentage of travel volume, by volume-to-capacity ratio			
	Less than 0.71	0.71–0.79	0.80–0 .95	Greater than 0.95
Interstate	27.3	10.9	23.0	38.8
Other freeways	36.1	8.8	21.0	34.1
Other principal arterials	71.8	8.4	10.7	9.2
Minor arterials	77.9	4.7	8.6	8.9
Collector	79.8	3.5	8.0	8.6

Source: Based on FHWA runs on highway sections in the Highway Performance Monitoring System (HPMS) database.
Notes: The volume of traffic used to calculate percentage shares in the last column includes local traffic. Minor arterials and collectors have been combined.
VC = volume to capacity.

4.0. Effects, Benefits, and Costs of Reform

By making people aware of the full economic costs of their travel choices, the widespread application of congestion pricing would encourage roadway users to determine whether the benefits of using the road at busy times of the day are worth the full economic implications of doing so. Many would continue to use the newly tolled roads. Some would change to alternative routes, change their schedule, switch to another mode such as public transit, or ride a bicycle or walk. Some would change their mind about making the trip or perhaps combine it with another trip. Such changes in behavior would help optimize the use of existing transportation facilities in the short run, and provide information and revenue to help optimize investment in the long run (Mohring 1999). As a result, the nation's highways and transit systems would be more effective, more economically efficient, and more financially sustainable.

4.1. Effectiveness

Anticipating the quantitative effects of congestion pricing on travel and traffic behavior is both analytically difficult and dependent on the degree to which states and localities would adopt it under the proposed federal incentive program, yet evidence from actual experience and analytical models is uniform in suggesting that journey speeds, travel times, and travel time reliability would improve. Based on a model that synthesizes various strands of empirical evidence, the analysis reported in Table 4 indicates that average speeds on the nation's most severely congested roads might increase, on average, between 11 and 16 percent after the introduction of congestion pricing. On the most congested interstates and freeways, improvements in speed would likely be even greater. These results depend on estimates of toll rates and the elasticity of demand for highway travel when those tolls cause the cost of travel to rise.

Toll rates are calculated to reflect the delay cost one driver driving one mile imposes on all other drivers on the same road at the same time. The delay costs depend on the level of congestion on a given road at a given time and the value of time lost, which I estimate at between $18 and $40 per hour.[7] I assume the elasticity of demand for highway travel is in the range of –0.4 to –0.8.

While significant in relation to current traffic conditions, the effects suggested above are likely con-

TABLE 4

Estimated Impact of Congestion Pricing on Traffic Volume and Speed on Interstates and Freeways during Peak Periods with Volume-to-Capacity Ratio above 0.95 (percent)

Traffic and speed	Baseline elasticity and value of time assumption	Alternative elasticity and value of time assumptions
Increase in speed	+11	+16
Reduction in vehicle miles of highway travel	–12	–19

Source: Adapted from HDR|HLB Decision Economics 2005.
Notes: Baseline assumptions place the value of time at $18 per hour and elasticity of demand for highway travel at -0.4. The alternative assumptions place the value of time at $40 per hour and the elasticity of demand for highway travel at -0.8. Congestion pricing is assumed to be applied on Interstates and freeways with volume-to-capacity ratios above 0.7. The estimated effect on traffic speed on all Interstates and freeways with volume-to-capacity ratios of 0.7 and above is +7 percent and +10 percent respectively, for the two assumption scenarios. The estimated effect of congestion pricing on vehicle miles of highway travel on Interstates and freeways with volume-to-capacity ratios of 0.7 and above is -10 percent and -16 percent respectively, for the two assumption scenarios.

7. The wide range of values for time reflects evidence that the empirically measured metric "value of time" is up to three times the prevailing wage rate when travel times are not only high but also widely variable from day-to-day and thus especially hard for people to predict (Small, Noland, Chu and Lewis 1999).

servative, understating potential improvements in speed and overstating the potential reduction in the volume of travel. This is because the model does not mirror the dynamics of traffic volume and travel time under the most severely congested conditions (wherein at certain times traffic—in the absence of congestion pricing—comes to a virtual standstill).[8] This is indeed a problem with traditional analytical transportation models. Presently, a great deal of research effort is going into improving the state of the art of analytic models.

These results are similar to those obtained by Mohring and Anderson (as cited in Mohring 1999) in their simulations of congestion pricing in the Twin Cities. They find that putting tolls on all congested roads would reduce expressway vehicle miles by 19 percent, and nonexpressway vehicle miles by 8 percent.

The discussion above pertains to the change in travel on highways during busy periods: the change in the total volume of travel will depend on the extent to which those who reduce their use of highways during peak times shift to other times of day, or to other modes—in particular to public transit. The extent to which a decline in total travel is mitigated will depend importantly on the use of congestion pricing revenues to invest in additional transit capacity. A strong program of transit investment could go far toward minimizing the disruption of daily life that might otherwise arise with congestion pricing.

4.2. Economic Efficiency

Although the quantitative estimates vary widely, economic theory, analysis, and evidence from field applications point to the same thing: a more economically efficient transportation system.

The immediate economic efficiency benefits of road pricing arise in the form of time savings to roadway users, reductions in vehicle operating costs, fewer collisions and related accident costs, and improved environmental conditions. In the longer term, we can expect less pressure to build highway capacity, more cost-effective highway investment decisions (due to the way prices help signal where investment is most needed and worthwhile), and a level playing field for transit, resulting in a better balance of investment between highway construction and public transit.

