Framework and Process for Economic Impact Assessment of Potential Highway Congestion Pricing and Tolling Schemes

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ABSTRACT

As interest grows in road pricing and tolling schemes, so too does concern about the broader benefits, costs and consequences for non-users -- including implications for neighborhoods, households and businesses. Since congestion pricing is a policy rather than a project, it is not automatically subject to the same level of benefit/cost review or impact review required of major road and transit infrastructure investments. However, experience to date with congestion pricing clearly shows that social and political acceptability are significant concerns that center on the equity and magnitude of expected impacts on travelers and non-travelers. Recognizing the need for more formal identification of benefits, costs and impacts, Oregon DOT developed and adopted an approach to explicitly assess potential impacts and benefits, with a screening process to identify the economic impact of proposed highway tolling schemes on users as well as non-users. These analytic procedures build on a series of research studies and represent a useful model for broader assessment of tolling and other transport pricing policies elsewhere. This paper describes the economic screening and assessment processes, their analytic foundation, procedures for use and broader potential applicability.

1. INTRODUCTION

Objective. The term "congestion pricing" generally refers to the imposition of a charge for travel in a congested road segment or area. While there are substantial implementation distinctions between the concept of area-wide road pricing and the tolling of individual roads or facilities, the two concepts are often considered together by public sector decision-makers and community residents for the fundamental reason that both involve the introduction of some form of user charge, which in turn raise questions about their impacts on the cost of living (or cost of doing business), equity and the potential for traffic pattern changes to avoid paying these charges.

From the perspective of economic analysis to assess proposed congestion pricing and tolling options, several important issues need to be recognized and considered. Both area-wide pricing and localized tolling can reduce traffic congestion and promote more efficient use of the available road capacity, by causing some travelers to shift to a different time of day, route or mode, or by shifting trip generation rates or destination patterns (one form of travel demand management). Imposition of tolling also has the potential to raise revenues to cover ongoing costs, or help finance new transportation investments. And both can potentially lead to unanticipated and sometimes undesired local consequences that disproportionately affect some neighborhoods, socioeconomic groups or sectors of the economy.

Since congestion pricing and toll schemes are *policies* rather than built *projects*, their benefits, cost and impacts are not necessarily reviewed in the same way as major road and transit investments. Yet the potential for unintended consequences is no less real. To address this need, Oregon DOT developed benefit/cost guidance specific to tolling issues, and it adopted a screening process to assess the impact of proposed highway tolling schemes on non-users – including neighborhoods, households and businesses – to ensure that any adopted schemes are reasonably equitable and acceptable to affected communities. This paper describes the elements of this screening process, the analytic framework and procedures for use.

Program Background. The Oregon case is instructive because it illustrates the range of issues public agencies face when required to turn vague concepts of congestion pricing and congestion tolls into real actions. In response to expanded authority granted to it by the legislature, the Oregon Department of Transportation (ODOT) in 2007 initiated a policy-making process on tolling and congestion pricing. This spanned both road user pricing options and localized tolling of individual facilities. Largely a rural state, Oregon's use of tolling has been limited to a few Columbia River Bridges.

As the state legislature authorized a congestion pricing pilot experiment for the Portland area, and interest also grew in broader statewide road user pricing options, ODOT decided to develop a formal process for reviewing proposed pricing schemes, comparing them with the *status quo* and identifying those that are potential candidates for implementation. The process was developed to more clearly define proposals for alternative tolling schemes, screen them to assess the nature of their local impacts, reject those with undesired or unacceptable local consequences, and then conduct more detailed assessment of their total cost and regional-level impacts. Based on information generated in that assessment process, recommendations can then be made for implementation. That pricing screening and assessment process is the subject of this

paper. The need for such a process comes from the recent history of policy issues and challenges facing congestion pricing and tolling in Oregon, though similar concerns have also arisen in other states confronted with the practicalities of implementing tolling schemes.

Policy Issues and Challenges. In Oregon, several prior studies were undertaken in the last decade to identify potential pricing or tolling options that could be implemented to address congestion (Road User Task Force, 2003) and to assess the economic costs of congestion (Economic Development Research Group, 2005), but there was no agreement on actions for moving forward. A more comprehensive study of congestion pricing conducted in the late 1990's by Portland's MPO faced strong public opposition such that it only could recommend considering pricing as a demand management alternative to new freeway capacity (Metro, 2000).

