

# **White Paper #5**

*Assessing the Economic Effects of Congestion Pricing*

**final**

**report**

*prepared for*

**Oregon Department of Transportation**

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*February 3, 2009*



# Table of Contents

Executive Summary .....	1
1.0 Introduction.....	3
2.0 Policy Motivations for Congestion Pricing .....	5
3.0 Typology of Congestion Pricing Applications .....	5
4.0 Theoretical Basis for Congestion Pricing.....	7
5.0 Potential Impacts of Congestion Pricing .....	14
6.0 Quantification of Potential Impacts.....	18
7.0 Comparison of Alternatives .....	20
8.0 Reliability of Findings .....	21
9.0 Ancillary Issues.....	21
10.0 Revenue Investment Implications .....	23
11.0 Institutional and Public Acceptance Issues.....	24
12.0 Conclusions and Recommendations.....	26
<b>Appendix A</b> <i>Glossary of Terms/Abbreviations/List of Acronyms</i>	
<b>Appendix B</b> <i>Bibliography</i>	



# Assessing the Economic Effects of Congestion Pricing White Paper #5

## ■ Executive Summary

Until recently, the idea of congestion pricing has lived in academia, where economists debated about things like recovering the difference between marginal private costs and marginal social costs, public goods and private goods, and regressive versus progressive policies. With new highway capacity so expensive to build and the environmental consequences of highway expansion a continuing concern, congestion pricing has moved from Ph.D. dissertations to the front page of newspapers.

Congestion pricing is different from tolling. Congestion pricing is not just about the revenue, but also about changing travel behavior to make the most efficient use of the transportation system. The basic idea is to shift some drivers to noncongested periods, other modes, alternative routes, or into shared-ride vehicles to let traffic flow more smoothly.

Most other products and services use market forces to set prices that provide value to the customer and profit to the producer. If demand exceeds supply, prices rise and some customers choose not to buy. Hotels, airlines, telecommunications, electricity, and some transit systems are examples of industries that use pricing to spread demand in order to avoid expensive investments in expansion. There is little history of such pricing techniques on highways because the technology to allow such pricing did not exist until a decade or two ago.

The most well-known congestion pricing projects in the United States are high-occupancy toll lanes (HOT lanes), where single-occupant drivers pay a toll to use a carpool lane, with the toll varying to keep lanes free flowing. This paper is not about HOT lanes. Instead, this paper is about congestion pricing concepts where tolls are charged on existing highways for the express purpose of changing travel patterns. Specifically, we looked at cordon or area pricing, tolling all freeways in a metropolitan area, freeway pricing in lieu of freeway expansion, and mileage-based pricing.

When something is perceived as free -- or at a price near free - people tend to consume as much of that good as possible. The use of public roads is often considered free or nearly free. This results in what economists call “market failure,” which we commonly experience as congestion. Because the theory of congestion pricing is not well understood, a common concern is that it impinges on our perceived right to travel whenever or wherever we please and that we are “double paying” for something for which we have

already paid in the form of taxes. In actuality, the purpose of congestion pricing is to expose drivers to the full social cost of road use through directly charging for those costs that vary with congestion.<sup>1</sup>

The fundamental problem of congestion pricing is that while it results in an economically efficient solution to road congestion—making the best use of the roadway system—the entire population, on average, is worse off. This is because congestion pricing charges everyone for something for which they had not previously been charged: the benefits of travel and the impact of their travel on others.

In fact, the overall value of the toll that is paid is very likely to exceed the travel-time saving benefits of congestion pricing. With congestion pricing, not everyone will fare the same. The ultimate economic argument over whether society is better off and who wins or loses is entirely dependent upon how toll revenue is spent. If the portion of the toll revenue equivalent to the losses experienced by drivers is refunded to society through, for example, a reduction in the gas tax or other taxes, there may still be dollars left over to invest in the system. This redistribution leaves no one worse off, and some better off than before.

Under any system in our typology—other than full mileage-based pricing—some people will be “priced off” of the highway of their choosing, and will thus “lose” when compared to their current situation. The other losers in this situation will be those drivers previously using an alternate route or living along alternative routes that have additional traffic and congestion caused by drivers avoiding the priced system. It is possible that the overall impact on the system will be positive—society at large will “win;” but those paying on the highway may win at the expense of others who have been priced off or who happen to share the roads with the priced off drivers.

Peoples’ choices of how, when, where, and whether to travel are influenced by numerous attributes of the transportation system, land use patterns, demographics, social attitudes, and other items we may not even recognize. Any change in the system—a new highway, bus service changes, or congestion pricing—can result in a reassessment of old travel patterns. Responses can be short-term (choose a different route or mode) or long-term (choose a different place to locate a home or business) and can vary by type of trip (personal, business, shopping). The responses will affect various income groups differently, and have different effects on people in one area versus another.

Before addressing the implementation challenges of congestion pricing—the technology, administrative expense, privacy considerations, decisions about how to use the revenue—one must tackle the real problem of developing analytical methods that can reasonably

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<sup>1</sup> Charging people the social cost of their activity is called charging the “marginal social cost.” This is the total cost to society as a whole for producing one further unit, or taking one further action, in an economy. This total cost of producing one extra unit of something is not simply the direct cost born by the producer, but also must include the costs to the external environment and other stakeholders.

predict the outcomes. Analytical techniques to test transportation options have come a long way since the 1950s, but most travel demand models have not been designed to adequately evaluate all the short- and long-term implications of congestion pricing. Methods to evaluate the effect of pricing on traffic flow, land use, greenhouse gas emissions are in their infancy, and lack good real-world data. Translating these factors into an economic analysis is, therefore, doubly challenging, but not reason enough to discard congestion pricing.

Congestion pricing needs to be approached with caution, and transparent, comprehensive, and methodologically correct analyses undertaken. The concepts are not easy to understand—even for transportation professionals—and some of the analysis methods have not yet been fully developed or tested. Analysts need to be open about where assumptions and methods may have more than the typical level of uncertainty, and test the implications of different assumptions. As with any controversial concept, early and frequent public and elected official engagement is important in order to provide adequate time and funds for the difficult analyses required to properly answer the bona fide questions of the public.

Any analysis of congestion pricing should include comparisons to fully formed alternatives so that elected officials can reasonably choose among available options. Complicated analyses must be condensed such that understanding does not require advanced degrees in economics and traffic flow, but not so simplified as to eliminate the nuance and acknowledgement of areas of uncertainty. None of this is any different from the kind of care that should be given to any project. However, the kind of changes that would come about as a result of congestion pricing amplifies the importance of this approach.

## ■ 1.0 Introduction

Since the Roman Empire, tolls have been used to finance highway infrastructure, with project users paying off large up-front capital cost of constructing highways over time. Although this motivation for tolling can be overly simplistic – toll revenue is often used for purposes other than simply operating and paying off the capital cost of a project – it is the picture most people have in their mind when they think: “tolling.”

Congestion pricing is different. Congestion pricing is not just about the revenue, but also about changing travel behavior to make the most efficient use of the transportation system. The basic idea is to shift some drivers to noncongested periods, other modes, alternative routes, or into shared-ride vehicles to allow traffic flow more smoothly.

The Federal Highway Administration document, *Congestion Pricing, A Primer*, explains it like this:<sup>2</sup>

*Congestion pricing – sometimes called value pricing – is a way of harnessing the power of the market to reduce the waste associated with traffic congestion. Congestion pricing works by shifting purely discretionary rush hour highway travel to other transportation modes or to off-peak periods, taking advantage of the fact that the majority of rush hour drivers on a typical urban highway are not commuters. By removing a fraction (even as small as five percent) of the vehicles from a congested roadway, pricing enables the system to flow much more efficiently, allowing more cars to move through the same physical space. Similar variable charges have been successfully utilized in other industries – for example, airline tickets, cell phone rates, and electricity rates. There is a consensus among economists that congestion pricing represents the single most viable and sustainable approach to reducing traffic congestion.*

The theoretical underpinnings of congestion pricing make sense, and we will explore those underpinnings in Section 4.0. Most other products and services use market forces to set prices that provide value to the customer and profit to the producer. When demand exceeds supply, prices rise and some customers choose not to buy. Hotels, airlines, telecommunications, electricity, and some transit systems use pricing to spread demand to avoid expensive investment in expansion. There is little history of such pricing techniques on highways because the technology to allow it did not exist until a decade or two ago.