The costs of congestion pricing include the capital and life-cycle expenses of toll collection and administration; and the loss of economic and social value incurred by highway users in various categories. Such groups include

- highway users who cut back the total number of journeys they make,
- highway users who adopt new activity schedules they find less convenient,
- highway users who switch to transit or other modes of travel (like walking) that they prefer less than driving,
- highway users who make shorter journeys than before,
- highway users who divert to auto routes they prefer less because they are more circuitous or inconvenient because of intersections and traffic lights, and
- highway users who experience increased congestion on roads to which people divert in order to avoid tolls.

Even a partial analysis of the benefits of congestion pricing in relation to a more comprehensive examination of costs indicates a strong likelihood of a quantitatively significant gain in economic efficiency. Employing the same model and assumptions as those used above in assessing traffic impacts in Table 4, Table 5 compares the estimated economic benefits due to time savings and reduced accidents to the loss of value to highway users who divert to

8. This point pertains to the difficulty modelers have in representing the backward-bending relationship between traffic volume and travel time during periods of hypercongestion. Indeed, the model underlying Table 4 assumes a monotonically increasing relationship between travel volume and travel time per trip.

other times of day, other routes, or other modes and the costs of toll collection and administration. The analysis indicates net benefits, over a twenty-year period, of $113 billion. By the twentieth year of the program, the ratio of benefits to costs is an estimated 2.7:1.0 ($2.70 in benefits for each $1.00 in cost).

Though not dissimilar from other benefit-cost assessments of congestion pricing, the estimated efficiency gain (net benefit) given above almost certainly understates the gain likely to follow from the introduction of nationwide congestion pricing for four reasons.[9] First (and as stated above) the model does not mirror the dynamics of traffic volume and travel time under the most severely congested conditions.

Second, the figures in Table 5 do not account for reduced fuel costs, reductions in environmental emissions, and savings that might arise from a reduction in pressure to build new highway capacity

TABLE 5

Time Savings and Accident Cost Savings from Congestion Pricing Relative to the Loss of Economic Value ("Consumer Surplus") for those Priced Off Roads (Interstates and Freeways with Volume-to-Capacity Ratio above 0.7)

	Economic benefits and costs	Year 1 of congestion pricing	Year 20 of congestion pricing
	Benefits (U.S. billions, 2002 dollars)		
1	Travel Time Savings to Road Users who Stay on the Roads and Accident Cost Savings	$13.68	$26.84
	Costs (U.S. billions, 2002 dollars)		
2	Loss in Economic Value to Road Users who Reduce the Number of Trips They Take or Divert to Other Times of Day, Other Roads or Other Modes	$0.70	$2.33
3	Costs of Toll Collection	$6.20	$7.60
4	Total Costs: (2)+(3)	$6.90	$9.93
5	Net Benefit: (1)-(4)	$6.78	$16.91
Net benefit (net present value) over 20 years (7 percent discount rate)		**$113 billion**	

Source: Adapted from HDR|HLB Decision Economics 2005.
Notes: Time savings represent $4.8 billion (35 percent) of total benefits in Year 1 while the social benefit from accident reduction accounts for $8.9 billion (65 percent). By the twentieth year, time savings and accident cost savings account for 44 percent and 56 percent, respectively, of total benefits. Time savings are probably understated due to the simplified version of the underlying speed-flow relation used. Research is ongoing in relation to this issue.

9. See, for example, Mohring and Anderson's analysis of congestion pricing in the Twin Cities (in Mohring 1999).

due to the reduced peak period demand. Analysis presented in the DOT's (2006) report on the conditions and performance of the nation's highways and transit systems reports that universal congestion pricing, by improving the performance of current highway system, could significantly reduce the level of future highway investment that would be required to maintain or improve the condition of our highways. The DOT report indicates that applying congestion tolls to all of the congested roads in the system could reduce the cost to maintain the system by $21.6 billion per year, or 27.5 percent, leaving capital needs at $57.2 billion, well below the current level of capital spending.

Third, efficiency gains are probably underestimated in Table 5 due to exclusion of the possible effect of congestion pricing on the quality of future investment decisions. The profound linkage between economically correct prices and the quality of resource allocation and investment decisions means that congestion pricing could well give rise to better highway and transit investment decisions going forward. Prices send better signals to transportation planners as to where capacity expansion is most critical.

The fourth reason why the estimated twenty-year efficiency gain of $113 billion given in Table 5 might be understated is that it ignores the impact of longer-run changes in consumer behavior, such as the possibility that travelers would lobby employers for widespread introduction of staggered work-hours in order to avoid congestion prices during peak periods, and would alter the pattern of their residential location choices in favor of shorter work trips and higher density (less automobile-intensive) living patterns. A study by Langer and Winston (2008) reports as follows:

> Based on a sample of the ninety-eight largest Metropolitan Statistical Areas (MSAs) in the nation, we find that efficient road pricing would generate $120 billion in annual revenues (2000 dollars), while reducing the value of the annual flow of services from housing $80 billion (2000) dollars, thus generating an annual net benefit of $40 billion. Our estimate of the benefits of congestion pricing is considerably greater than previous estimates that do not account for adjustments in land use and represents a first step toward accounting fully for road pricing's benefits. We conclude that policymakers should recognize that road pricing mitigates congestion and improves the quality in life in a metropolitan area by improving land use.