In attempting to develop a comprehensive set of state pricing/tolling policies, ODOT responded to a number of significant challenges, reflective of a general lack of prior experience with congestion tolling. They were:

- *Range of Goals.* It became clear that in Oregon, as elsewhere around the US, lacked a consensus about the goals of congestion pricing, with various proponents suggesting differing objectives including highway system performance management, revenue generation, modal diversion, urban growth management or environment enhancement. It also became clear that there was not a full appreciation of the potential for conflicts among goals. ODOT developed a conceptual framework for considering the varied objectives of tolling (Cambridge Systematics, 2007), but the range of possible policy objectives is still under discussion.

- *Range of Pricing Schemes.* In considering options for the congestion pricing pilot, it became clear that a wide number of possible pricing schemes remain possibilities, ranging from localized spot applications to individual roads or bridges to more systematic freeway pricing schemes. (Parsons Brinckerhoff and David Evans, 2009). As a result, ODOT determined that there was a need to develop analytical procedures capable of comparing and assessing alternative proposals spanning this wide range of possible pricing schemes.

- *Analytic Challenges.* To assess the potential success and consequences of alternative pricing schemes, it became important to develop methods capable of evaluating both: (a) direct impacts on behavior by directly affected travelers, and (b) broader impacts on non-users, including potential adverse impacts on neighborhoods, vulnerable population groups and the economy. In response, ODOT is contributing to a major upgrade to Metro's travel demand model to insure more accurate predictions of travel behavior under tolled conditions. ODOT commissioned a series of issue papers, including a discussion of likely economic effects of pricing (Cambridge Systematics and CH2MHill, 2009A) and a technique for economic comparison of alternatives (Economic Development Research Group and Parametrix, 2009).

- *Likelihood of Success.* European experience suggests that the approach used in developing any comprehensive pricing scheme is itself of considerable importance in affecting the likelihood of success. This finding was underscored by both a US DOT

report outlining international experience in implementing congestion pricing schemes (K.T. Analytic, 2008) and a European Review of road user charges (Curacao, 2009). Both reviews highlighted the need to understand the full range of potential effects of a pricing scheme (positive and negative) as thoroughly as possible and to insure active, on-going participation by relevant political decision makers who may have to adjust the proposal according to the resultant "winners and losers" calculus. Based on those findings, ODOT commissioned a paper identifying applicable approaches for refining and implementing congestion pricing schemes (Cambridge Systematics and CH2MHill, 2009B).

Guidance Documents. These policy issues – revolving around identification of the full range of positive and negative impacts – were the motivation for ODOT to develop two methodologies for analyzing the economic effects of tolling and pricing proposals: one for screening individual tolling proposals and another for broader, more systematic assessment of benefits and costs (Economic Development Research Group, 2010A and 2010B). The tools were constructed in a manner that "walks" local decision makers and the public through a series of analysis steps, so that impact issues can be identified and pursued further. The "hands on" educational component of these methodologies is considered critical to their success, given the currently limited local and state experience with tolling and broader congestion pricing schemes. The approach taken here also reflects the Oregon Transportation Commission's conclusion that any significant increase in the use of tolling or congestion pricing would constitute a major policy change for Oregonians, warranting a clear understanding of how the public is affected before taking action.

2. LITERATURE REVIEW – PAST RESEARCH

Forms of Impact. Traditionally, research and analysis concerning the economic effectiveness of congestion pricing and tolling has focused on estimation and measurement of congestion reduction and revenue generation. Both outcomes are driven by basic *user response and consequential impacts*, defined in terms of effects on travel fees/costs, travel times and travel route/mode patterns. They can be directly related to key measures of performance and activity -- the level of the toll, baseline traffic volumes and flow, travel time savings, the composition of users (mix of vehicles and trip purposes) and available route or mode alternatives. In addition, *environmental impacts* (reduction in emissions) can be directly estimated on the basis of changes in traffic (vehicle-miles of travel) and flow (changes in speeds and reduction in starts/stops).

However, there is a more limited literature of research on congestion pricing and tolling *equity impacts* (among various population segments and business sectors) and *spatial externality impacts* (among various neighborhoods and business districts affected by diversion of traffic patterns). Yet local public acceptability of tolling schemes can be directly affected by these two categories of economic impact, which are reviewed here.

Equity Impacts on Population Groups. Concern over the equity impacts of congestion pricing and tolling schemes, and their impacts on low income traveler groups, has received significant attention over the past twenty years (Cohen, 1987; Giuliano, 1994; Langmyhr, 1997; Bonsall and Kelley, 2005; US DOT, 2008). However, research on the distributional equity of

wider impacts for surrounding area populations has been more recent. A notable review of the environmental justice (EJ) implications of highway tolling was conducted by Prozzi et al (2007). That study developed a methodology to distinguish the potentially differing impacts of constructing new toll roads, converting existing non-toll roads to tolls, and tolling capacity enhancements to existing facilities (e.g., new express or access lanes). The study recommended a "toll road impact matrix" to track additional distributional impacts (beyond direct user effects). The matrix covers: (1) *Mobility impacts* (affecting population access to work, education, health care and shopping), (2) *Environment impacts* (incidence of noise and air pollution effects of traffic diversion), and (3) *Economic development impacts* (from shifts in business access to customers and deliveries, affecting commercial and residential location demand as represented by property values).

