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Evaluating the Promise and Hazards of Congestion Pricing Proposals: an Access Centered Approach

with special reference to the proposed pilot project at the entrance to Tel Aviv[1]

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Publication No. 2/11

Jerusalem, 2000

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About the Paper

This paper gives decision makers a framework for assessing proposed implementations of congestion pricing, a transport policy increasingly under consideration internationally and in Israel. Using overall urban accessibility as a touchstone, this framework helps evaluate the potentials and hazards of a given implementation, including its impacts on land use and social equity. The paper applies this framework to analyze the High Occupancy Toll (HOT) variant of congestion pricing, and to assess and suggest improvements to the proposed HOT implementation at the southern entrance of Tel Aviv. The paper was presented as an invited lecture to the Israeli Society for Transport Research on July 6, 2000.

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Executive summary

This paper discusses the opportunities and dangers presented by "congestion pricing," a policy increasingly discussed in transport circles, including in Israel. It contrasts two approaches to this measure, and demonstrates that one could cause significant harm to Israel's broad urban planning and transport goals, the other bring significant benefits. A mobility-centered approach treats congestion pricing simply as a measure for relieving congestion for car drivers, and its implementation could further car dependency, encourage sprawl, and worsen social equity. In contrast, an access-centered approach treats congestion pricing as part of a package of measures designed to increase overall access throughout the metropolitan area, and across a broad range of social segments.

The paper provides a detailed discussion of the transport, land-use, and equity implications of these two kinds of implementations in order to give decision-makers a framework for judging particular proposed implementations of congestion pricing. In particular, it discusses the High Occupancy Toll (HOT) variant of congestion pricing being considered in Israel, and the pilot project proposed for the entrance to Tel Aviv. The paper shows why this project is packaged with features that, if implemented, will prevent it from damaging the city's viability and accessibility, and describes several additional measures that would markedly contribute to its access-promoting functions, and thus considerably bolster its claim for broad and enthusiastic public support.

A frequently proposed approach to transportation problems in urban areas is congestion pricing. This policy would impose variable tolls on congested stretches of roadway at a level high enough to reduce the number of automobiles attempting get through the roadway. According to standard economic accounts, charging drivers for the use of infrastructure in congested times would help rationalize travel decisions and reduce the wasteful "queuing" on over-crowded roads.

While this approach has been advocated by analysts of transportation for thirty five years, it encounters significant technical and political barriers (predominantly the reluctance to charge for road use), and there are only a limited number of examples in practice worldwide. Nevertheless, it is clearly on the political horizon in a number of countries and regions, including Israel, where a concrete pilot program has been developed for some of the entrances to Tel Aviv.

Based on its economic rationale, many transportation analysts have viewed congestion pricing as an inherently desirable policy, albeit one that has been politically challenging to implement. In contrast, we argue that **the promise of congestion pricing is conditional; some implementations of congestion pricing can be extremely helpful in promoting broad urban planning and transport goals, but others can actually harm these**.

To explain why this is so, we employ the distinction between mobility and access. We argue that a congestion pricing implementation geared to improving mobility alone will be harmful, while an implementation that is part of a larger

philosophy and package of measures committed to the enhancement of access will be beneficial, and worthy of public support.

Enhancement of *mobility*, defined here as reduction in the time and money cost of travel per kilometer, has traditionally been at the center the transportation profession's attention. However, this attention is misplaced, since very few trips are taken for the pleasure of motion itself but rather to *access* desired destinations. It is true that where the locations of travel origins and destinations are fixed, decreasing the per-kilometer costs of travel (usually achieved through allowing cars to move more freely) increases people's accessibility. The problem is that policies such as extensive road building that can lower the cost of travel per kilometer can, over the longer run, induce land uses to spread farther and farther apart, leading to rapid growth in vehicle kilometers traveled (VKT). Under this scenario, while travel costs per kilometer may have dropped, the time and money costs of travel per destination may actually increase; access has been degraded. A congestion pricing policy to foster *access* and not merely *mobility* must therefore be sensitive to land use impacts, encourage development in areas of already high levels of accessibility, and avoid accelerating low density, decentralized metropolitan development. It should also provide alternatives to car-based mobility, which increases the throughput of people, rather than vehicles, into cities.