The system of paying for highways that has been in place since the beginning of automobile travel—based in large part on motor fuel taxes, excise taxes, sales taxes (in some places), and tolls (under special circumstances)—has helped shape the fabric of our society. We are accustomed to the pricing mechanisms currently in place. Moving to a system that takes into account congestion and other factors would be a big leap that would entirely change the historical economics of where people choose to live, work, locate businesses, and get around.

Not all congestion pricing is the same. Motivations, applications, and results may vary dramatically from the economic ideals. We explore these motivations and potential applications in Sections 2.0 and 3.0, respectively. It is the purpose of this paper to explore the policy motivations and pricing applications that may be considered in Oregon, look into the theoretical basis of congestion pricing (Section 4.0), and discuss in general terms the potential effects pricing applications might have (Section 5.0). We explore issues of quantification of impacts (Section 6.0), how to make comparisons among pricing alternatives and other ways to achieve the same objectives (Section 7.0), and how much we can rely on the analyses we are able to perform (Section 8.0). Section 9.0 addresses ancillary issues such as equity and environmental justice, privacy, and the administrative costs of carrying out congestion pricing. One of the most important and potentially overlooked aspects of congestion pricing is the question of how the revenue from pricing is used. We explore this issue throughout the paper, and then summarize it in Section 10.0. Section 11.0 addresses issues related to acceptance of congestion pricing by

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<sup>2</sup> Federal Highway Administration, Office of Transportation Management, HOTM, *Congestion Pricing, A Primer*, December 2006.

the public as well as the public institutions responsible for its implementation. Section 12.0 has conclusions and recommendations.

This paper is one of seven ODOT-commissioned white papers addressing various aspects of tolling and congestion pricing. Several of the sections summarize work from those other papers. While some of the other papers focus on tolling applications whose purpose it is to generate revenue for new highway projects or tolled managed lanes, this paper is devoted to more extensive concepts of congestion pricing that involve tolling on existing facilities for the purpose of managing demand.

## ■ 2.0 Policy Motivations for Congestion Pricing

Until recently, the idea of congestion pricing has lived in academia, where economists debated about things like recovering the difference between marginal private costs and marginal social costs, public goods and private goods, and regressive versus progressive policies. We will get to those issues in Section 4.0. When congestion pricing is discussed in the retail market of public policy—the legislature, governor’s office, the airwaves, and blogs—there are a variety of policy motivations that do not necessarily connect to economists’ ideas. It is useful to begin our discussion with some of these:

- Reducing peak-period congestion, in general, or targeted to a particular highway;
- Improving travel-time reliability;
- Encouraging transit use;
- Reducing air pollution, green house gas emissions, and energy use;
- Changing urban form;
- Paying for transportation projects (highway or transit); and
- Promoting economic development.

As pointed out in *Future of Tolling in Oregon; Understanding How Varied Objectives Relate to Potential Applications*,<sup>3</sup> the types of effects of congestion pricing are entirely dependent on how pricing is applied, so it is difficult to make generalizations such as, “pricing is effective at reducing greenhouse gas emissions,” or “pricing promotes economic development;” and few congestion pricing applications approach the kind of efficiency envisioned by economists.

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<sup>3</sup> Cambridge Systematics, Inc., *Future of Tolling in Oregon; Understanding How Varied Objectives Relate to Potential Applications*, prepared for Oregon Department of Transportation, August 2007.

## ■ 3.0 Typology of Congestion Pricing Applications

There are numerous ways congestion pricing can be carried out, only some of which may have application to Oregon. This paper will focus on five concepts, as follows.

### *Cordon or Area Pricing an Inner Cordon*

With cordon or area pricing, drivers within a defined area pay a toll. This concept has two variations: one in which drivers pay each time they cross the cordon, the other in which drivers pay for the privilege of driving within the cordon (more properly termed “area pricing.”) The policy intents are similar, and both are termed “cordon pricing” in this paper.

Typically, the intent of cordon pricing is to relieve intense congestion in a dense urban area; and it has been tried in London, England; Stockholm, Sweden; and Singapore, as well as in some smaller communities (such as the old city of Durham, England). Beyond congestion relief, additional policy objectives might be to reduce greenhouse gas emissions; improve the environment of the cordoned area through reductions in air pollution, noise, and the other side effects of too many motor vehicles; and to reduce delay and improve reliability for buses in the cordoned area. Underlying all of these concerns is the desire to enhance the attractiveness of an urban core, thereby improving its economic competitiveness. For this to happen, the positive impacts of congestion reduction and greater mobility must outweigh the out-of-pocket costs to drivers of paying tolls or choosing travel modes that they might not normally use.

Details such as: the prices charged; whether money is collected at entry and exit or within the cordon, or both; exemptions for certain categories of drivers; and how (or if) they vary by time of day can all impact effectiveness for providing congestion relief and meeting other objectives.

As important is how the toll revenue is spent. As demonstrated throughout this paper, this question is critical to the outcome of any congestion pricing concept.

### *Cordon Pricing at the Urban Growth Boundary (UGB)*

An extension of cordon area pricing concept in Oregon may be to go beyond dense urban centers and into a much larger metropolitan area, as defined by the state’s urban growth boundary. The policy motivations for this would be similar to that for an inner cordon, with an additional objective of influencing long-term land use decisions. This policy may effectively increase costs of living outside the UGB, but also may substantially increase the economic benefits of dense, efficient land use within the UGB. As a result, prospective residents and employers may consider living and working either wholly within or outside of an UGB, thus reducing vehicle-miles traveled (VMT) growth overall. It is unclear whether cordon pricing and associated land use regulations would have Measure 37 impacts.

### ***Tolling All Freeways in a Metropolitan Area***

In this concept, the freeways in a metropolitan area are tolled. Motivations for this might be simply to use congestion pricing as a means for keeping the freeways free flowing, as a way to provide income for transportation (or other) purposes, or both. The precise policy motivation drives how this is actually carried out. For example, if revenue generation is a prime motivator, then tolling all of the freeways in a given area might be the result. If revenue is a secondary consideration, the areas of tolling might be limited to those that actually experience routine recurring congestion. Policy motivations also drive whether or how toll rates might vary by time of day, or whether there might be times when tolls would not be charged.

### ***Freeway Pricing in Lieu of Freeway Expansion***

This concept is similar to the “tolling all freeways” concept, except that congestion pricing is used to control traffic demand on the freeways to keep them free flowing when there is demonstrated congestion. The policy motivation is to avoid the capital cost of building new lanes in expensive urban areas and avoid the environmental impacts of such construction, while still allowing for traffic – particularly freight – to flow freely.

### ***Mileage-Based Pricing***

Mileage-based pricing involves tolling all roads in the state (or in a given area). Concepts can be as simple as a set price per mile regardless of when or where, or can include more intricate ideas that address congestion or other social costs on a link-by-link basis. When economists talk about the potential of congestion pricing to bring about economically efficient outcomes, they are usually talking about extensive systems of mileage-based pricing. There are two potential policy motivations for mileage-based pricing. One is to generate revenue to supplement or replace the motor fuel tax, which would not involve congestion pricing concepts at all. The other is to charge the full social cost of highway travel to achieve economic efficiency, which exercises congestion pricing to its fullest extent.