The concept of "winners and losers" is reflected by various researchers, with focuses ranging from commuters (Cohen, 1987) to broader environmental externalities (Levinson, 2002). There is also a line of research on the public acceptability of tolling and road pricing schemes, which finds that public acceptability (and hence also politically acceptability) is driven in part by consideration of the incidence and allocation of fees and revenues, and specifically fears that some households or businesses may be disproportionately disadvantaged (Schade and Schlag, 2003; Jaensirisak et al, 2005).

Spatial Externality Impacts on Business and the Economy. The research literature also examines public and political concern about impacts of congestion pricing and tolling on businesses. The logical reason for concern is straightforward – whenever it becomes more expensive to travel to one destination than to another, there is the prospect that some people will shift the route or destination of their shopping or recreation trips and hence shift where they spend money.

A range of potential impacts of toll roads were identified by Clower and Weinstein (2006), who discussed ways toll facility design could affect land development patterns. They noted that the toll roads have more limited ingress and egress points than non-tolled highways, so adjacent businesses may experience impacts similar to those of raised medians, managed lanes, limited access lanes, and other features that change access. These are in addition to impacts that could occur from diversion of some traffic seeking to avoid paying tolls. Schmocker et al (2006) also showed that congestion pricing can affect the frequency of shopping trips to affected areas. While not addressed in either of these studies, there is also a potential for sustained traffic pattern shifts to affect long-term business location patterns.

In practice, the effect of road pricing and tolls on business patterns is difficult to measure and isolate. At a micro scale, localized impacts over time can be observed in the vicinity of key entry or exit ramps. Such effects can be forecast by travel demand models, and assessed using economic impact models. However, ex post research on regional scale economic impacts of congestion pricing is limited and to date inconclusive, due to three factors: (1) usually only short-term impacts have been observed, (2) there is a high likelihood that adverse effects of an added toll charge is at least partially offset by reduced congestion, improved access and/or greater availability of modal alternatives in some affected areas, and (3) in recent years there have been simultaneous factors occurring such as economic downturns and consolidations in many retail

and office-based industries. Consistent with this finding, the Curacao *State of the Art Report* asserts, "There is no simple answer to the question: how will road pricing affect the local economy?" It also notes, however, that uncertain economic impacts are frequently cited as one of the main reasons for cities' reluctance to introduce road pricing (Curacao, 2009). In reality, it is naïve to expect simple and consistent impacts from a wide range of different road pricing and tolling schemes being implemented in different areas. A more useful conclusion to be drawn from the literature review is that pricing and tolling schemes can have complex impacts with localized interactions that need to be carefully evaluated in order for effective and acceptable schemes to be adopted.

3. A FORMALIZED STRUCTURAL FRAMEWORK

Overview. To address the wide range of issues and concerns swirling around congestion pricing and tolling schemes, ODOT set forth to develop a guidance document (Economic Development Research Group, 2010B) and process for conducting a systematic economic assessment of proposed congestion pricing or tolling projects (herein referred to as "tolling schemes"). It is designed to cover a very wide range of potential impacts, so that any schemes passing this assessment process stand a chance of being politically and socially accepted, and thus being successfully implemented and operated. A key to achieving that goal is the existence of a formalized framework that includes a detailed enumeration of the ways in which alternative tolling schemes can potentially lead to economic consequences. While the completeness of that enumeration may appear tedious at times, that the comprehensive nature of the screening process is intended to help identify major issues with tolling proposals at an initial stage in their consideration, and to instill public confidence in the resulting assessment process. Indeed, the process was presented to the Oregon Transportation Commission and to stakeholders through an open hearing, and then revised based on comments from those groups.

The process involves two phases: (1) an *initial screening assessment* to identify the potential for undesirable local economic consequences, and (2) a *regional impact assessment* to evaluate regional scale economic consequences – but only for those proposals that pass the initial screening process. The Phase 1 "Initial Screening Assessment" involves four steps:

- Step 1: Lay out an appropriate way to systematically classify proposed tolling schemes;
- Step 2: List what can happen & who would be affected (in terms of transportation change);
- Step 3: Identify potential for localized economic benefits, costs and impacts; and
- Step 4: Identify severity of potential local outcomes.