This paper offers an access-centered perspective as a more systematic and holistic means for evaluating congestion pricing schemes.

For example, **the use of toll revenues**. While some regard these primarily as a tool to win the political support necessary for congestion pricing measures, their deployment is far more than a public relations move. Because it increases the overall time plus expense of travel for users, congestion pricing leaves the public worse off overall (by definition--this increase is what reduces travel volumes). It is only through the reinvestment of these "harvested" benefits that congestion pricing becomes a public benefit. The form this reinvestment takes is of justified concern. Unless the use of congestion tolls is stipulated from the start, pressures are likely to prevail that would distribute these to (auto)mobility-enhancing measures that would increase mobility while harming accessibility. Drivers would call for the tolls they have paid to be used for their benefit, such as spending for highway improvement. For this reason, unless it is framed as an accessibility-enhancing measure, congestion-pricing could thus become an ongoing mechanism through which the better off segments of society guaranteed and expanded the long-run free flowing mobility of cars, while promoting metropolitan sprawl. In contrast, earmarking these tolls for alternatives to (auto)mobility would simultaneously allocate road space more efficiently while enhancing metropolitan accessibility and livability across a range of societal sectors.

An access-centered approach is also important in understanding the **land-use consequences of congestion pricing**, and countering potential harmful effects. Because congestion pricing increases the time-plus-money costs of travel into congested areas for all but a small portion of the population, it could push firms on the margins of deciding to do so to relocate outside the city center, to avoid this new burden on their clients and workers. Congestion pricing could, in other words,

become sprawl-inducing, undermining the viability of the city center and of alternatives to car travel. An access-centered approach to congestion-pricing, however, would act to ensure that while the overall cost of driving to the city was raised, the cost of access to the city was lowered. It would ensure that congestion-pricing was part of a package that included compensatory measures that increase access to and thus desirability of the tolled areas. This could be done, for example, through improving dedicated busways and rail, by increasing the supply of affordable housing within the tolled areas, and by flex-time and ride-sharing programs. To ensure that congestion pricing is in fact enhancing of accessibility and not merely mobility, toll revenues should be *a priori* earmarked for measures such as these.

This paper also demonstrates how an access-centered implementation of congestion pricing is **more equitable in its distribution of costs and benefits across society**. A mobility-centered approach focuses on freeing roads from congestion through the regulation of tolls; the vehicle becomes the unit of concern, and level of service on roads a key index. Because an access-centered approach centers on a variety of ways to improve people's access to opportunities, it provides a better tool for analyzing and addressing how congestion pricing affects a broad range of people, not just drivers. Our analysis describes five main groups affected by congestion pricing, and compares the effect of two distinct approaches to congestion-pricing on each of these. A mobility-centered approach--focused on congestion relief, with toll revenues going to further highway improvements--would selectively benefit the stronger segments of society (drivers with a high value of time), and harm the weaker ones, especially non-drivers. It increases the gap between the haves and the have-nots. An access-centered approach--which provides a range of public transport and land-use planning measures to replace and augment the people able to visit city centers conveniently without cars—has fewer negative social impacts, while its benefits are distributed more evenly across the lower bulk of the social spectrum. Thus it reduces social polarization.