Langer and Winston's estimate of $40 billion *annually* in net benefits from congestion pricing radically exceeds the estimated twenty-year net benefit of $113 billion reported in Table 5.

4.3. Equity

While the discussion above indicates that congestion pricing is likely to generate a gain in the efficiency of the road system, it does not account for the increase in driving costs that tolls impose and the implications for individuals. In the cost-benefit analysis in Table 5, toll payments are treated as a transfer of resources rather than as a cost to society. However, this social cost-benefit analysis does not take into account the effects of toll payments on individuals. For some the value of time savings from reduced congestion is greater than the amount of the toll, but for others congestion pricing would leave them worse off. Professor Robin Lindsey states it thus:

> Tolling raises drivers' private costs, as indeed it must if travel is curtailed. The revenue from the toll accrues to the toll-road operator, which is usually assumed to be a government agency. Unless the government uses the revenue to expand road capacity, to improve an alternative form of transport, to reduce other user charges, or to provide rebates to drivers in some lump-sum fashion, drivers end up worse off (Lindsey 2006).

But we also know the following from Mohring:

> "That tolls would eliminate the deadweight [efficiency] losses from unpriced congestion and lower the time cost of still-made trips guarantees that

> increased toll revenues would exceed consumer losses. Hence, in principle, a compensation system for losers could be found that would not only leave them better off, but also provide funds for the highway authority to perform good works" (Mohring 1999, 186–187).

In other words, while congestion pricing disproportionately hurts certain drivers with low time savings, especially low-income drivers, the government could use the revenue from the tolls, and other transfers if necessary, to fully offset any negative distributional impact and leave everyone better off. If toll revenue alone is not enough to fully compensate for consumer losses, the government can use the toll revenue to at least partially offset these effects. I discuss using revenues from congestion pricing to compensate for consumer losses in §5.

4.4. Financial Context

Projected toll revenues from congestion pricing can be placed in a financial context by comparing them with DOT's estimated requirements for highway investment over the next two decades. One preliminary estimate of toll revenues from applying tolls on all congested interstates and freeways places them at about $105 billion annually (in constant 2002 dollars; HDR|HLB Decision Economics 2005).According to the DOT's report (2006) on conditions and performance, the average annual cost to maintain highways (and bridges) for the twenty-year period 2005–24 is an estimated $78.8 billion (in 2004 dollars). These figures represent the estimated level of investment by all levels of government required both to maintain the existing level of bridge deficiencies in constant dollar terms and to keep the physical condition and operational performance of the highway system at a level sufficient to prevent average highway user costs (including travel time costs, vehicle operating costs, and collision costs) from rising above the existing level in constant dollar terms. Congestion prices would not only provide significant revenues to finance these requirements but would also reduce the cost of these requirements by lowering demand for highways and reducing their wear and tear. For transit, the National Surface Transportation Policy and Revenue Commission (2007) puts average annual investment requirements in the range of $21 billion to $32 billion annually. Estimated revenues from congestion prices could help finance these requirements as well.

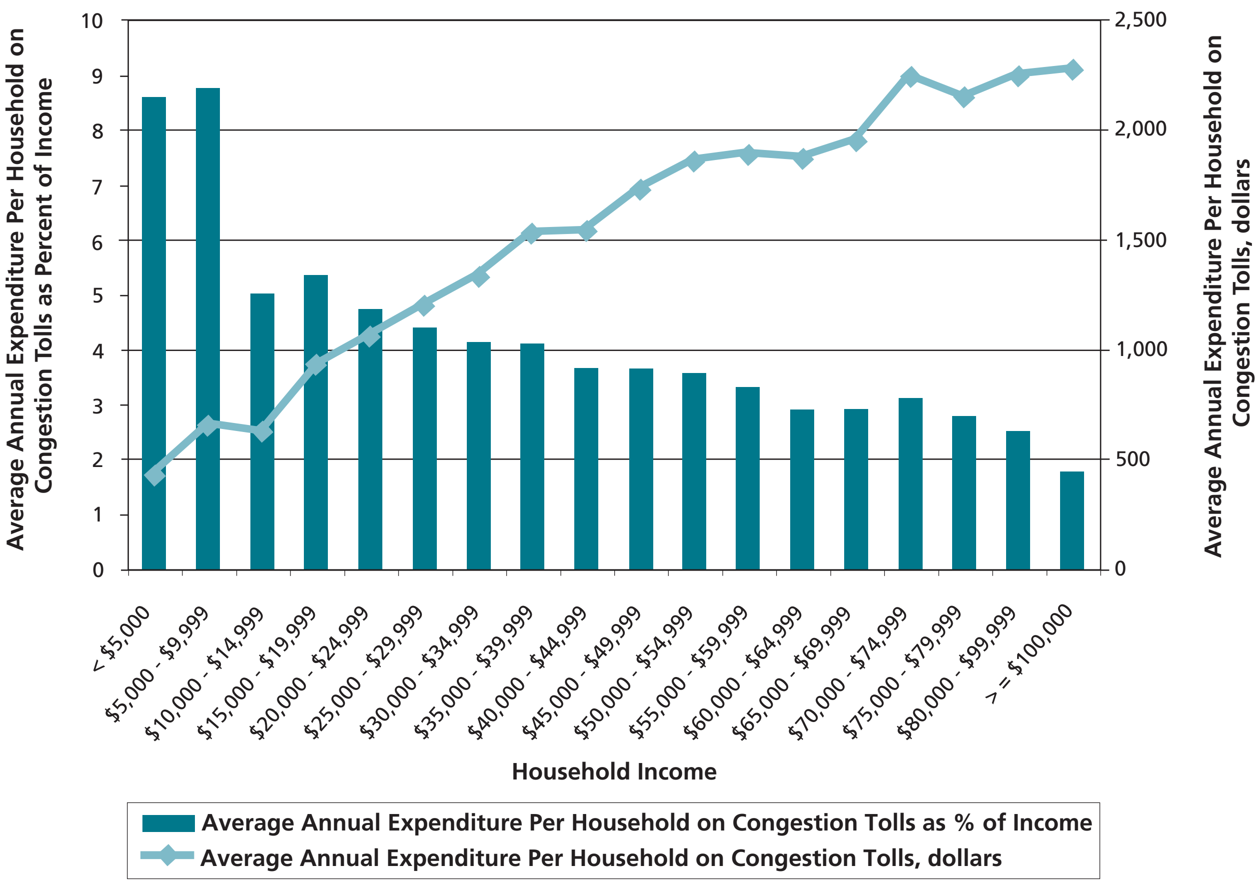
The DOT (2006) report also gives the average annual maximum economic investment level for highways and bridges for the twenty-year period 2005–24. This value, estimated to be $131.7 billion (in 2004 dollars), represents the level of investment by all levels of government required to implement all the highway and bridge improvements judged in the DOT model to be cost-beneficial improvements on highways and bridges. As indicated earlier, the DOT finds that congestion pricing would, by improving the performance of highways and bridges, reduce total investment requirements. Thus even under a "maximum economic investment" scenario, the revenues from congestion pricing are relatively significant.