The four steps together provide a process for consideration of local economic impact factors and consequences, to pinpoint those that are potentially problematic in terms of adverse effects. They allow for "red flags" to be raised if any schemes are likely to lead to unacceptable levels of negative local consequences. The information from this initial screening provides input to a formal review of proposed tolling schemes, and only those that pass the review become candidates for follow-on regional analysis.

The Phase 2 "Regional Impact Assessment" involves three additional steps:

- Step 5: Bifurcation: Distinguish schemes with need for further analysis or refinement;
- Step 6: Refine schemes that need to be modified to reduce adverse local impacts; and

- Step 7: Conduct full regional economic impact analysis.

These last three steps provide a process for refining proposed schemes and then conducting a assessment of their regional benefits and impacts. The results are designed to indicate which schemes can potentially serve to improve the economic health of the region, and which ones are likely to have negative overall impacts on productivity, competitiveness, jobs and income in the region. This represents one form of input to a broader process for selection of congestion pricing schemes to be implemented. The seven steps are described in the text that follows.

STEP 1: CLASSIFY TOLLING PROPOSALS.

To assess the economic consequences of potential tolling options, it is first necessary to establish the fundamental design factors that determine those consequences. They are: (a) the amount and type of toll, and (b) the context in which it is implemented. All other transportation and economic consequences occur as a direct or indirect consequence of those two factors.

To illustrate these interdependencies, consider the simple case of a new bridge toll. If the toll raises vehicle travel costs for a major commuting corridor, then travelers may shift to other bridges or else shift to other modes, depending on the options available to them. If some travelers move to use another bridge, then the transportation consequences may include a shift of congestion to that other location. And if increased congestion on that other bridge and its access routes causes increased delays in freight deliveries to a major just-in-time manufacturer, then the economic consequence may be an adverse effect on business costs and economic competitiveness.

Of course, it is also possible the toll may not shift travelers to other routes, but cause some travelers to shift their time-of-day work and travel patterns, thus leading to more efficient use of the transportation facilities with reduced congestion for all. The economic consequences of more reliable and timely employee arrivals at work may include additional job growth in the affected business centers. At this juncture, all we can know for sure is that both positive and negative consequences are possible, depending on the specific type of tolling and the local context in which it is to be applied.

The step 1 classification of tolling options starts with a worksheet process that can display explicit assumptions about the types of tolling that are being proposed. All potential tolling proposals are rated in terms of three key components:

- ***Spatial Aspect*** – Is the tolling applied to (a) a *single point* such as a bridge, (b) a *highway corridor* of a given length, (c) a *local system* such as a highway corridor along with its access and feeder links that serve a popular destination, or (d) an *area* defined by a perimeter that includes multiple roads, such as an office or commercial district. The importance of this factor is that it plays a major role in determining the extent to which a toll is likely to cause traffic to be shifted to other transportation facilities and routes. These four options represent a range of increasingly broad-based tolling. In general, the broader the area or set of road facilities being covered, the harder it is for travelers to circumvent the toll collection.

- ***Pricing Aspect*** – How will the toll levels differ by (a) *class of vehicle* – e.g., weight and type, (b) *class of highway service* – e.g., express or local lanes, (c) *time of day* – e.g., fixed pricing, time-of-day preset pricing, or continuously variable "real time" pricing and other/or other factors (e.g., Vehicle- miles traveled (VMT)-based charges) ? The importance of this factor is that it plays a major role in determining the distribution of toll cost burden among various user segments or groups, as well as the distribution of benefits among these same groups.

  Variation in who pays and who benefits from tolls is inevitable. For instance, congestion fees that encourage car drivers to switch to other times or travel modes may help reduce high costs of delay for time sensitive cargo movements. Since freight movements generally cannot make use of transit options and some are sensitive to schedule constraints, it could be appropriate in some cases for car tolls to be used to help free up more highway space for truck freight movements. On the other hand, the most egregious disparities, in which one population group is fully subsidizing another group, are generally not popular with the general public. This framework makes it possible for tradeoffs in pricing schemes and benefit impacts to be explicitly considered.

- ***Implementation Aspect*** – How will the tolls be implemented, in terms of technologies such as: (a) *transponder* – e.g., with overhead sensors that allows for full speed movement and automated money transfers, (b) *optical readers* – e.g., systems with license plate readers and mailed-out billings, (c) *automated lane machines* – e.g., with exact change, user pass or credit card options, and/or (d) *toll booths* – e.g., manned facility to provide change to travelers? The importance of this factor is that the toll collection technology directly affects travel speed and delay characteristics as well as potential use of the toll facilities. In general, the higher technology solutions allow for less disruption in travel speeds and less need for lane changing, but they can discourage some users who operate on a cash only basis without credit card or pre-pay accounts.