The kind of congestion pricing proposed for Israel is the HOT (High Occupancy Toll) variety, under which a single lane of a highway would be used by high occupancy vehicles, especially public transport, and by drivers willing to pay the toll; remaining lanes of the facility would be used by general purpose traffic. In essence, HOT lanes are high occupancy lanes in which excess capacity is sold to drivers willing to pay a toll dynamically set at a level that preserves this lane congestion free. Much of this report is devoted to analyzing this form of congestion pricing, and the specific implementation of it proposed for the entrance to Tel Aviv. The paper analyzes these lanes not, as is commonly done, as a political stepping-stone to public acceptance of general congestion pricing, but as a way of enhancing access through (1) increasing the total throughput of people (not vehicles) on highway facilities, and (2) increases the political and financial viability of expanding the network of transit priority lanes into areas in which the volumes of public transport and high occupancy vehicles alone would not justify the dedication of a full lane to HOV use.

By allowing drivers to "buy their way out of congestion," HOT lanes would seem to extend the privilege of the wealthy. But the closer ethical analysis elaborated in the paper suggests that a HOT scheme can be socially just by substantially raising

the condition of the worst-off in society if it improves the situation of transit-dependent (and usually poorer) travelers. And because they are optional, and increase the overall throughput of people into the city, HOT lanes are less likely to have the sprawl-inducing effect that a corridor- or area-wide congestion pricing scheme would.

The access/mobility distinction allows a principled and integrated analysis of congestion pricing, and in particular of the HOT pilot scheme currently under consideration for the entrance to Tel Aviv. The paper describes this pilot project, and shows that it has enough access-enhancing features (such as using an existing lane for HOV use, dedicating its income to transit-enhancement, and including a free shuttle service for "tolled off" drivers and other travelers) so as to not be damaging to Tel Aviv's accessibility. In order to merit public expenditures, however, a project would have to demonstrate that it goes considerably beyond simply not causing damage. The extent to which this project does this can be judged by decision-makers, using the access-centered framework offered. The access-enhancing effects of this scheme—and thus its claim on public support—could be considerably enhanced by a range of improvements to the pilot project, suggested in the paper's concluding section. Some of the measures discussed include:

- framing the project as a step toward an expanded network of HOV lanes;
- making the lane a true HOT lane in which 3 and 4 passenger vehicles can travel for free;
- integrating bus lines to use the lane and the associated park-and-ride lot;
- considering replacing or supplementing the shuttle service with a frequent rail connection from the Kfar Habad station in the immediate vicinity, and/or with vehicles running on clean energy sources rather than diesel;
- expanding the catchment areas of the of the shuttle through improved pedestrian and bike access at the Ayalon stops;
- bundling the congestion-pricing law proposal with other synergistic measures, such as parking cashout and taxation of employee car allowances;
- removing from this law proposal the clause allowing toll revenues to also be used for tax relief for drivers;

Project proponents might argue that "complicating" the project's implementation with these measures would be distracting, and make an already difficult project less likely. We would argue that to expand the accessibility-enhancing capacities of the project is to expand its contribution to the public good, and the breadth and enthusiasm of the coalition that would support it. Politically, this may be worth the extra effort.

Introduction: the (qualified) promise of congestion pricing for Israel

Background

Congestion pricing is moving from theory to practice abroad

Many developed regions and countries are currently examining road pricing and congestion pricing (more recently sometimes termed "value pricing") policies. These consist of charging of fees for entry into or travel within congested areas, with a series of claimed benefits: rationalizing transport costs, easing congestion, raising revenues for other transport ends. The economic-theoretic underpinnings of congestion pricing have been well understood for the better part of a century (Pigou 1920, Vickrey 1963), and the international discussion of congestion-pricing has been especially active in the past decade. The base of working examples for these policies is still narrow, but the number of locales in which some variant of congestion pricing is employed has increased significantly, and we are likely to see more examples of these schemes employed over the coming years.