## ■ **4.0 Theoretical Basis for Congestion Pricing**

Recall the definition of congestion pricing in Section 1.0, used by FHWA:

*Congestion pricing – sometimes called value pricing – is a way of harnessing the power of the market to reduce the waste associated with traffic congestion. Congestion pricing works by shifting purely discretionary rush hour highway travel to other transportation modes or to off-peak periods, taking advantage of the fact that the majority of rush hour drivers on a typical urban highway are not commuters. By removing a fraction (even as small as five percent) of the vehicles from a congested roadway, pricing enables the system to flow much more efficiently, allowing more cars to move through the same physical space. Similar vari-*

*able charges have been successfully utilized in other industries – for example, airline tickets, cell phone rates, and electricity rates. There is a consensus among economists that congestion pricing represents the single most viable and sustainable approach to reducing traffic congestion.*

How have economists reached this consensus, and what is it based on? Since the emergence of modern microeconomics, theories have shown that people's demand for a good responds directly to the price of that good. As prices rise, some people choose not to purchase and when prices fall, vice versa. In the case of goods with limited supply, if prices vary and those price differentials are communicated to customers, people will make choices appropriate to their situations and supply and demand will remain in balance. Pricing of last-minute airline tickets, daytime cell phone use, and electricity rates are some examples of time-based pricing of goods. In each of these cases, customers causing peak congestion pay a premium, while those who can purchase at times when the resource is not scarce pay less. When demand remains strong even in the face of high prices, the producer receives a market signal that additional investment in expansion on a particular route or region may be profitable.

The pricing of road use has not worked like this. Government has had a monopoly on road building and people have perceived roadways to be a "public good." A public good is one in which no one is excluded, everyone has equal access, and one person's use does not diminish the value to others. Public goods are those that everyone enjoys, but that are paid for by taxpayers. However, roadways may not be a true public good because under congested conditions, one additional vehicle on the road may prevent another vehicle from enjoying the same benefits of travel.

Society pays for road transportation through fixed charges—registration and license fees, excise taxes for vehicles, tires and batteries—and through variable charges such as motor fuel taxes. Although motor fuel taxes vary in proportion to use, they do not fully capture the value of roadways at different times. Some regions have other mechanisms to pay for highway improvements; local option sales taxes are particularly popular. Unlike excise taxes and motor fuel taxes that have some relationship to use, sales taxes are entirely unrelated to use and to the benefits received. All existing methods of transportation finance are regressive; that is, people of lesser means pay a higher percentage of their disposable incomes. This is an important point to keep in mind when later considering some of the consequences of congestion pricing.

When something is perceived as free, or near free, people tend to consume as much of that good as possible. The use of public roads is often considered free or nearly free. This results in what economists call "market failure," which is commonly experienced as congestion. Because the theory of congestion pricing is not well understood, a common concern about congestion pricing is that it impinges on our perceived right to travel whenever or wherever we please, and that we are "double paying" for something we already pay for with taxes.

In actuality, the concept of congestion pricing is to expose drivers to the full social cost of road use by directly charging for those costs that vary with congestion. As early as 1912, the economist Arthur Pigou is credited with expressing the concept behind congestion

pricing or having people pay for the cost that their presence on the road imposes on everyone else, called the “marginal social cost” of driving. When drivers must absorb that additional cost, they alter their behavior accordingly, and the fixed resource – the road – will operate more efficiently. This correction of market failure comes about by internalizing to some drivers the “negative externalities” of congestion on all of society.

In addition to congestion costs, road user charges also may be designed to recuperate costs associated with environmental and safety impacts on society or to provide revenues to finance future road and transit improvements. However, we do not need a shift to congestion pricing to recover these additional social costs because they could be recovered through changes to motor fuel tax or excise tax policy. For the purposes of this white paper, we focus strictly on the social costs of congestion, but the recovery of other social costs of driving is an important concept that should not be ignored when formulating long-term policy.

## **Congestion Pricing for Social Efficiency**

William Vickrey further developed the idea of congestion pricing in the 1950s and 1960s. At the time, implementing his ideas was impossible because of the primitive nature of toll collection. By the 1990s, tolls could be collected electronically without requiring drivers to stop, and there were several working examples of toll roads without tollbooths. These developments fueled a renewed interest in road congestion pricing, and Vickrey received the Nobel Prize for Economics in 1996 for his original work in congestion pricing.

Vickrey’s idea was to apply market principles to achieve the highest level of economic efficiency by gaining the greatest mobility for the least expenditure. It is important to understand, however, that moving from our current system (economically inefficient) to a system based on Vickrey’s concepts (economically efficient) may result in the greatest potential benefit to society, but also will result in changes – positive as well as negative – for individual members of society. That is, there will be winners and losers, and addressing the fate of the losers is an important consideration in the policy debate over congestion pricing.

The change in circumstances for individuals and particular groups is an essential point. If, when automobile travel emerged at the beginning of the 20<sup>th</sup> century, we had developed a system of road use charging based on recovering societal costs from individual drivers, the decisions made over the last century, including motor vehicle fleet composition and land use patterns, would have been very different, and well suited to that system. We can see some of these differences in Europe, which has embraced the idea of marginal social cost pricing for some time. Motor fuel taxes in Europe are many times higher than taxes in the United States. As a result, Europe has more fuel efficient fleets, less motor vehicle ownership, higher levels of investment in public transit (and transit use), and more compact land use patterns. In the United States, the process of migrating from the current system, with people making decisions based on a distorted view of the cost of travel, to one that forces full recognition of these costs has the potential to cause a significant disruption of our social fabric.

Of the congestion pricing proposals in the typology described in Section 2.0, it is the mileage-based pricing concept that is closest to the congestion pricing “ideal.” Full realization of the ideal would require full knowledge of congestion on the entire road network at all times, and algorithms to predict the result of price choices on each link simultaneously. Every other congestion pricing concept proposed must make compromises because of technical or political limitations. These compromises will exacerbate the winners and losers calculation, and differ by type of application.

The fundamental problem of congestion pricing, however, is that it results in an economically efficient solution to road congestion—making the best use of the roadway system—yet the entire population, on average, may be worse off than before. This is because congestion pricing charges everyone for something they had not previously had to paid for: the benefits of travel and the impact of travel on others. As a result, some people would clearly be worse off than before. Consider these examples:

- **People who choose to pay the congestion charge** will continue to use the same road at the same times they always have, yet they will pay more. They may save some time, which has a value to them, but the total cost will likely be higher than it was before, even when considering the time savings. Because they are paying the congestion charge, that choice is still better than the alternative (driving at a different time of day, taking transit, or foregoing the trip), but they are still paying more than they would have before the congestion charge. Note that *some of these people* will be better off—those with very high values of time. For them, the value of the time savings exceeds the value of the congestion charge, but on average, the group that pays the congestion charge is worse off than before.
- **Those who are priced off** of roads they routinely drive on will be worse off, because they will not traveling when, where, or how they want.
- **Those who were on alternative routes before** will be worse off because there will now be more travelers competing for that road space.

In fact, the overall value of the toll that is paid will very likely exceed the travel-time saving benefits of congestion pricing. With congestion pricing, not everyone will fare the same. The ultimate economic argument of whether society is better off and who wins or loses is entirely dependent on how toll revenue is spent.

If the portion of the toll revenue equivalent to the overall losses experienced by drivers is refunded to society through, for example, a reduction in the gas tax or a reduction in other taxes, there may still be dollars left over to invest back in the system. This redistribution would make no one worse off, and some may be better off than before (a Pareto improving result, named after the economist Vilfredo Pareto who, in 1906, defined social efficiency as the optimal allocation of resources in society, achieved only when it is not possible to make anyone better off without making someone else worse off.)

The recent Traffic Choices Study in the Puget Sound region of Washington made this point abundantly clear. Using the results of a congestion pricing trial program, the authors analyzed the potential benefits and costs of such a system. They found that until

the value of the toll revenue was added, congestion pricing had a negative benefit/cost ratio.<sup>4</sup>

Some of the factors that influence whether congestion pricing can be a socially efficient or responsible idea are discussed in the subsections below.

## Price Setting

Implementing congestion pricing on a large scale would require extensive and simultaneous knowledge about congestion levels on all parts of the transportation system. It would also require the ability to anticipate how each driver's decision to leave on a trip would effect the system later on when they reach points of their route downstream. Vickrey understood that the decision to travel is made at the beginning of a trip, but the impact of travel is felt along the entire route of a trip and persists well after the trip is made due to the nature of bottlenecks.