For each of the tolling options, the local context is also identified in terms that will help enable prediction of resulting traffic changes and economic consequences. The local context has two major elements:

- ***Affected Routes*** – A proposed tolling scheme may be applied to one or more facility, route or system of roads. Depending on details of the tolling scheme, some portion of traffic may be given incentive to bypass or minimize the toll impact by switching to an alternative route, mode or time of day or even trip destination. It is also possible some trips may be avoided. A key part of the screening process is to identify explicitly affected transportation routes and services, including: (1) tolled routes, (2) the feeder network of non-tolled roads leading to and from the toll route, (3) alternative routes that allow vehicles to bypass or minimize tolls paid and (4) alternative modes allow travelers to bypass or minimize tolls.

- ***Affected Constituencies*** – Tolling impacts on both tolled and non-tolled facilities will affect various user groups or constituencies. These constituencies are defined in terms of the mix of (1) vehicle types, (2) trip purposes and (3) origin/destination pattern of vehicles using the affected routes. Depending on details of the tolling scheme and where it is implemented, various classes of vehicles or person trips may be disproportionately affected because of

differences in their time sensitivity, ability to shift routes, ability to shift modes or the toll charges assigned to them. This information can be useful to identify cases where a tolling scheme is proposed for corridors that have particularly high portions of commuting, truck delivery or multimodal terminal-oriented traffic.

STEP 2: DETERMINE TRANSPORTATION IMPACTS

Whereas the first step classifies tolling proposals, the second step uses that information to identify *what can happen* (in terms of traffic changes) and *who would be affected* (in terms of key user groups and affected activities). This screening of transportation impacts is accomplished through three elements:

- ***Traffic Patterns and Locations*** – In most cases, the applicable regional agency has some form of travel demand modeling system (including a road network model) that can be used to make initial forecasts of the expected impact of alternative tolling schemes on traffic patterns. The nature of traffic diversion is expected to be driven in large part by the form, level and location of proposed tolls, as well as the context of local transportation choices – all of which were identified in Step 1. The traffic impact forecast of imposing tolls can be shown in terms of four forms of traffic change: (a) changes in volume and speed for traffic that stays on the now-tolled facility, (b) traffic shifts to alternative routes, (c) traffic shifts to alternative modes, and (d) traffic that goes away (trips cancelled).

- ***User Market Segments*** – Once the traffic effect of a proposed toll scenario has been subject to the screening process, it will be possible to identify potential impacts on specific user groups. This is accomplished by obtaining transportation model results distinguishing impacts on four major market segments of road users: (a) commuting trips, affecting workplace and household job access, (b) product and service delivery trips using trucks and vans, largely affecting businesses in industrial centers, (c) shopping and recreation trips affecting access to retail centers and parks, and (d) travel to and from intermodal terminals including airport, marine port and intermodal rail terminals. Of course, all roads and bridges essentially serve a mix of multiple trip types, so there is only interest in identifying the subset of cases where the corridor or location is particularly critical for a particular use.

- ***Distributional Aspect*** – Once the potential impact on key user market segments has been subject to the screening process, it will be also possible to identify the potential distributional shift impacts on locations of economic activity in the region. This will be necessary only for those tolling scenarios in which significant impacts on particular market segments (as identified in the previous discussion) are expected. This is accomplished by identifying four major classes of distributional impacts that may potentially result from the from imposition of tolling: (a) shifts in the attractiveness of various labor/job markets, affecting places to live and work, (b) shifts in business among traffic dependent business on routes that stand to gain or lose pass-by traffic, (c) shifts in attractiveness and potential competitive position of intermodal services (airport, marine and intermodal railroad terminals) that stand to gain or lose customers if access speed is improved or degraded, and (d) recreation activities that stand to gain or lose customers if access speed is improved or degraded. The intent is to highlight those proposals in which there are notable impacts on one or more market segment.

STEP 3: LOCAL ECONOMIC IMPACT ASSESSMENT

The economic impacts that are examined in this third step are defined as direct effects on local business revenues, local business costs and local household expenses. While local impacts also lead to wider (indirect and induced) economic effects at a regional level, this step focuses only on direct localized impacts. The basic logic is that expected economic impacts of imposing tolls are determined largely by (a) size of the toll charges, (b) location and context in which these charges are applied, (c) expected changes in traffic conditions and (d) profile of affected users. This screening of economic impacts is accomplished by considering four types of impact, any of which may be either positive or negative:

- ***Direct Impact on Local Travelers.*** For any route where tolling is proposed, travelers now using that route will experience some time or cost change. The traveler response to tolling will be some combination of: (a) continuing to use the tolled facility, (b) switching to alternatives (other modes, routes or times of day), or (c) eliminating trips. The availability of alternative travel options, and likelihood there may be significant conversion to them, were previously assessed as part of the Step 2 traffic impact modeling process. The potential for positive or negative transportation impacts was also identified in that step. Based on those findings, the likely range of VMT, Vehicle- hours traveled (VHT) and congestion (Volume/Capacity) impacts can now be converted to dollar terms representing the value of direct economic impact on travelers. This can be done by applying factors representing average toll cost and time delay values, as well as applicable accident rates and reliability impacts. One important use of this calculation is to highlight options that appear to impose a toll price or delay at toll collection points that may offset savings from congestion reduction.