It is also now being seriously considered in Israel

In Israel, this method has been considered in principle for several years. Discussion has been formalized through the efforts of the inter-ministerial committee established to "examine steps to manage and improve the efficiency of road use" created by a 1997 government decision (#2457). Congestion pricing has assumed a prominent place within the range of measures that might be considered by this committee. The committee's "infrastructure pricing" team has circulated a preliminary call for comments and subsequent intermediate report on the topic.[2] The latter recommended that by the end of 1999 the respective working groups do the following:

1. Draw up a proposal for a law that would allow tolling on Israeli roads based on the Dutch law and an earlier Israeli proposal;

2. Examine the feasibility of a pilot High Occupancy Toll (HOT) lane (a lane-at-a-time approach to congestion pricing, in which single occupancy vehicles are allowed to purchase excess capacity on a high occupancy vehicle lane) at the entrances of one of the metropolitan areas (Tel Aviv, Haifa, Jerusalem);

3. Evaluate additional options for congestion pricing, both HOT and cordon (enclosure of an entire area) schemes, for each of these cities.

A fairly detailed proposal has indeed been developed for a HOT pilot project at the entrance to Tel Aviv[3], and the background legislation that would allow the selling of excess capacity on high occupancy lanes was tabled in the Knesset Economic Committee on January 18, 2000.

Overview of this paper:

Congestion pricing could be a targeted way to improve road conditions, public transport, and urban vitality

Our essay is an intervention in the discussion of congestion pricing for Israel. It attempts to examine the promise and dangers of congestion pricing in a broadly systemic perspective (see Table 1); it stipulates the kinds of conditions and collateral measures necessary for congestion pricing to achieve its promise; it examines the pilot HOT project proposed for the entrance to Tel Aviv, and finds that its current configuration achieves many of these; and it suggests policies for the further development of congestion pricing that continues to advance sustainable transport in Israel.

On the face of it, congestion pricing—the selective pricing of road use—would seem to be a technologically feasible way to rationalize traffic flows economically, thereby reducing some of the worst impacts of private car use in and around cities. It promises to replace the current wasteful method for allocating scarce road space (by queuing) with a more economically and environmentally efficient one; it would bring us closer to having the marginal price of travel more actually reflect its true social costs; and it has the potential to do this in a way that is more focused than universal increases in motoring costs (by increasing the price of gasoline, for example), since it targets the times and locations where congestion and pollution are greatest. When coupled with the measures described later in this report, the benefits of congestion pricing could extend beyond the road system, to boosting public transport and urban vitality. In short, the technique might be a real-world tool for making a big jump toward more efficient and sustainable transport systems.

But congestion-pricing's economic-theoretical appeal is not enough to merit the automatic endorsement of decision-makers. Congestion pricing is a powerful intervention in an extremely complex system. Unless its broader context is examined, it is likely to become a rather crude and isolated tool with unintended consequences that could neutralize or even outweigh the gains we hope for. For this reason, we show in this report how congestion pricing must be considered against the background assumptions accompanying and orienting it, with an eye to its less direct and immediate consequences, to the sources of political acceptability that will transform congestion pricing from a bright idea into a working system, and together with other measures and goals.

However, this promise is conditional

Congestion pricing could be an important tool for improving Israel's transport system. However, the promise of this tool is conditional. Because the structures and tools for ensuring transport integration in Israel are still very weak, it is especially important that this measure not be decontextualized from broader goals for the transport system, that it not be conceived as a means to a narrow end (such as revenue generation, or congestion-reduction exclusively), that it be prioritized among and

bundled with other transport measures, and that its unintended consequences (on land use, on equity) be recognized and mitigated.

Narrowly conceived, congestion pricing could undermine the goals of a sustainable and equitable transport system

A well considered congestion pricing scheme could be an important part of a broader transport strategy. For example, it could accentuate the benefits of a range of positive measures and provide a reliable source of revenue with which to finance them. Haphazard or narrowly conceived implementation of congestion pricing, on the other hand, could be wasteful or harmful. If not part of a package for improving access and environmental quality while preserving or maintaining equity, congestion pricing could trigger significant unwanted consequences. If public transport alternatives are not expanded, and land-use impacts are not considered, area-wide congestion pricing could further undermine Israel's city centers, and add to pressures for out-of-town car-dependent development. If distributional equity is not considered, or revenues are devoted principally to road improvements, rather than to land use and transportation alternatives to solo automobility, congestion pricing would selectively benefit the richest car owners who value their time highly, while harming most other sectors of society, especially poorer car owners. A congestion-pricing scheme whose primary goal is to ease congestion will miss the far more fundamental goal of making Israeli cities more accessible and livable. And in practical terms, a narrowly conceived and poorly packaged scheme would be less able to win the broad support of the various constituencies necessary to ensure its political acceptance.