Carrying congestion pricing to its theoretical limit would require the ability to anticipate the economically efficient prices, communicating those prices to travelers so they could decide how to respond, and then anticipating those responses so that the lower priced portions of the system could compensate – all in real time. We have seen this idea work on HOT lanes, where prices are set dynamically based on traffic level in priced lanes and prices change frequently enough to maintain optimum traffic flow. Moving beyond a single 10-mile corridor to a longer corridor introduces additional complexity, as does moving to a system of priced freeways or an entire priced roadway system.

Beyond the technical complexity of pricing different parts of the system in an economically efficient manner lies the political complexity. Economic efficiency is only one part of the equation, and the nature of our society is to strive for equity and fairness in charging. One can see this on urban transit systems. Transit systems often charge a flat rate, regardless of time of day or even distance traveled. Some systems like Washington D.C.'s Metro charge higher prices during peak hours, but most have constant rates all day. Moreover, no systems charge higher rates on more congested or more popular routes—as economically efficient as that might be. People would consider that unfair.

More practical than a custom price for each minute of the day and each road on the system would be a simplified system of user charges based on time of day, type of road, and perhaps general location (e.g., central business district, urban, suburban, rural). These charges would be something less than fully economically efficient, and the degree of efficiency improvement would vary with the extent of the political compromises that needed to be made. Given the nature of political compromise, it is quite possible the resulting system would be very far from perfectly economically efficient, though it would be more

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<sup>4</sup> Puget Sound Regional Council, *Traffic Choices, A Summary Report*, April 2008, available at: <http://psrc.org/projects/trafficchoices/summaryreport.pdf>.

so than the *status quo*, and equity issues could be addressed by redistributing the toll revenue.

## **The Priced Off and Those Impacted by the Priced Off**

Under any system in our typology other than full mileage-based pricing, there would be nonpriced parts of the system. This means that some people would be priced off the highway of their choosing, and would “lose” when compared to their current condition. The other losers in this situation would be those drivers previously using an alternate route or living along alternative routes that would now be faced with additional traffic and congestion from those avoiding the priced system.

An oft-quoted demonstration<sup>5</sup> of the value of congestion pricing is the ability of pricing to restore the full volume of a roadway by managing demand. The optimum flow on a highway occurs when vehicles travel at about 45 miles per hour. When demand exceeds a certain point, speeds drop precipitously, with the result of less throughput despite higher demand. This paradox is born out daily in stop-and-go conditions on freeways. If pricing can manage demand to the level that maintains speeds at 45 to 55 miles per hour, traffic flow can be optimal and the most value for the investment realized.

The problem, though, is what happens to drivers on roads that are not priced. The condition of roads that are not priced could not help but become diminished. Because freeways carry so much traffic, it is possible that the overall impact on the system would be positive. Society at large would “win,” but those paying on the highway may win at the expense of those priced off and those that happen to share the other roads with priced off drivers.

## **Market Signals to Identify Where Improvements Should be Made**

Some advocates of congestion pricing emphasize the effectiveness of comprehensive pricing strategies in identifying places in the transportation system where improvements are needed. Just as an airline might raise prices on a popular route to manage the available seats; at some point, adding another flight to the route may be profitable and the airline may choose to make that investment. Constant competition for seats on that route and the high prices that can be charged signals the operator that expansion may be a good idea.

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<sup>5</sup> Washington State Department of Transportation, *The PRICE Is Right! A simple demonstration of how peak hour traffic flow through variable pricing can make highways more efficient and saves money and aggravation for everyone*, undated, available at: <http://www.wsdot.wa.gov/NR/rdonlyres/4D0BFFF3-E59B-45EE-ABB4-1F00F762C5DE/0/MacDonaldRiceHandout.pdf>.

Under a market-based system, the same market signals could be applied to roadway capacity. The problem, though, is that traffic demand is only one of many measures used to decide whether or where to make improvements. Physical constraints, environmental issues, and social equity may be equally important considerations. Again, final decisions made under full considerations would not be the most economically efficient solutions, but would reflect the reality of public decision-making in a democracy.

## **The Importance of Dealing with Revenue**

Pricing seeks to recover the social costs of driving not been previously charged for, resulting in revenue gains to government. Until we consider what would be done with this revenue, it is difficult to determine whether society would be better off. Distribution of revenue is an age-old political issue, and it would be no different with congestion pricing. For the sake of fairness and gaining political support, there would be a strong temptation to use the revenue to overcompensate the losers or to spread benefits around to all groups. In all circumstances, an underlying purpose of redistributing revenue would be to make a positive contribution to society in some way. Some approaches to achieve this include:

- Investing in transit improvements in the affected area;
- Subsidizing improvements to the highways system (e.g., parallel arterials);
- Rebating motor fuel taxes;
- Reducing general taxes such as income or property;
- Awarding unspecified grants to the affected communities; and,
- Devising a system whereby users during peak times pay a price, and those who travel during off-peak get a credit. Credits might be used for travel on another day or on transit.

It is important to note, however, that these uses of revenue contrast with public ideas of how toll revenues should be used. Lessons learned from the FHWA's Value Pricing Pilot Program suggest that people support the use of tolls to benefit corridor-level improvements, including the transit system; or that toll revenue should only be spent for the benefit of those paying the toll, in particular, through investments in the highway being tolled. This is the traditional political justification for financing roads, bridges, and tunnels with tolls. These traditional public views of when tolling is justified run counter to the idea of recovering the marginal social cost of driving with tolls.

An interesting treatment of this topic by University of California planners King, Manville, and Shoup suggests using congestion pricing revenue to compensate communities

directly.<sup>6</sup> Their argument is that those people perceiving themselves as losers under congestion pricing are likely to form strong political resistance to the idea. As a result, one mechanism to gain support would be to target the distribution of revenue to create groups that perceive themselves as winners and, thus, more likely to be supportive. Actually implementing a congestion pricing project without building long-term, consistent support from those affected, for better or for worse, is likely impossible.

## ■ 5.0 Potential Impacts of Congestion Pricing

Peoples' choices of how, when, where, and whether to travel are influenced by numerous attributes of the transportation system, land use patterns, demographics, social attitudes, and other items we may not even recognize. There are entire disciplines of research and practice devoted to understanding these relationships, and the concept of "cost" is central to all of these.

Cost can be reckoned in different ways. The most obvious are out-of-pocket costs that involve paying for fuel, parking, and tolls when driving a car, or fares when using transit. Less obvious are the wear and tear (depreciation) on a personal automobile incurred by driving where the cost is not reckoned until the car is sold. Nevertheless, this is still a monetary cost. There also is the cost of time, because time spent traveling is time that could be used for other, arguably more productive, purposes.

Any change in the system can result in a reassessment of old travel patterns. If the frequency of bus service improves from once an hour to once a half hour, some may find it a better option. Similarly, if security concerns on transit are improved or if the stations are more comfortable, transit may become a better option. If the drive from home to work used to take 15 minutes but now takes 30 minutes because of congestion, a driver may choose to leave earlier or later to avoid the congestion. Or, the driver may have little flexibility or not care enough about the value of her time to make any change. If a new road is built, drivers may find the new road more convenient and start using it, but if that road has a toll on it, they may only use that new road when time is important to them. If the changes are significant enough, drivers may change basic patterns of living. A new highway or transit system might improve accessibility to land that was otherwise hard to reach, and people may move from one place to another or choose different places to work as a result. This is but a small sampling of the factors affecting traveler choice.

The "price" in congestion pricing is another such change to the transportation system that will bring about a traveler response. The response due to pricing will vary considerably according to how it is applied and what the prices are, so it is impossible to generalize. We can, however, identify the kinds of impacts that might be expected, and how those

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<sup>6</sup> David King, Michael Manville, Donald Shoup, *The Political Calculus of Congestion Pricing*, January 2007.

impacts might change with how the tolls are applied. In addition to the importance of the details of specific pricing programs, it also is important to understand that there is very little real-world experience with pricing. Most of the pricing experience in the United States has revolved around relatively minor adjustments to toll rates on existing toll facilities and HOT lanes. Lessons from these implementations may not translate well to other types of pricing such as tolling existing freeways or cordon pricing. Other implementations, such as cordon pricing, have been tried overseas, but in environments very different from those in Oregon, so these findings do not translate well either.