5.0. Distributional Impacts and Methods of Redress

Introducing congestion pricing would increase the efficiency of the road network, but additional steps need to be taken to ensure that benefits are broadly shared. The immediate effect of congestion pricing would be to penalize those who pay the tolls or take fewer road trips to avoid the tolls. This effect would, moreover, be regressive—namely, it would be inversely related to the incomes of those affected, as can be seen in Figure 2 and Table 6.[10] If states and localities eventually adopt congestion pricing on all congested interstates and freeways (those where the ratio of volume to capacity exceeds 70 percent), Figure 2 indicates that additional outlays would be proportionately higher for lower-income households.

FIGURE 2

Income Distributional Consequences of Congestion Pricing on Congested Roads in Urbanized Areas



Source: Author's estimates based on 2001 National Household Travel Survey and an average congestion charge of $0.25 per mile. Figures plotted in this figure are shown in Table 6.

10. A correlation between income and the frequency of use of roads with congestion prices is evident is surveys of users of the SR-91 express lane facility. They show that commuters in the high-income group (those earning more than $100,000 a year) are slightly more than twice as likely as commuters in the low-income group (earning less than $25,000 a year) to be frequent toll lane users (23 versus 10 percent): high-income users are about half as likely as low-income users to be nonusers (37 versus 73 percent).

TABLE 6

Income Distributional Impact of Congestion Charges on Interstates and Freeways with Volume-to-Capacity Ratio above 0.7

Gross annual household income	Annual household expenditure on congestion charges per household	Annual household expenditure on congestion charges as a percentage of annual income	Annual cost of compensation for congestion charges to households (Billions of 2007 dollars)
< $5,000	$428.55	8.6%	$1.0
$5,000–$9,999	$655.28	8.7%	$3.4
$10,000–$14,999	$622.30	5.0%	$2.9
$15,000–$19,999	$930.49	5.3%	$5.3
$20,000–$24,999	$1,061.29	4.7%	$5.1
$25,000–$29,999	$1,198.90	4.4%	$7.9
$30,000–$34,999	$1,334.43	4.1%	$5.8
$35,000–$39,999	$1,530.65	4.1%	$10.0
$40,000–$44,999	$1,540.55	3.6%	$4.94
$45,000–$49,999	$1,730.82	3.6%	$9.61
$50,000–$54,999	$1,858.29	3.5%	$4.80
$55,000–$59,999	$1,890.05	3.3%	$8.47
$60,000–$64,999	$1,871.12	3.0%	$3.57
$65,000–$69,999	$1,950.93	2.9%	$6.23
$70,000–$74,999	$2,243.30	2.9%	$3.58
$75,000–$79,999	$2,146.45	2.8%	$5.98
$80,000–$99,999	$2,248.22	2.5%	$11.33
> = $100,000	$2,277.41	1.8%	$18.92
Total			$41.4

Source: Author's estimates, based on data from 2001 National Household Travel Survey and assumptions in the notes.
Notes: Assumptions are (1) the percentage of vehicle miles of travel (VMT) in urban areas is equal to 55 percent of total VMT (assumption based on 2001 Highway Performance Monitoring System (HPMS) runs obtained from FHWA); (2) the percentage of VMT in congestion conditions exceeding VC of 0.7 is equal to 41 percent (assumption based on 2001 HPMS runs obtained from FHWA); and (3) the expenditure on congestion costs includes a charge of $0.25 per mile for all miles driven in congested conditions. Annual compensation is calculated as the average expenditures on congestion charges in Column 2, multiplied by the number of households in income bracket category. Income groupings shown reflect 2001 conditions, whereas tolls paid reflect 2007 prices.