Against this background, congestion pricing could be ineffective, wasteful, or even harmful if it is not integrated into a general access-driven strategy and package of measures and policies. In contrast, an integrated access-centered congestion pricing policy holds significant promise. This paper highlights why, and points to the linkages necessary for such integration.

Table 1. Some systemic considerations for congestion pricing

Orienting paradigm	What are the underlying goals of congestion-pricing? For example, is it to reduce congestion? to approach the true costs of car use? or to shift the entire transport and land-use system in more sustainable directions? In particular, does it derive from the mobility-based approach to transport planning that was common until a decade ago, or from an access-centered approach that has begun to replace it?
Indirect and long-term consequences	What are the potential subtle, indirect, and long-term consequences of congestion pricing? In particular, how does this measure interact with the economically stratified nature of society, and how does it effect locational

	decision-making of firms and individuals over the long-term?
Political acceptance	What is necessary to bridge the gap between policy recommendation on the one hand, and political acceptance and implementation on the other? What knowledge and incentives need to be provided to the public in order to increase support for measures that may be socially-desirable yet novel and personally inconvenient? How can the interests of other stake-holders, from bus companies to environmentalists to mayors, be linked into a consensus of support for a package that serves them all?
Integration and bundling	How should and can congestion pricing be integrated and bundled with other sustainable transport measures that neutralize its undesirable effects, maximize its benefits, and ensure broad support?

Congestion Pricing Theory

"External" costs are central to understanding congestion pricing

The core notion underpinning congestion pricing is the concept of the "negative externality," i.e. the cost imposed on a party not involved in an economic transaction. A classic case of a negative externality is industrial pollution; a firm produces a particular good for sale to a customer, yet the costs of its pollution are borne by the firm's neighbors, who are not party to the original economic transaction.

Without intervention, markets tend to produce too many negative externalities: because the firm does not bear the cost of the pollution, it lacks the incentive to economize on the pollution costs, as it does with ordinary internal costs of production, such as land, labor and capital. This tendency can be countered by a policy of "internalization" of externalities: a public taxation of the agent causing the externality for the social cost that the externality imposes (Pigou 1920). Under this policy, a firm is likely to begin to treat pollution or other externality costs similarly to other costs of production, and try economize on them efficiently.

On the surface it may be difficult to see the similarities between the externalities of environmental pollution and traffic congestion. After all, there is no single actor involved that is imposing costs on third parties; instead, multiple vehicles seem to be imposing costs of delay on one another.

In addition, one could argue that drivers do respond to the costs of congestion. When a driver decides to take an automobile trip on a particular roadway at a congested time of day, rather than at a time when the traffic flows smoothly, she will take certain additional costs into account. For example, she might think: "this trip will take me ten more minutes at eight o'clock than at ten o'clock in the morning. But it's important enough for me to take the trip first thing in the morning, that I'm willing to bear the additional costs." Thus some congestion costs are internal to each driver, as our hypothetical driver is in fact incorporating the ten minutes of delay into her decision making.

Congestion pricing rationalizes travel decisions by internalizing the external costs of congestion that drivers impose on one another

But congestion does in fact involve a form of negative externality, as each additional driver on the road imposes additional costs on all other drivers by virtue of having entered into a congested transportation facility. Thus, approximately two minutes' delay may be added to the entire system by each additional vehicle kilometer that is added under periods of heavy highway congestion (Decorla-Souza and Kane 1992); since this increment of delay is imposed by our driver on others, it represents a pure case of a negative externality.