The discussion that follows is a synthesis of what has been observed on real pricing projects, what has been studied for particular applications, and what is theorized by economists. The following hierarchy can characterize the potential responses to price.<sup>7</sup>

## Short- and Long-Term Responses

Short-term responses are arguably the most obvious because they relate to day-to-day trip-making decisions. A short-term response assumes an existing pattern of behavior, places to live and work being the most influential. Adding a toll to an existing nonpriced system will bring about this range of short-term responses:

- Change of travel path from a tolled route to a nontolled route or to a lower toll route, if either of these exists under the scheme.
- Change of mode of travel, in particular if no nontolled routes are allowed for or if the nontolled routes are of poor quality. Change of mode could include ridesharing.
- Change of time of departure, if variable prices by time of day (or congestion levels) are used.
- Change of destination, if there is such flexibility in the short term. For example, if I want to buy groceries, and one store is reached via tolled routes and one via nontolled routes, the toll may be sufficient for me to change the store at which I choose to shop.
- Not make the trip, or combine several trips to save on the toll cost.

With more time to react and a pricing regime in place, people may respond in more far-reaching ways. The increased out-of-pocket cost to travel on a particular highway or in a particular area may lead people to sell one or more cars and, as a result, take transit more often. Some people might react to the new pricing regime by changing their place of residence or employment, or both, to avoid the new toll cost. If one or the other is changed, this would result in a shift of travel from one part of a region to another. If both are changed, it may move that travel to another region entirely.

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<sup>7</sup> A good discussion of travelers' reactions to prices can be found in *TCRP Report 95, Road Value Pricing, Traveler Response to Transportation System Changes*, 2003, available at: [http://trb.org/publications/tcrp/tcrp\\_rpt\\_95c14.pdf](http://trb.org/publications/tcrp/tcrp_rpt_95c14.pdf).

Other travelers may respond in exactly the opposite way. They may see the additional toll cost as a small price to pay for improved travel times and reliability. Thus, if pricing is successful at bringing about improved efficiency in the transportation system, the out-of-pocket costs would be more than offset by the travel-time benefits. Some classes of travelers may see this positively and be attracted to locations with such features. This may be particularly true if toll revenues are used to enhance transportation alternatives and bring about less congestion (and a more pleasant environment).

## **Responses by Type of Trip**

Pricing will have an impact on different trip purposes in different ways. The elements of the trip-making decision involved here relate to value of time and scheduling flexibility. Toll charges are likely to have the least amount of impact on business trips that are “on the clock,” and these trips will likely benefit from pricing the most. Commute travel for some people tends to be inflexible in terms of schedule, but is a recurring charge. There is considerable evidence of people changing their time of departure (earlier or later) to avoid the wasted time cost of traveling during the peak of the peak. If time-of-day pricing is used, toll charges may move people with less scheduling flexibility into the peak because they may be willing to pay for the decrease in congestion. At the same time, it may move others away because their trip type can occur at a different time. The types of trips with more flexibility might include social visits and shopping.

Shopping trips are particularly sensitive in many discussions of congestion pricing, particularly cordon or area pricing schemes. The fear is that the toll price will discourage shoppers from coming into the priced zone, thereby having an impact on retail businesses in the zone. Here again, it is the overall impact on travel that will determine whether the effect on shopping travel will be positive or negative. If the benefits received from the entire pricing program—including congestion reduction from pricing itself and capital or operating improvements brought about by toll revenue exceeding out-of-pocket costs—the effect on shopping travel can be positive. If the public does not perceive sufficient benefit from the program, then there could be negative impacts. The ultimate answers will depend on the details of the entire program.

Freight travel also is of particular concern. Freight can benefit from congestion pricing if congestion is reduced on highways and deliveries can be made more reliably, because “just-in-time” delivery regimes put a high value on schedule compliance. However, because of the emphasis on the schedules of shippers and receivers, dislodging freight trips from peak periods through the use of pricing has been shown to be particularly difficult. Studies in the New York region have shown that truckers are squeezed from both sides when faced with congestion pricing. Their time of travel is dictated by their

customers, and their prices are very competitive, meaning that they have difficulty passing on the cost of the tolls to their customers.<sup>8</sup>

## Responses by Income Group

Income clearly influences responses to road pricing, but not always in ways that are expected. Oft-quoted findings from HOT lane projects<sup>9</sup> have shown that all income groups use priced lanes, although high-income travelers use them more frequently. And attitude surveys have shown that a majority in all income groups are in favor of the HOT lanes.

We need to be careful, though, of translating findings from HOT lane projects to other types of pricing projects. HOT lanes are unique in two ways. First, there is always a choice between the priced lane and the immediately adjacent free lane. Second, nothing has been “taken away.” HOT lanes always add capacity, either by freeing up unused capacity in an existing HOV lane, or by building new lanes and pricing them. No one is made to pay a toll where previously they had not.

With the typology of pricing projects under discussion in this paper, however, there is always a “take away.” Lower-income drivers will have a more difficult time affording toll charges, and are more likely to be “priced off” of the road or time of travel that they prefer. The ultimate impact on different income groups, however, will be heavily influenced by how the revenue from congestion pricing is spent.

## Geographic Extent of Impacts

Regardless of the geographic extent of the congestion pricing application, all applications are likely to have travel responses that go beyond the local areas. Moving from the broadest geographical extent of impacts to the narrowest provides some insights. In all cases, the long-term impacts on live/work decisions will be driven by how pricing affects overall accessibility: a combination of the cost of congestion, the price of the congestion charges, and the desirability of alternatives.

With **mileage-based pricing**, all travel in the state would be directly impacted. The exact response would depend on how much the concept changes the cost structure from what people currently experience through the gas tax and parking charges. In particular, responses would depend on the extent to which prices vary by time of day and location,

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<sup>8</sup> Holguín-Veras, J. *The Truth, the Myths, and the Possible in Freight Road Pricing in Congested Urban Areas*. National Urban Freight Conference, Long Beach, 2006.

<sup>9</sup> Sullivan, Edward, *Continuation Study to Evaluate the Impacts of the SR 91 Value-Priced Express Lanes, Final Report*, December 2000.

and whether revenues are used to make capital improvements to highways or transit within the impacted areas.

Under a concept to **toll all freeways in a metro area**, the impacts would extend to all freeway users, with similar variations depending on how pricing is varied by time and place. The “toll all” freeways concept has the added wrinkle of how diversion from freeways affects parallel arterial routes. The impact of only tolling freeways that have become congested would be more limited and focused on the traffic sheds of these congested highways. Again though, the interplay of higher out-of-pocket costs on these highways to the improved traffic flow from less congestion and potentially improved services through the spending of congestion pricing dollars could alter this equation substantially.

**Cordon Pricing at a UGB** is likely to have broad impacts on live and work decisions throughout a metropolitan region if prices are set high enough. However, these impacts on travel decisions might be tempered by potential corrections in the real estate market to adjust for the higher cost of travel. **Cordon pricing in an inner cordon** is probably of more limited geographic scope, but if the combination of pricing and congestion relief changes are substantial enough, it could have an impact on long-term development patterns in the entire region.

## ■ 6.0 Quantification of Potential Impacts

Up until now, we have been talking about the theory of congestion pricing, and the many ways in which it might affect people and populations. When moving beyond general concepts to actual proposals, we need to have a way to quantify the impacts in advance to allow informed decision making. It is particularly important to be able to compare road-pricing options to options that do not involve pricing. There are numerous challenges associated with estimating the impacts of pricing, covered in detail in some of the other papers.

Estimating changes in travel behavior is the basic underpinning of any evaluation of road pricing. Travel demand models, in general, attempt to simulate the behavior of groups of people, estimating the number of trips, when they are made, where those trips go, the travel mode, and the route. All models struggle with the issue of toll price; and a variety of ways to work around the problem have been used over the years, some involving post-processing of model results. White Paper #3 covers this issue in detail. Travel demand models, in general, struggle to produce reasonable results without constant adjustment and customization to individual analytical situations. When tolling is added, travel demand models need to estimate how many people will use the toll facility at particular prices (to estimate revenue), impacts on corridor and regional travel, and impacts on different groups of people.