- ***Direct Impact on Route Reliant Businesses.*** Once the magnitude of traveler cost impact is estimated, it can be assigned to (or split among) one or more of the travel market segments previously identified in Step 2: commuting, truck delivery, shopping, recreation, and port/terminal connections. The assignment can be made on the basis of route-specific factors, e.g., vehicle mix and locations served. (Examples are truck deliveries to/from industrial parks, commuting to downtown or major office centers, truck freight connections to key terminals, car access for specific neighborhoods or pass-through freight movements.) The allocation of impacts by market sector can then be simplified by translating it into effects on major business destinations, such as that shown in the table below.

Market Sector Impact:		*Translation to Business Result at Destinations:*
Time/cost for shopping trips	→	Retail center destinations: revenue
Traffic pattern for pass-by trips	→	Traffic-dependent Retail: revenue
Time/cost for commuting trips	→	Office center destinations: effective wage rate
Time/cost for truck trips	→	Industrial center destinations: cost competitiveness
Time/cost for neighborhoods	→	Residential neighborhoods: property values
Time/cost for terminal access	→	Intermodal trips: cost competitiveness

At this point in the screening process, only rough estimates are needed since the intention is to distinguish tolling scenarios that may have major (positive or negative) consequences for

particular types of business. For each affected business sector, it also should be possible to identify the location of industrial parks, office centers, residential neighborhoods or intermodal facilities that would be most affected.

- ***Direct Impact on Broader Market Access and Connectivity.*** Once the direct business impacts have been identified, it will be possible to identify other localized economic impacts related to access and connectivity. This will be necessary only for those tolling scenarios in which there are expected to be significant direct impacts on business. Since this is still part of a screening process, there is no need to actually acquire or apply any regional economic model. Instead, the recommended procedure is to note the proposed tolling scenarios affecting route(s) with a disproportionately high portion of trips associated with: (a) truck trips to/from major industrial parks (including high tech clusters), (b) Truck trips to/from intermodal rail or marine port facilities, (c) Car or truck trips to/from the international airport and (d) Car or truck trips to/from major office centers (downtown or office parks). In this way, tolling scenarios with potentially high access or connectivity impact can be noted.

- ***Unintended Consequences on Spatial Patterns of Economic Impact.*** The preceding elements of Step 3 have assessing the overall magnitude of economic impacts on travelers market segments, and translated them into sectors of the regional economy and types of business. However, those are aggregate impacts. There is also a need to identify unintended consequences on specific locations that are affected by a toll scheme. For instance, it is possible that tolling may relieve congestion along a busy travel corridor and achieve significant regional benefit, but at the same time make it expensive for residents of a low income area to get into and out of their own neighborhood. More generally, we identify four key types of unintended consequences:
  – *Unintended Cost Burden for Vulnerable Group* – increase in living cost for low income and vulnerable populations that cannot easily avoid the toll;
  – *Unintended Dispersal of Economic Activities* – pressure to disperse homes and businesses away from affected areas;
  – *Unintended Shift in Mix of Economic Activities* – pressure to discourage shipping/ warehousing or other economic activities that generate or rely on traffic;
  – *Unintended Land Use Changes* – a consequence of the prior two factors, reducing density of development and concentrations of economic activity, or encouraging new development to move out to the periphery of the region.

To identify such situations, the analysis must consider both (a) cases where a proposed tolling scheme may provide little or no alternative for accessing certain residential or business locations, and (b) cases where the tolling scheme will divert traffic to new areas.

STEP 4: SCREENING PROCESS FINDINGS -- RED FLAGS

This step establishes indicators of the acceptability of proposed tolling schemes on the basis of four dimensions of economic impact, by calling attention to “red flag” problems:

- ***Red Flag #1: Tolling proposals that trigger negative direct impacts***. Step 3 provides an estimate, for each tolling scheme, of the potential magnitude of direct economic gain or loss

for businesses and households. They provide a means for distinguishing those proposals that can trigger significant negative impacts due to either: (a) a level of toll that triggers significant and undesirable spillover congestion on non-tolled routes, or (b) new bottlenecks associated with the toll collection method itself. Both forms of impact can be inadvertently triggered when retrofitting a tolling mechanism on existing routes. It is also important to note that this assessment is based on economic impacts, rather than on congestion reduction for affected routes. The distinction is important, for setting what is the optimal toll for reducing congestion on key routes can (in some cases) lead to unacceptable increases in economic costs associated with either traffic diversion or implementation of tolling processes.