One way in which to help redress the regressivity of congestion pricing would be to reimburse households below a designated income level for some or all of the financial losses they incur. The third (last) column of Table 6 estimates the annual cost of such an approach. Since the figures in Table 6 assume existing travel rates (i.e., no economic losses from fewer trips, diversion to more circuitous routes and so on), the costs shown in column three might be sufficient to compensate for both tolls paid by low income people who pay them and economic losses for those priced off. A major problem with this approach, however, is that it would destroy the incentives to drive less or at less busy times. One way in which to minimize such incentive-blunting effects is to offer a degree of tax relief to lower income households that pay tolls rather than compensating them for the full amount of the tolls they pay. This approach would also allow a share of the available revenues from congestion tolls to be invested in transportation improvements.

Indeed, investing congestion pricing revenues in improved alternatives to highway transportation is an important facet of any plan to help alleviate the distributional consequences of congestion pricing. Options include

- directing toll revenues for particular transit projects,
- establishing minimum quality standards for alternative free routes as a precondition to imposing tolls, and
- establishing programs to encourage firms to permit flexible working hours, financing the administration of ride-matching, ride-sharing programs, and the like.

Whereas total revenues from tolls are likely to be sufficient to mitigate the most egregious social costs, there is no economic rule by which to ascertain the allocation of such revenues best suited to alleviating problems for disadvantaged groups. The literature offers various approaches. Small (1992) proposes an allocation of one-third in monetary reimbursement to trip makers, one-third to offset general taxes presently used to fund transportation services, and one-third for new transportation services (transit, roads, or both). DeCorla-Souza (2004) proposes a scheme wherein tolls would be exempted for designated user groups (such as high-occupancy vehicles [HOVs]). In his plan, 70 percent of net toll revenues would be employed for roadway and transit capital improvements, and 20 percent of net revenue would go to cash reimbursements against tolls and transit fares incurred by low-income travelers. Goodwin (1989) proposes a division of a one-third reduction in existing taxes; one-third in the construction of new roads, the improvement of existing roads, or the improvement of roadway maintenance standards; and one-third to improve public transport services. Goodwin's suggestion is thus that about one-third of toll revenues would go to direct reimbursement while fully two-thirds would be steered to indirect investment in mitigating social costs through improved roads and transit. Both Small and Goodwin recommend their approach as being easy for the public to understand, and being a reasonable basis for widespread public support and consensus. These two attributes are also attributes of a compensation and mitigation program to which states and localities should pay particular attention.

Under the proposal for reform presented in this paper, Congress would stipulate that steps be taken to alleviate problems for disadvantaged groups, and would direct the DOT and the IRS to establish a model program for state or local implementation of a PRMT, along with specific guidelines, administrative mechanisms, and authorities for doing so. The principal aim of the proposed congestion pricing policy framework is to introduce the incentives needed to facilitate an efficiently operating highway system while ensuring that congestion pricing program is as equitable as possible. In particular, the policy framework seeks to avoid leaving disadvantaged groups worse off, such as groups with low incomes and people without access to alternative means of getting about. Congress would direct the DOT and IRS cooperatively to design the PRMT model program for states and localities to adopt in conjunction with congestion pricing. The allocation of toll revenue between tax credits, direct rebates, and infrastructure investment must be determined locally so as to align with local circumstances and preferences. As such, the PRMT model should provide wide local latitude with regard to income thresholds, program qualifications and other parameters. At the same time however, the PRMT model should provide states and localities a template of sufficient technical and administrative specificity, and any necessary federal authorities, to guide full-scale implementation.

To help illustrate the intent of this recommendation, Table 7 gives a broad, hypothetical example of such a model template. Figures shown for average expenditures on tolls as a percent of income (second column) are based on the national data in Table 6. In this example, a 100 percent tax credit is occasioned by households within a designated income bracket with two or more wage earners. While progressively smaller credits are occasioned by households with fewer workers, households with no workers (such as retirees and people with disabilities who are not working) would be eligible. The intent of the model must be to balance the provision of finan-

TABLE 7

Progressive Refundable Mobility Tax Credit Program: Example of A Model Template

Annual income (dollars)	Average expenditure on tolls as a percent of income	Refundable tax credit as a percent of earned income		
		0 wage earners	1 wage earner	2+ wage earners
0–9,999	8	2	4	8
10,000–19,999	5	1.25	2.5	5
20,000–49,999	4	0.75	1.5	3
50,000+	2	0	0	0

Qualifications

Lives and/or works within a congestion pricing area

Lives and/or works more than one-fourth mile from transit or eligible for ADA paratransit

Other requirements pertaining to children, age, disability, investment income, residency, citizenship, etc.