Travel demand modeling for traffic and revenue studies for a new toll road focuses on the question of revenue, and most effort is devoted to convincing potential investors the forecasts are reasonable. When considering congestion pricing, the analysis also must con-

sider a variety of other factors such as impacts on corridor/regional traffic, and impacts on different populations. In particular, congestion pricing is concerned with how traffic might shift from congested periods to less congested periods (in the short term). Over the longer term, the impact of pricing on destination choices (e.g., whether one shops at a store when one has to pay a toll to get there), and housing and job location decisions are important. Most models are not well suited to these tasks when the only thing that changes is toll price because there is so little experience. Although White Paper #3 addresses these issues, the reality is that until congestion pricing concepts are tried and studied, we will not know with certainty how people respond.

If we take an example where a new toll is imposed on the existing freeway system in order to create free-flow traffic, there are several potential effects:

- Some people will choose to avoid the toll or pay a lower toll by shifting their time of travel;
- Some will choose to avoid the toll by taking an alternative route;
- Some will avoid the toll by shifting to transit, or reduce the cost of the toll by carpooling;
- Some will be happy to pay the toll and stay where they are;
- Some that already had shifted their time of travel to avoid congestion will shift *back* to the peak travel period because the value of the toll is less than the value of their time; and
- Some will just keep doing what they were doing, but pay the toll.

These are not trivial sets of choices to be made, and with lack of experience, there is little for the model to go on. And this is only one example. The estimation challenge is higher when we consider concepts that include dynamic pricing, where the toll varies from minute to minute based on congestion levels. The choices change when we talk about cordon pricing (no parallel options) or tolling all roads with a VMT fee (no drive-options at all).

The impact of pricing on land use decisions is of particular concern, because the winners and losers represent real estate or business interests with a lot riding on the outcome. We have the capability to develop models to estimate the changes, and these models exist, particularly in the Portland region, but our confidence with how to treat the offsetting effects of congestion reduction (costs savings) with congestion tolls (out of pocket costs) should not be high, because we have little to go on.

One of the oft-mentioned benefits of congestion pricing is increased reliability. As noted in White Paper #4, reliability is difficult to define and even more difficult to measure. Beyond measuring reliability in the field, *forecasting* changes in reliability due to changes in travel patterns is even higher on the scale of difficulty, because the relationships between forecast volume/capacity ratios and the resulting travel-time reliability are not well understood. Even if we could reliably measure and forecast reliability, there are

methodological issues with respect to assessing the economic value of that reliability. For example, different industries will place different values on highway time reliability, depending on how much they care about just-in-time delivery, the perishability of their goods, how they staff their shipping and receiving departments, and other factors.

Therefore, while reliability may be a big selling point for congestion pricing, it is difficult to provide a value for it when assessing whether or not to do a project. One approach may be to treat reliability as we do other nonquantifiable concepts such as quality of life or equity.

Policy-makers are paying considerable attention to the relationship between greenhouse gas emissions and transportation. Pricing strategies may affect the number and type of vehicles owned by a household, as well as where people live and work, the number of trips they take, the time of day of these trips, whether they choose to drive or use transit or some other model of travel, and the roadway operating conditions in terms of vehicle operating speed and the frequency of accelerations and decelerations. Some of these impacts may occur immediately, while others may occur over several years. An analysis of the impacts of road pricing on greenhouse gas emissions, therefore, needs to be based on how each of these factors will change over time and the resulting impacts on VMT and vehicle operating conditions. While significant data and analytical methods are available to evaluate the travel and emission impacts of potential road-pricing strategies, these existing approaches still are short of being fully satisfactory. More work on developing improved models to address greenhouse gas emissions is needed, which is discussed in White Paper #1.

Ultimately, the test of whether Oregon should invest in a project depends on whether it gets an economic return from that investment. As noted in White Paper #6, there are many ways of looking at the economics of a project, one of which is benefit/cost analysis, which tallies up the life-cycle benefits and costs of a project considering the time value of money. Another is an economic impact analysis, which considers how a project impacts the local or regional economy. Benefit/cost analysis addresses the benefits of users and nonusers that might be affected, while the economic impact analysis multiplies the effects of those initial benefits into how the economy might respond. Quantitative issues surrounding economic analysis are tied up with the quantitative issues of travel demand modeling, land use analysis, and valuing the reliability of travel-time savings.

## ■ 7.0 Comparison of Alternatives

Because congestion pricing involves tolling, people often assume that the basis of decisions is financial; in other words, does the project make enough money to cover capital and operating costs over the life of the project? But congestion pricing is about more than just the financial transaction, and this white paper discusses many of those factors, such as user benefits, economic benefits, winners, and losers.

When comparing alternatives, the most important step is to identify the basis for comparison, or baseline condition. All other alternatives involve a change from that baseline. Comparing alternatives that involve congestion pricing is really no different from comparing other project or program alternative comparisons, except that the toll component is usually front and center in people's minds.

White Paper #6 explores issues relating to benefit/cost analysis, an important element in any alternatives analysis. Benefit/cost analysis, however, addresses the net benefits and costs to society as a whole. When considering pricing projects (and others, for that matter), it will be important to distinguish whether some populations may gain at the expense of others, whether the net result will be positive changes to the environment or land use, and whether the policy is being applied fairly across geography. Some of these elements are not necessarily quantifiable, but they can be explored and explained in methods used for other transportation projects.

## ■ 8.0 Reliability of Findings

There are reliability issues throughout the analysis of congestion pricing projects, primarily because it is so new and untested. While there is some experience with traveler response to HOT lanes, there is little experience with how people will react when pricing existing highways or streets, which is what would happen with most congestion pricing proposals. In addition to the short-run effects, like choosing a different route or time to travel, there are long-term effects that may not play out for years or decades; so even the experience of congestion pricing in London or Stockholm is too new to determine what the long-term effects might be.

## ■ 9.0 Ancillary Issues

Not all issues of interest to decision makers can be captured in economic benefit/cost analysis. This section addresses other issues related to congestion pricing: equity and environmental justice, privacy, and administrative costs.

## Equity and Environmental Justice<sup>10</sup>

We may be concerned about equity when it comes to introducing changes to the existing system because it appeals to our sense of fair play. But there also are legal considerations of equity that have collectively come to be known as Environmental Justice, defined as follows:<sup>11</sup>

1. To avoid, minimize, or mitigate disproportionately high and adverse human health or environmental effects, including social and economic effects, on minority populations and low-income populations;
2. To ensure the full and fair participation by all potentially affected communities in the transportation decision-making process; and
3. To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority populations and low-income populations.

As articulated by a publication from the Institute for Transportation Studies at the University of California at Berkeley, equity and fairness issues most frequently arise when:<sup>12</sup>

- Some communities get the benefits of improved accessibility, faster trips, and congestion relief, while others experience fewer benefits;
- Some communities suffer disproportionately from transportation programs' negative impacts, like air pollution;
- Some communities have to pay higher transportation taxes or higher fares than others in relation to the services that they receive; or
- Some communities are less represented than others when policy-making bodies debate and decide what should be done with transportation resources.

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<sup>10</sup>This section is a very brief summary of a much more extensive report on Equity and Fairness in tolling prepared by the Texas Transportation Institute in collaboration with Cambridge Systematics, Inc. for the Washington State Transportation Commission, contained in *Washington State Comprehensive Tolling Study, Volume 2, Background Paper #4*, available at: [http://wstc.wa.gov/Tolling/FR1\\_WS\\_TollStudy\\_Vol2\\_Paper04.pdf](http://wstc.wa.gov/Tolling/FR1_WS_TollStudy_Vol2_Paper04.pdf).

<sup>11</sup>Federal Highway Administration. *Questions and Answers on Environmental Justice and Title VI*, <http://www.fhwa.dot.gov/environment/ejustice/facts/index.htm>, accessed October 9, 2005.