- ***Red Flag#2: Tolling proposals that generate a mismatch between who pays and who benefits - which may occur among different sectors of the economy.*** Steps 2-3 provide an estimate of the potential distribution of impacts on various classes of vehicle (car, truck), classes of users (household, business) and sectors of the economy (industrial, office, retail, intermodal supply chain movements). They also distinguish tolling proposals that can positively or negatively affect activities with greater than normal consequences for growth of regional economy (because they affect "traded" industries that bring income flowing into the region). So while every tolling proposal will have some distributional consequences, depending on the specific corridors being affected and their mix of traffic, it is not necessarily a problem. It only rises to become a problem if there is severe and unacceptable inequity between "who pays" and "who benefits."

- **Red Flag #3:** ***Tolling proposals that have undesired equity impacts on low income travelers*** due to toll rates and collection methods. While the preceding discussion considered access and property value impacts on low income *neighborhoods*, there can be a different form of equity impact on low income *travelers* now using routes in which tolling is proposed. This problem can have two elements: (a) lower income travelers, many of whom can ill afford new tolls, may tend to seek alternative routes and modes at a greater rate than other travelers; and (b) lower income travelers who stay on tolled routes may have lower rates of adopting toll collection scanning methods because they commonly require credit or pre-payment accounts. As a result, they may be more likely to have to endure longer waits at manual payment lanes if available. Other distributional equity effects are also possible, particularly if the tolling plan is also expected to affect availability of public transit or other mobility options.

- ***Red Flag #4: Tolling proposals that generate undesired land use impacts*** such as reduced property values or incentives for greater dispersal of development (including development across the urban growth boundary). Step 3 identified specific business centers or residential areas that are likely to be particularly affected by the tolling because of limited options to avoid the tolls. Depending on the nature of those affected areas, such an impact may be judged good or bad. For instance, forcing pass-through traffic and daily commuters to pay a toll may be deemed appropriate, but it may be undesirable if this also leads to: (a) disproportionate cost impact on low income neighborhoods, (b) unintended reduction in property values for some neighborhoods, (c) incentive for some employment activities to leave the city, (d) diversion of traffic onto local streets or (e) shifts in development and

investment from higher density mixed use areas to lower density outlying areas. Long term land use effects may require analysis by more sophisticated economic land use modeling.

Since there is not always a natural definition for what constitutes an unacceptable level of impact or incentive shift, it may be more appropriate to rank proposed tolling schemes by the degree of impact that they represent. This can be done by rating the extent to which the affected groups are "captive" to (i.e., lack other options to avoid) that potential problem. Situations where this issue can potentially be problematic, therefore, can be identified.

STEP 5: BIFURCATION: NEED FOR REFINEMENT

This step draws on the findings of prior steps to bifurcate proposed tolling schemes into two groups – (1) those that need to be modified (to mitigate critical local problems) before they can be considered further, and (2) those that can now be fully assessed in terms of their regional economic impacts and overall benefits. For each tolling proposal, two issues are addressed:

- ***Classify Severity of "Red Flag" Issues.*** Step 4 highlighted those projects that have significant distributional inequities – i.e., disproportionately hurt some local neighborhood, some portion of local travelers or some sector of local business in a way that is likely to raise significant objections or controversy. The next step is to use that information to decide whether any such problems represents: (1) a "fatal flaw" that effectively eliminates the tolling option (as currently defined) from further consideration, (2) an issue that warrants some form of special analysis in order to insure it is properly understood by the public and decision makers, (3) a "fixable problem" that may be reduced or eliminated with further modification in specification of how the tolling option would work, or (4) a "minor matter" that might be addressed in implementation planning, or else ignored as it will not by itself eliminate the tolling option from further consideration.

  The split of tolling proposals is to be made by considering four factors: (a) Level of adverse impact (*Is the adverse impact large enough to represent a significant hardship in terms of time, cost, access or lost income) for the affected parties?*), (b) Scale of affected groups (*Do the adversely affected parties constitute a large share of travelers or nearby residents?*), (c) Vulnerability (*Are the adversely affected parties comprised disproportionately of low income, minority or other vulnerable parties*) and (d) Availability of solutions (*Are there straightforward ways to modify the tolling option, or make offsetting compensation, to eliminate or reduce the adverse impacts?*).