Example Households

Household #1

Income: $15,000/year:
Two wage earners
Living in congestion pricing zone:
Not living within one-fourth mile of transit or eligible for ADA paratransit

Refundable credit; 5.0 percent of gross annual income = $750.00

Household #2

Income: $25,500/year:
One wage earner
Working in congestion pricing zone:
Not working within one-fourth mile of transit or eligible for ADA paratransit

Refundable credit; 1.5 percent of gross annual income, $382.50

Household #3

Income: $35,000
No wage earner (retired couple)
Residing in congestion pricing zone
Not residing within one-fourth mile of transit or eligible for ADA paratransit

Refundable credit; 0.75 percent of gross annual income, $262.50

Source: Author's calculations and statistics from Table 6.

cial assistance to those who require it while avoiding the granting of windfalls to those who would not incur losses from congestion pricing. Limiting the maximum tax credit to households with two or more workers, as in the Table 7 example, might be appropriate in light of relevant commuting statistics. Mohring (1999), for example, finds that in the Twin Cities fewer than about one-fifth of households, on average, have one or more members who travel during the morning peak period.

In application, the PRMT model would provide guidance to states and localities as to how best to construct column two from local survey analysis. Based broadly on the national data in Table 6, the cost of the example in Table 7 would be in the order of $20 to $25 billion annually. Administration of the program would add a further 5 to 10 percent. These costs would be lower to the extent that the model program is designed to further minimize windfall gains (to those who do not drive at all, for example). The complete elimination of such windfalls is probably impossible, however, without targeting the program so precisely as to blunt the incentive characteristics of congestion pricing.

The model program illustrated above reflects the evidence given earlier that, before taking into account the way in which the revenues from tolls might be put to use, many people could be made worse off by congestion pricing. Mohring (1999) forecasts that, under areawide congestion pricing in the Twin Cities, the time-plus-money costs of travel for those people in the lowest quartile of household income would almost double as they seek less-congested (thus lower-tolled), but more circuitous, routes. Mohring finds, moreover, that even higher-income groups would not be fully compensated for their tolls by the travel-time savings they gain. Safirova, Gillingham, Parry, Nelson, Harrington, and Mason (2004) draw similar conclusions in a 2003 model simulation of congestion pricing in metropolitan Washington, DC.

Equity depends importantly, therefore, on the way in which congestion pricing is implemented in a given local area, on the volume of revenue generated from tolls, and on the way in which such revenues are employed. In the case of areawide congestion pricing, Mohring (1999) concludes that, since projected toll revenues would exceed the value of the costs imposed on travelers overall, it should be possible to compensate disadvantaged travelers without incurring a fiscal deficit. The results of Safirova et al. (2004) are in agreement (see Safirova et al., Table 10, p. 199). In principle, therefore, revenues are likely to be sufficient to compensate people for their economic losses.

There are two possible approaches to compensation: (i) monetary measures and (ii) investment in the provision of new and better public transportation and highway services. Monetary compensation could be achieved through rebates to designated eligible persons or modifications to elements of the tax system (such as the PRMT program recommended here or payroll deduction) for the purpose of making lump-sum transfers to eligible individuals.

Investment in expanded highway and public transit services, the second form of compensation, would provide travelers with an alternative to the use of tolled highways.

Which approach, or combination of approaches, is best? An effective and well-balanced approach depends on affording a great deal of local flexibility to find a balance of locally relevant and administered tax credits, rebates, and infrastructure investment that reflect unique, local circumstances. Almost certainly, however, financial protection is needed as a backstop to ensure that congestion pricing will not drive more people into poverty or make very poor households poorer. As indicated above, such households could see their annual transportation costs almost double. To protect these households, transfer payments through the locally executed PRMT would be established for travelers in the lowest-income groups. The actual income thresholds would need to be determined locally, along with other qualifying criteria, as framed within the model template for PRMT to be developed by the DOT and IRS.[11]

Although splitting the revenue to both compensate low-income households and invest in transportation infrastructure gives fewer resources to each goal, the two actions are complementary. Without more and better transit, many people would not be able to avoid tolled roads without making excessively long journeys by circuitous routes, or forgoing trips altogether. Without improved road services, metropolitan areas would be unresponsive to the market signals that toll revenues can send, namely that more roadway capacity is economically warranted. And without some rebates for locally defined groups, some localities might not find it possible to achieve the consensus needed to achieve the necessary degree of political support for congestion pricing. In any given community, the optimal division of revenues among alternative compensation mechanisms will, in the end, represent a combination of reasoned economic analysis and community discussion and consensus.

11. The PRMT example outlined above would result in a total cost of between $20 billion to $25 billion annually. Based on figures for metropolitan Washington, DC, presented in Safirova et. al. (2004), fully compensating those in the lowest quartile might consume about 13-15 percent of total revenues from tolls. Taking the estimate of total revenue from tolls at $105 billion, a PRMT might thus cost between $14 billion and $25 billion a year (plus the one-time costs of setting up the program and the yearly costs of its administration). The remaining revenues (more than 75 percent of the total) would be reserved for investment in the widespread expansion of transit services, highway investment, and, as necessary, transfers and rebates to particular groups identified at the local level. While the roughly $80 billion annual sum this represents would not be sufficient to cover all estimated highway and transit capital requirements (see §2.1, this paper) it does represent a significant share.

6.0. Questions and Concerns

A number of questions arise in relation to congestion pricing and in relation to the proposal given in this paper.

Does congestion pricing constitute double taxation?