<sup>12</sup>Cairns, Shannon; Greig, Jessica; and Wachs, Martin. *Environmental Justice and Transportation: A Citizen's Handbook*, Institute of Transportation Studies, University of California at Berkeley, January 2003, <http://www.its.berkeley.edu/publications/ejhandbook/ejhandbook.html>, accessed October 9, 2005.

All of these issues come into play in congestion pricing, and price is only part of it. As with everything else, it is the net benefits and disbenefits to different groups that will determine how people are affected. Again, how the revenue collected from a congestion pricing project is used in the community will affect that calculation.

## **Privacy**

Congestion pricing relies on all-electronic tolling. By its nature, all-electronic tolling needs to identify a customer at a particular time and place in order to collect revenue, or at least to enforce a revenue system. Virtually all electronic tolling systems operate on an opt-in concept. If you choose to pay electronically, you agree to have certain information about you recorded. If you do not want that information recorded, you can continue to pay cash, if a cash option is allowed.

The congestion pricing concepts we are talking about in our typology go beyond an optional system, because they put prices on roads that were previously free. So, if someone “opts out,” they are denied access to the road. This means that any congestion pricing system will have to wrestle with how to ensure revenue collection while guaranteeing the privacy of citizens.

Addressing privacy concerns can be done through a combination of business rules and technology, including:

- Offering anonymous transponders or accounts;
- Providing options for single-use payments;
- Making sure that there are proper data encryption and protection policies, and that data is purged after it is no longer needed to validate transactions; and
- Having clear policies relating to access and use of customer data.

## **Administrative Costs**

Collecting tolls is considerably more expensive than collecting motor fuel taxes and excise taxes. There is little experience with congestion pricing beyond several HOT lanes in the United States and a few cordon-pricing implementations overseas. We do know that collecting tolls from traditional toll facilities can cost anywhere from \$0.10 to \$0.60 per transaction or more. Although electronic tolling holds promise for bringing costs down, many places have not yet realized those cost declines. This comes as a surprise to many people, but electronic toll collection usually involves considerable labor in the back office, verifying license plate reads, sending collection statements, and so on. Some have described electronic tolling as simply moving the toll collectors from the traffic lanes to the back office.

All electronic tolling would likely involve some combination of transponder-based toll collection, GPS-based toll collection, and video. All systems would require a video element to ensure compliance with the system, which contributes significantly to the cost, because it requires human interaction.

The area-pricing scheme in London is known to have more than 50 percent of its toll revenue used to support the cost of toll collection.

## ■ 10.0 Revenue Investment Implications

Use of toll revenue is a controversial topic with tremendous influence on the public debate surrounding tolling. The traditional approach to tolling is that tolls should be used exclusively for improvements to the tolled facility and removed as soon as initial capital debt is paid off. This will never be the approach, however, for the pure congestion pricing concepts discussed in this paper.

Another approach is to compensate those who “lose” from pricing with the revenue. This can take many forms:

- Pay for capital and/or operating costs of transit services in the same corridor or area;
- Pay for improvements to nonpriced roads in the corridor/area that might be affected by diverted traffic; and
- Pay the municipalities a share of the revenue to compensate them for any impacts.<sup>13</sup>

Any of these approaches can dramatically affect the calculation of costs and benefits. As noted in Section 4.0, a pure pricing strategy is likely to have a negative benefit/cost ratio until the effect of how revenues are spent is taken into account. Use of revenue also will strongly influence public acceptance, as discussed in the next section, as the public tends to have a strong distrust that government will spend revenue wisely.

## ■ 11.0 Institutional and Public Acceptance Issues

Regardless of the analytical outcomes, existing institutions and public opinion may oppose congestion pricing. This can arise from the uncertainty associated with a change from the status quo, and realities or perceptions relating to winners and losers. The public and/or institutions may find that the policy rationale for pricing is not compelling, do not

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<sup>13</sup>King, David; Manville, Michael; Shoup, Donald, *The Political Calculus of Congestion Pricing*, 2007.

believe it is an effective solution, or are particularly concerned it will negatively impact them personally or as an organization. Regardless of the policy merits, however, there also may be concerns about the ability of existing public institutions to manage a pricing program.

There is little actual experience with congestion pricing, and the public acceptance challenges in each area will depend on the population served, the historical record of trust in public officials, the specifics of the pricing proposal, including the existing and anticipated transportation system.

A recent report compiled public opinion data related to tolls and road pricing,<sup>14</sup> and found that the public:

- Wants value; that is, they want to see a benefit for the price that they pay;
- Learns from experience; as tolling and pricing options are actually implemented, the fear of the unknown recedes and approval increases;
- Cares about the use of revenues and wants tangible projects;
- Believes in equity and wants fairness; and
- Wants simplicity and prefers tolls to taxes.

The one example of a community trying to undertake extensive congestion pricing in the United States occurred in New York City in 2007. There, Mayor Bloomberg rolled out a comprehensive program of reforms for the City called PlaNYC, one element of which was a cordon toll below 86<sup>th</sup> Street in Manhattan.<sup>15</sup> It was a bold plan, but was ultimately defeated as the Mayor barely managed to get the support of his own City Council and failed to get the support of the state legislature. At the risk of oversimplification, the issues came down to many of the things discussed in this paper: who pays, who wins, who loses, and what would be done with the revenue. It was a complicated project that the general public did not fully understand. The project proponents also failed to build consensus and to negotiate elements of the project, which ultimately led to its defeat.

More modest congestion pricing projects, primarily HOT lanes have moved successfully through the public process, are now accepted, and get high marks for public approval. With HOT lanes, unlike the congestion pricing concepts discussed in this paper, there are no “takeaways.” They all price unused capacity. So, despite the popular moniker of “Lexus Lanes,” surveys have shown that people across the income spectrum favor these facilities because they offer an opportunity for reliable travel if and when someone really needs that service.

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<sup>14</sup>National Cooperative Highway Research Program, *Synthesis Compilation of Public Opinion Data on Tolls and Road Pricing, A Synthesis of Highway Practice*, 2008.

<sup>15</sup>Details can be found on the program’s web site: <http://www.nyc.gov/html/planyc2030/>.

This will not be the case for cordon pricing, freeway pricing, or mileage-based pricing. All of these represent takeaways of existing nonpriced travel, and will face opposition from people who will (rightly) perceive they are being made worse off. Unless people conclude the revenue is being used effectively (in a way that benefits them) and trust the government to carry out the program as advertised, congestion pricing programs are likely to run into stiff opposition, as in New York City.

Successful implementations of congestion pricing will go a long way toward demonstrating the potential value of these concepts. London's area pricing scheme and Stockholm's cordon toll both had opposition, both had adjustments along the way, but both generally can be called successful and even popular. This is not to say that both do not still generate their share of opposition. Attempts to expand the London scheme to incorporate emissions charges proved too aggressive and were defeated.

## ■ 12.0 Conclusions and Recommendations

If, at the beginning of the motor vehicle era, we had possessed the technology to allow road pricing, and we had decided to use it to capture the full marginal social cost of driving, then the fabric of our communities would be very different from what it is today. Urban areas would be more compact, and there would be more public transportation. We can see this in Europe, which has a history of charging motor fuel taxes several times higher than the levels in the United States. Because Europe has a longer tradition of trying to capture the marginal social costs of driving, it is little surprise that they have had far more success in moving contemporary congestion pricing ideas forward.

The United States is very different. We have a social and economic world built on the foundation of inexpensive automobile travel. Changing the rules in midstream may be the best long-term solution for society as a whole, but there will be winners and losers. Those winners and losers are not just those who would choose to pay a toll and those who would not, but also property and business owners who are counting on the continuation of those rules.

Congestion pricing needs to be approached with caution, and transparent, comprehensive, and methodologically correct analyses undertaken. The concepts are not easy to understand – even among transportation professionals – and some of the analysis methods have not yet been fully developed or tested. Analysts need to be open about where assumptions and methods may have more than the typical level of uncertainty, and test the implications of different assumptions.