- ***Identify Need for Additional Analysis or Refinement of Tolling Proposals.*** Sometimes a tolling proposal is found to require some form of special analysis. For instance, there could be concern that some particular class of traveler or residential neighborhood or commercial area is potentially vulnerable to disproportionate impact, but that the impact is not proven due to limitations in the spatial and/or time-of-day detail inherent in the transportation network model that was used, or some other aspect of the initial screening process. In that case, it could be appropriate to conduct a more detailed traffic analysis of alternative routes and times of day in which traffic diversion is likely to be most severe. If a tolling proposal is deemed to have adverse effects, then a further effort may be needed to identify exactly (1) what part of

the proposal causes the problem and (2) what kind of planning or implementation action may be available to mitigate it. In some cases, problems may be related to design factors that can be modified such as payment collection mechanisms, physical structures, entry/exit routes, and/or alternative bypass routes.

STEP 6: REFINING SCHEMES WITH LOCAL ISSUES

For each tolling scheme deemed to have local adverse impacts, there is an option for review and refinement. The review process must first consider and substantiate the extent to which certain tolling schemes are flawed by serious adverse impacts. This involves effort to establish the extent to which adverse impacts are indeed a valid concern, and identify options available to alleviate or mitigate the adverse impacts through redesign of the tolling scheme or addition of compensation schemes to offset expected adverse impacts. The redesign can encompass: (1) toll levels, (2) toll collection implementation schemes and options; (3) toll locations, (4) likely traffic route diversion impacts and (5) other actions to mitigate adverse impacts (which might include compensation for affected groups, special pricing for residents of specific neighborhoods, or additional changes in traffic regulation or access routes).

STEP 7: REGIONAL ECONOMIC ANALYSIS

Tolling schemes that pass the screening and refinement process can then be subject to a complete analysis of their potential regional economic impacts and benefits. This can include both short-term and long-term impacts on the health of the regional economy, as well as overall efficiency and productivity benefits for the region. Economic impact and benefit measures can then be used (together with separate studies of cost, traffic and environmental impacts) to rate alternative tolling schemes and make recommendations for implementation.

To ensure transparency and relevance for public discussion, the regional economic analysis should: (a) correspond to the desired region of study, (b) distinguish direct impacts, productivity and competitiveness impacts, (c) break down impacts by sector of the economy, including households and industries, and (d) present results in terms of both income and job impacts of interest to various stakeholder groups. Transportation-focused economic models, such as TREDIS[1], can be used for benefit-cost assessment and economic impact analysis, if desired.

It is most important that any such economic analysis tool be directly sensitive to relevant congestion pricing factors including:

- Costs of implementing applicable congestion pricing mechanisms
- Traffic impacts including reliability as well as VMT, VHT, cost and safety impacts
- Differences in valuation of benefits depending on the affected vehicle mix, time of day, and trip purpose (distinguishing commuter, local truck delivery and intercity freight movement)
- Access impacts that depend on affected locations and routes, distinguishing impacts on labor markets, truck delivery markets, and connectivity to intermodal terminals.

[1] Transportation Economic Development Impact System, www.tredis.com ; discussed in Weisbrod (2008).

Ultimately, results of the regional economic analysis must tell a story about the ways in which tolling schemes can affect various classes of households and businesses, distinguishing: (1) the effect of toll charges on increasing operating cost for various sectors of the economy, (2) the offsetting effect of congestion reduction and reliability enhancement on reducing operating cost and increasing productivity for some sectors of the economy, and (3) differential net effects on various groups. This information can be used to rank or rate the alternative tolling schemes in terms of their net economic impact and it can be combined with other studies of cost and environmental impacts, to support a final recommendation for implementation of proposed tolling schemes.

4. CONCLUSION

Public decisions concerning the design and implementation of congestion pricing and tolling schemes must be made on the basis of sound economic analysis, but accompanied by more detailed information about the distribution of potential direct and indirect impacts on various parties. The long history of public debate concerning implementation of congestion pricing and tolling schemes, demonstrating broad-based fear and concern about adverse economic and equity impacts, makes it clear that stakeholders need to be well informed in order for public discussion and political decision-making to go forward. The detailed screening and analysis framework adopted by Oregon represents a model approach for addressing many of those concerns.

Of course, each state and region needs to adapt approaches to the context of their transportation conditions, economic conditions and political situations. Thus, both the analytic framework and the seven-step assessment process now being used in Oregon should be viewed as merely an example of a general approach for more informed decision-making. The details of that process also can be useful as a checklist of potential issues that may be usefully addressed through analysis. Ultimately, though, this paper is meant to spur discussion. So if later analysts find more gaps and identify additional issues and analytic approaches not discussed here, that should be recognized as evidence of movement towards improved analytical methods.

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