Critics of congestion pricing argue that it constitutes a double tax because tax revenue has already paid for surface transportation. Motor fuel taxes, other user fees, and general taxes paid for the costs of constructing roads—mainly labor, material, and design and engineering services. However, congestion pricing, which does indeed function as a tax, pays for a different set of costs, namely the economic costs of delay, pollution, and lost productivity due to the highway crowding. And unlike fuel taxes, congestion tolls act as a signaling mechanism to guide people to make economically efficient travel decisions. In so doing, tolls help guide investment dollars to their highest and best use from the perspective of consumer and economic needs.

Estimating the traffic impacts and economic costs and benefits of congestion pricing is subject to considerable uncertainty. Is it too soon to contemplate a comprehensive proposal such as this?

It is true that forecasting the effects of congestion pricing remains a technically difficult and uncertain science. However, most analytic studies and evidence from actual experience arrive at the same fundamental conclusion: congestion pricing improves highway efficiency and performance and yields economic benefits. Improved forecasting capabilities will follow from ongoing research and more experience in field applications of congestion pricing.

Congestion pricing is not a one-size-fits-all proposition—different conditions around the country would require different approaches to congestion pricing. In light of this, can a top-down federal incentive program be expected to work?

The proposed federal incentive program contemplates granting wide latitude for local choice and flexibility in the approach to be taken in any given situation. Under the proposal, the DOT would develop regulations designating the attributes of projects that make them subject to the incentive program. Beyond that, the regulations would provide the widest possible degree of local flexibility to introduce congestion pricing approaches suited to the local conditions at hand. In addition, quite apart from federal action, the proposal calls on states and localities to bring their own initiative to bear in the strategic use of congestion pricing.

Apart from seeking to encourage the local use of congestion pricing as a sound practice, what is the policy rationale for the federal government providing financial incentives for so doing?

Because the absence of congestion pricing encourages peak period demand that would not otherwise arise, the need for highway investment is increased accordingly. A federal incentive program can be seen to reflect the proposition that the federal taxpayer should not be burdened by investment costs that are not economically justified.

Does congestion pricing mean that highways are being privatized?

No. Public agencies can and do operate toll roads. By creating a revenue stream, congestion pricing might make privatization or public-private partnerships an option for states and localities to consider, but the public policy issues associated with privatization and public-private partnerships need to be considered on their merits.

What is known about the effects of congestion pricing?

While analytical models are certainly in their infancy with regard to accurately simulating and forecasting the effects of congestion pricing, a great deal is known from first principles (economic theory) and from observation of various programs around the country and the world. Seventeen years ago, Congress authorized the Congestion Pricing Pilot Program under the Intermodal Surface Transportation Efficiency Act of 1991. The program was reauthorized in 2005 as the Value Pricing Pilot Program, and Congress set aside a total of \$59 million to support pre-implementation activities and to pay for implementation costs. Congress and the executive branch have since launched a series of further initiatives under which states can apply to the federal government to use congestion pricing for new construction and repair of existing federally funded interstates, toll roads, HOT lanes, and express lanes. In 2006, the DOT announced a National Strategy to Reduce Congestion on America's Transportation Network to reduce congestion on the nation's roads, rails, runways, and waterways. A major component of the National Strategy is the Urban Partnership Agreement (UPA) initiative. Under a UPA, metropolitan areas can apply for grants from a pool of more than \$1.1 billion to pursue strategies under the umbrella called the "Four Ts"—tolling, transit, telecommuting, and technology—a combined approach to reducing traffic congestion. A stated federal goal is to demonstrate success of the congestion pricing approach in reducing congestion in the short term. Yet the extent of congestion pricing arising from all these initiatives remains modest—again, under 1 percent of total road mileage. Whereas the vast majority of congestion is associated with traffic on existing highways, local congestion pricing initiatives financed under the federal programs outlined above apply almost exclusively to the use of congestion pricing in association with the construction of new highway capacity (Table 8).

Is technology up to the task of a national program? What about compatibility between different areas?

The capacity-limiting character of traditional toll collection methods (wherein vehicles come to a stop at toll plazas) has been largely overcome with the advent of electronic toll collection. Such systems record vehicle movements on an electronic tag installed in the vehicle. The tag is read by a receiving antenna at the toll plaza and the toll is electronically deducted from a prepaid toll account. Fully twenty different toll road authorities in eleven states are presently interoperable with such technology. Other new technologies, such as open-road tolling, are expanding the range of options for various approaches to congestion pricing, and discussions are reportedly under way among automobile manufacturers to install electronic devices at the time of manufacture (Worrall 2007).

Aren't the political barriers to congestion pricing too formidable to contemplate nationwide application?

Political barriers are indeed formidable, which is why a new level of federal leadership is needed. Some perceive the "free" in "freeways" as close to a civil right. Importantly, however, opinion about road pricing does not fall neatly astride the normal political divide. Evidence indicates that political barriers can be and are being overcome. Most Americans have experienced conventional toll roads and bridges either in their home states or in their travels, and the congestion pricing programs listed in Table 8 are evidence of states and localities having overcome public resistance. Nevertheless, introducing congestion pricing on previously untolled roads is likely to face considerably more hostility. Yet evidence from abroad indicates the prospect of achieving widespread public acceptance. Both London and Stockholm have introduced citywide congestion pricing programs. Ken Livingstone, then Mayor of London, introduced congestion pricing against significant public hostility. Reports indicate the hostility diminished materially, but only after the fact, once significant traffic, air quality, and transit improvements were evident (Litman 2006; major new transit investments are being financed with revenue from congestion prices). The Stockholm story has had similar results.