One approach to treating this phenomenon is to charge the driver for the two minutes that she imposes on the rest of the system for every kilometer she drives. Had the driver taken this additional cost into account, she may have eliminated or delayed the trip if its value to her was not worth the **total** (internal and congestion fee) costs. On the other hand, if she decided to take the trip nonetheless and bear

the costs, this indicates that the trip was worth at least as much to her as it cost society and should therefore have been taken (as its private benefits outweigh the sum of its personal and societal costs).

How much toll needs to be imposed? Under a congestion tolling policy, the amount of the toll would vary by levels of congestion; during times of day where no congestion was present, no tolls would need to be assigned, since vehicles would not be imposing delays on one another. Estimates for the needed tolls during period of peak congestion vary, but under typical conditions center on a range between 3-5 cents (Levinson and Gillen 1998, Bay Area Economic Forum 1990) to 16-22 cents (Decorla-Souza and Kane 1992, Keeler and Small 1977) per vehicle kilometer depending on assumptions and location. High end estimates under conditions of severe congestion range up to 38 cents per vehicle kilometer (Mohring and Anderson 1998).

Until collected toll revenues are used, congestion pricing leaves most travelers worse off

It is crucial to note that under a congestion pricing policy, most travelers are not immediately better off after the imposition of the tolls than before; rather the economic benefit of the policy can be expressed as the surplus of the toll collected over the value of the losses by the travelers. This surplus then constitutes a reserve from which the system as a whole (and individuals within it) can be made better off than before. Thus for most individuals, the benefits of congestion pricing are contingent on the distribution of the funds collected.

To be sure, there is a generally small group with a very high value of time whose accessibility is immediately enhanced by the opportunity to save time by spending money. But as with other transportation policies, a congestion pricing policy creates "winners" and "losers", that is, has a distributional effect on accessibility between groups. A number of authors have sought to delineate the classes of winners and losers under congestion pricing schemes (Litman 1996a; Gomez-Ibanez 1992; Small 1992). Three groups of principal immediate impact present themselves:

1. Travelers who previously traveled on an untolled facility and remain after it became tolled (the "tolled on");

2. Travelers who previously traveled on an untolled facility and avoid the facility after tolls are imposed (the "tolled off");

3. Travelers who previously traveled on alternative routes to the tolled facility (the "tolled onto"), which now bear the addition of trips made by the “tolled off”-- people from group 2 avoiding the tolled facility.

Group 3 clearly is worse off after the imposition of congestion pricing. Similarly, group 2 is worse off, because its members have now begun to travel on routes that are worse for them than the routes off of which they have been priced. Given this, one might expect that members of group 1 would be immediate beneficiaries from congestion pricing.

Indeed, a subset of individuals within group 1 will indeed value their time highly enough so that they are better off for having the opportunity to pay some money to save time. But as a whole, group 1 is not an immediate beneficiary of congestion pricing. This somewhat counter-intuitive proposition rests on the fact that, by definition, this group's gains from time savings are more than offset by its losses from paying the toll. This is illustrated graphically in standard congestion pricing expositions (e.g., Hau 1992) but can be explained conceptually as well. For congestion pricing to work, it has to be capable of pricing some trips off the road during peak congested times. In order for this to happen, the total price of travel--time plus money--needs to rise. From this we see the impossibility of the average traveler's valuation of time saved exceeding the toll levy he or she pays. If this were the case, the total price of travel in the tolled facility (i.e. time plus toll) would have dropped, and total travel volume would therefore increase. In other words, tolling that rendered group 1 as a whole better off is, under most circumstances, a logical impossibility, since this would increase, rather than decrease vehicular traffic.