In some cases, we may not know the real answers until someone actually implements a congestion-pricing concept beyond a HOT lane. That approach worked in Stockholm, Sweden, where a \$500 million demonstration was carried out with the government agreeing to remove the system if the people voted against it. With a skeptical public at the outset, voters in Stockholm, by a slim majority, gave their government the go-ahead to turn a demonstration project into a permanent installation. As with any controversial

concept, early and frequent public and elected-official engagement will be important, leaving adequate time and funds for the difficult analyses that will have to be done to properly answer the bona fide questions of the public. Any analysis of congestion pricing should have comparisons among fully formed alternatives so that elected officials can reasonably choose among them. Complicated analyses must be boiled down such that understanding does not require advanced degrees in economics and traffic flow, but not so simplified as to eliminate the nuance and to overlook areas of uncertainty.

None of this is any different from the kind of care that should be given to any project. However, the kinds of changes that would come about as a result of congestion pricing amplify the importance of this approach.



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# Appendix A

*Glossary of Terms/Abbreviations/List of Acronyms*



## ■ Glossary of Terms/Abbreviations/List of Acronyms

**Amortization** - A financial term referring to terms of a loan where the provision is made in advance for the gradual reduction of an amount owed over time.

**Area Pricing** - A tolling approach where vehicles are charged a fee to enter or travel within a high-activity center, such as a downtown or business district. Prices may vary by time of day to encourage motorists to enter the zone during less busy times or to use transit. A related and familiar example would be Fareless Square in Portland, where transit is available for free to discourage short-term and short-distance automobile travel within the business district.

**Bus Rapid Transit (BRT)** - High-frequency bus service on dedicated lanes separate from general travel. BRT combines the advantages of rail transit—exclusive right-of-way to improve punctuality and frequency—with the advantages of a bus system—low implementation costs and flexibility to serve lower density areas.

**Congestion Pricing** - An overarching term used to describe measures that reduce congestion by charging drivers tolls that vary by time of day or traffic volumes.

**Consumer Surplus** - In economics, the difference between the price a consumer pays for an item and the price she would be willing to pay rather than do without it.

**Cordon Pricing** - Similar to area pricing, where drivers are charged a fee when entering a high-activity area such as a downtown. The difference between a cordon and an area are that motorists are charged a fee when they cross the boundary line into the activity center. Motorists are charged each time they cross the cordon line. Prices could vary by time of day to encourage motorists to enter the cordon zone during nonpeak periods or to make peak-period trips using transit.

**Cost/Benefit Analysis (CBA)** - An analytical technique used in determining the economic value of a project or plan. Costs and benefits are typically denominated in dollars and include the money, time, resources, and consequences associated with a project or activity.

**Distance-Based Tolls** - Fixed toll rates based on distance traveled and vehicle type.

**Diversion** - The result of people making different travel choices; in this case, as a result of a toll. Diversion can refer to taking different routes or changing modes, travel time, or destination.

**Dynamic Congestion Pricing** - Tolls that change based on real-time travel conditions. For example, when traffic volumes go up, so do the tolls. Rates are lowered as demand eases.

**Elasticity** - The price elasticity of demand measures the nature and degree of the relationship between changes in quantity demanded of a good and changes in its price. High

elasticity implies high sensitivity to changes in price while low elasticity, often referred to as inelasticity, means low sensitivity to price changes.

**Electronic Toll Collection (ETC)** - Using technology to collect tolls from drivers without requiring them to stop and make cash payments.

**Equity** - The idea that all travelers are of equal standing, and should be considered in the development of toll policy. Social, geographic, and income equity are examples of equity issues that arise in toll policy development and implementation.

**Express Toll Lanes** - Limited access, normally barrier-separated highway lanes requiring drivers of all vehicles to pay toll in order to use the facility. All tolls are collected electronically.

**Fixed Tolls** - Toll rates that do not change. They are typically used to pay for the bridge or road on which they are charged. Trucks pay more than cars.

**Fixed-Schedule Congestion Pricing** - Tolls charged at predetermined rates reflective of demand levels at different times of day; rates can be based on hour of the day, day of the week, direction of travel, and vehicle type.

**Greenhouse Gas Emissions** - Greenhouse gases refer to a set of gases that trap heat within the atmosphere. These include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and fluorinated gases. The burning of fossil fuels such as oil, gasoline, coal, and natural gas to power cars, factories, and utilities is adding the amount of greenhouse gases in the atmosphere and resulting in an increase in global average temperature and other changes in weather conditions.

**High-Occupancy Vehicle (HOV)** - A vehicle containing more than one person.

**High-Occupancy Vehicle (HOV) Lane** - A travel lane restricted to transit and carpool vehicles meeting occupancy requirements of two or three people per car. HOV lanes are meant to carry more people in less space than general purpose lanes.

**High-Occupancy Toll (HOT) Lanes** - Travel lanes restricted to either qualifying HOVs or solo drivers willing to pay a toll. The toll typically varies by time of day or traffic levels and are collected electronically.

**Managed Toll Lanes** - Any toll lane that uses variably priced tolls to maintain superior, less congested travel conditions.

**Marginal Social Cost** - The total cost to society as a whole for producing one further unit, or taking one further action, in an economy. This total cost of producing one extra unit of something is not simply the direct cost borne by the producer, but also must include the costs to the external environment and other stakeholders.

**Mileage-Based Fee or Mileage Tax** - A fee or tax charged on a per-mile basis.

**Nonrecurrent Delay** – A type of travel delay that occurs because of incidents and is, therefore, not as predictable as recurrent delay caused by traffic exceeding capacity, bottlenecks, other infrastructure problems.

**Open Road Tolling** – Use of electronic toll collection methods to keep traffic moving, as opposed to making people stop at tollbooths to pay the toll.

**Opportunity Cost** – In economics, the value of the next-highest-valued alternative use of a given resource.

**Peak Period** – The busiest travel times of the day, also known as commute time or rush hour. There are typical two peak periods each weekday – the morning and afternoon commute times.

**Pricing** – A concept of tolling where the level of toll (price) is used to change travel behavior.

**Public Good** – In economics, a good that is nonrival and nonexcludable. This means consumption of the good by one individual does not reduce the amount of the good available for consumption by others and no one can be effectively excluded. A noncongested public highway can be considered a public good.

**Recurrent Delay** – A type of highway delay that occurs regularly due to too much traffic and/or geometric constraints.

**Single-Occupancy Vehicle (SOV)** – A vehicle containing only one occupant.

**Systemwide Tolling** – Implementing tolls on highways and major arterials to reduce congestion, minimize route diversion, and increase transportation revenues.

**Theory of the Second Best** – In economics, a theory of what happens when one or more optimality conditions are not satisfied in an economic model. It implies the need to study the details of a situation prior to assuming theory-based conclusions because improvements in market performance in one area may not mean an overall improvement. This is significant in congestion pricing schemes where theoretically optimal conditions are likely to be unachievable.

**Time-of-Day Pricing** – A tolling approach that varies by the time of day in order reduce congestion at peak hours; rates are higher at peak hours than at off-peak.

**Tolling** – Charging a price to use a road, bridge, or tunnel.

**Travel Demand Management** – Travel demand management involves the application of techniques that affect when, how, where, and how much we travel. While these are typically individual decisions, travel demand management here refers to a purposeful activity undertaken by government or other organizations. The techniques include education, policies, regulations, or other combinations of incentives and disincentives.

**Truck-Only Toll (TOT) Lanes** - Limited access, normally barrier-separated toll lanes available only to trucks for a variably priced toll. All tolls are collected electronically.

**Value of Time** - One of the most important benefits of road pricing, as well as other transportation projects, is travel-time savings. What these savings are worth to motorists can vary by income, gender, age, trip purpose, mode used, length of trip, uncertainty of travel time, and other factors. This, in turn, implies analytical difficulties in applying values to given situations.

**Value Pricing** - Toll rates that vary in direct proportion to travel demand or congestion on alternative free routes.

**Variable Toll** - A toll that changes by time of day, traffic volumes, or other factor.

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# Appendix B

*Bibliography*



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