TABLE 8

Federally Financed Value Pricing and Urban Partnerships Projects, as of 2007

Converting HOV lanes to HOT lanes[a]	
California	HOT lanes on I-15 in San Diego
California	I-680 SMART carpool lanes in Alameda County
California	HOT lanes on I-880 in Alameda County
Colorado	HOT lanes on I-25/US 36 in Denver-Implementation
Florida	HOT lanes on I-95 in Miami-Dade County
Georgia	HOT lanes on I-75 in Atlanta
Georgia	I-75 South HOT/truck-only Toll (TOT) study in Atlanta
Minnesota	HOT lanes on I-394 in Minneapolis
Texas	HOT lanes on two radial corridors in Houston (I-10 and US 290)
Cordon tolls (like the London program)	
California	Area road charging and parking pricing in San Francisco
Florida	Cordon pricing in Lee County
Fair lanes[b]	
California	Fair lanes with dynamic ridesharing in Alameda County
Priced new lanes	
California	Express lanes on SR-91 in Orange County
California	Extension of I-15 HOT lanes in San Diego
California	Implementation of dynamic pricing on SR-91 in Orange County
California	Vehicle enforcement system on I-15 managed lanes in San Diego
California	HOT lanes in median of SR-1 in Santa Cruz County
Colorado	Express lane on C-470 in Denver
Florida	Express lanes on I-4 in Orlando
Florida	Price queue jumps in Lee County
North Carolina	HOT lanes on I-40 in Raleigh/Piedmont
Oregon	Express toll lanes on Highway 217 in Portland
Texas	I-35 value-priced express lanes in Waco
Texas	IH-10 value-priced express lanes in San Antonio
Texas	Loop 1 HOT lane enforcement and operations in Austin
Texas	Managed lanes on the LBJ Freeway in Dallas
Texas	Managed lanes on the Katy Freeway in Houston
Texas	Managed lanes on I-30/Tom Landry in Dallas
Texas	Managed lanes on I-35 in San Antonio
Washington	HOT lanes on SR 167 in the Puget Sound Region
Pricing on toll facilities[c]	
California	Peak pricing on the San Joaquin Hills Toll Road in Orange County
Florida	Bridge pricing in Lee County
Florida	Extension of value pricing to the Sanibel Bridge and Causeway
Florida	Variable tolls along the Sawgrass Expressway in Broward County
Florida	Variable tolls for heavy vehicles in Lee County
Florida	Pricing options on the Florida Turnpike in Miami-Dade County
Illinois	Illinois tollway value-pricing pilot study
New Jersey	Variable tolls on the New Jersey Turnpike
New Jersey	Variable tolls on Port Authority interstate vehicle crossings

New Jersey	Express bus/HOT lane study for the Lincoln Tunnel
Ohio	Northern Ohio freight efficiency study
Pennsylvania	Variable tolls on the Pennsylvania Turnpike
Usage-based vehicle charges	
California	Car sharing in the City of San Francisco
Georgia	Simulation of pricing on Atlanta's interstate system
Minnesota	"Variabilization" of Fixed Auto Costs
Oregon	Mileage-based road user fee evaluation
Washington	Global positioning system (GPS) based pricing in the Puget Sound region
Regional pricing initiatives	
Florida	Sharing of technology on pricing
Georgia	GA-400 variable pricing institutional study in Atlanta
Maryland	Feasibility of value pricing
Minnesota	Project development outreach and education
Texas	Regional value pricing corridor evaluation and feasibility study
Texas	HOT lane network evaluation in Houston
Virginia	Regional network of value-priced lanes
Virginia	Value pricing for the Northern Virginia and Hampton Roads regions

Source: Federal Highway Administration 2006, supplemented by author.
HOT = high-occupancy tolls; HOV = high-occupancy vehicles.
a In HOT lanes, low-occupancy vehicles are charged a toll, while HOVs are allowed to use the lanes free or at a discounted toll rate.
b Fair lanes are freeway lanes separated into "Fast Lanes" and "Regular Lanes" using plastic pylons and striping. Fast lanes are electronically tolled express lanes, where tolls are set in real time to limit traffic to the maximum that can be accommodated at speeds close to free-flow speeds.
c Introduction of congestion-sensitive tolls on traditional toll-financed roads.

7.0. Conclusion

Traffic congestion arises for many reasons, and more than one mechanism is needed to combat it. It is most unlikely, however, that serious inroads on the problem will be made without fundamental reform in the way consumers are charged for the use of existing and newly constructed roads. Reform is needed to make paying the true economic costs of using congested roads as natural to travelers as paying more for any good or service supplied in the economy. Such reform is a necessary step in the search for an effective, efficient, and sustainable highway system for the twenty-first century. Reform must reflect a strong component of federal leadership, and a congressional incentive for nationwide congestion pricing by 2020 to be enacted as part of the 2009 reauthorization of the nation's federal legislation governing surface transportation. State and local reform is also imperative, both to prepare for implementation of the federal incentive program and to shape their approaches to local circumstances, which are not always associated with federally financed roads.

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