It is only in the use of toll revenues that benefits captured by congestion pricing are transformed back into "public good"

If the three principal groups referred to above are immediate losers overall from the imposition of congestion pricing, what is the source of a congestion tolling policy's economic benefit? The answer is that the tolls collected should be more than sufficient to render all groups better off than before. This deepens our understanding of the impulse—found in many treatments of congestion pricing—to use the toll revenues to increase this measure's political acceptability. The use of toll revenues is not just a public relations move, in a shallow sense, but actually the means to transform the benefits collected from the public back into public good; without this, congestion pricing will have made the public worse-off overall. Public concern over the use of these "locked up" benefits is, therefore, entirely justified.

In the next section, on accessibility, we focus in on one particularly important dimension of the use of toll revenues: its impact on accessibility and its distribution in society. An (auto)mobility-based congestion pricing policy will use revenues largely to expand automotive capacity; an accessibility-driven congestion pricing policy will use them to facilitate alternatives to driving and paying the toll, thus enhancing overall access. We describe the dangers of the former, and show why accessibility (rather than mobility) considerations should be the basis for congestion pricing.

Congestion pricing: as a (partial) approach to full-cost pricing

Despite its visibility, congestion remains just one of the externalities associated with the transportation system. While congestion pricing is a step towards appropriate pricing of vehicular transportation, other external costs remain only partially internalized by congestion pricing schemes. Notable among these are the costs of air pollution, accidents, and the costs for parking and highway infrastructure that are not borne by drivers. This distinction is important.

Most estimates of the long run average full cost of driving range around 34 cents (Levinson and Gillen 1998) to 60 cents (Litman 1996b) per vehicle kilometer, with between one third and two thirds of the costs internal to the driver. In the most comprehensive analysis to date, Delucchi (1997) seeks to detail a complete range of the costs of driving. His estimates of total costs range from 47 cents to 92 cents per vehicle kilometer. It should be noted, however, that his figures are for travel by the entire US vehicle fleet in 1991-1992, including the more costly 9.6 percent of vehicle kilometers traveled by heavy duty gasoline vehicles, and light and heavy duty diesel vehicles. According to Delucchi's calculations, between 7 and 28 percent of this total cost of vehicular transportation is in the form of externalities or public subsidy not originating with motor vehicle users. This estimate should be considered low in that he explicitly excluded certain externalities from consideration, including important ones such as land use damage and the socially divisive effect of roads as physical barriers in communities.

Thus while congestion pricing addresses one kind of externality—congestion—many other externalities mean that travel remains significantly under-priced. To be sure, when travelers pay the congestion costs of their travel decisions they come closer than previously to paying the full societal costs of automotive transport. Yet there remain mismatches or even conflicts between congestion pricing and full cost pricing.

For example, a car traveling on an uncongested stretch of roadway imposes environmental, safety and other costs that would remain unaffected by a congestion pricing scheme. And even when driving on a congestion-tolled road, the time-plus-toll costs still do not adequately reflect the full social costs of travel. Thus, the statement in a recent Israeli position paper on congestion pricing, claiming that this measure achieves "optimal use of the road system and optimal distribution of traffic in space and time," is far from correct. Such optimization would rest on internalizing all the external costs of automotive transport, not merely congestion.[4]

More serious than the gaps between congestion- and full-cost pricing are the potential contradictions between the two over the longer term. A phenomenon, which economists call the "Second Best Theorem," implies that in a situation where other relevant prices are not equal to marginal costs, then marginal pricing

in one particular sector not only may not achieve an optimum even in that sector, but may actually cause a move away from it.[5]

While on the whole it would seem reasonable that charging for more of transport's externalities leads to a more optimal situation than not, we need to be careful. For example, in the next section we argue that a poorly conceived congestion pricing threatens to encourage metropolitan decentralization and its attendant increases in vehicle kilometers traveled (VKT) per capita, as land uses may seek to flee the tolled areas. Under a full price transportation scheme, one would have to conclude that such land use impacts were desirable adjustments to newly corrected price signals, but the situation here is different: the imposition of tolls to capture one kind of externality (congestion) potentially exacerbates others (the long term costs of increased urban sprawl).

Accessibility versus (auto) mobility in transportation planning

The broadest systemic test for congestion pricing is whether it is embedded within a paradigm of mobility-enhancement, or one of access enhancement. Since this question, which permeates this report, involves concepts that are both new and subtle, this section describes them at some length.

Travelers seldom move for movement's sake; most often they travel to access opportunities

An axiom of modern transportation planning is the notion that transportation is a "derived demand;" (Meyer and Miller 1984:228) that is, people rarely consume transportation for the pleasure of movement per se, but rather travel in order to reach opportunities available at destinations. This fundamental understanding was developed in order to facilitate the modeling of transportation flows based on the arrangement of land use patterns across a metropolitan region (Mitchell and Rapkin 1954). Despite some current speculation that some market segments may view movement as an end in itself (Salomon and Mokhtarian 1997), the "derived demand" hypothesis remains the consensus of the field, a view supported by the preponderance of empirical evidence.

The derived demand framework has an important implication, which the transportation planning field has too rarely confronted. Traditionally, the profession has offered its services towards guaranteeing the mobility of the population, and in particular has sought to match road capacity to vehicular volumes in order to seek the free flow of cars -- that is to facilitate automobility. This goal is embedded in the tools traditionally used to evaluate transportation outcomes, notably "level of service" or freedom of a particular link from congestion (Transportation Research Board 1992). The problem is that the pursuit of freedom from congestion can induce destinations to move farther and farther apart as land uses spread out in response to added transportation capacity (Transportation Research Board 1995). Thus a paradox can arise: increased freedom of mobility can actually be associated with more time and money spent in travel, rather than less. Thus travel to more remote shopping or work might be accomplished at a high speed, but the spread of these destinations can demand more travel time than in more compact urban arrangements.

Transport planners should enhance access, not mobility

If travelers do not consume transportation for its own sake but in order to access destinations, then policies that lead to increased resources spent per destination would be counterproductive because they would leave the travelers with less time and fewer resources to spend at their destination. Thus acceptance of the profession's "derived demand" framework for transportation necessarily implies a rejection of "mobility" per se as the overarching goal for transportation policy. Rather, planning should be oriented around providing the ultimate goal of transportation, which is the ability to access destinations, or accessibility.

Both mobility and accessibility are relative, not absolute concepts, and are thus most readily defined in comparative terms. In this study, an improvement in

mobility is a reduction in the time and money cost of travel per kilometer; in contrast, an accessibility improvement is a reduction in the time and money cost of travel per destination.

The contrast between these two approaches is starkest when enhancements to mobility reduce access

Where locations are viewed as fixed in space, each mobility gain is automatically translated into an accessibility improvement as both the costs per kilometer and the costs per destination are reduced. But where mobility improvements induce the movement of destinations -- as when one's job moves to a more remote location in response to transportation system changes, or moves to a location accessible only by car -- mobility gains can be translated into accessibility losses. Thus, in contrast to the traditional mobility-based view of transportation planning, mobility is inherently subordinate to accessibility as a public policy goal for transportation and land use planning. That is, enhanced mobility in general, and enhanced automobility in particular are valued only to the extent that they increase accessibility over the long run; mobility gains likely to translate into accessibility losses are to be avoided.

Land use approaches to transport increase access while reducing mobility

Land use approaches to transportation issues provide a rich palette of accessibility-enhancing strategies that are not based on mobility enhancements. Policies facilitating compactness of urban development, mixed land uses, or development clustered around high quality public transportation can all increase accessibility not so much by reducing the per kilometer time and money cost of automotive travel, but by reducing the total travel resources needed in order to access one's destinations. The idea is an old one in urban planning thought, dating at least back to the "garden cities" of Ebenezer Howard (1902). It has found modern expression in "transit metropolises" worldwide that use policy consciously to adapt their metropolitan development to their public transportation (Cervero 1998). In contrast, low-density, auto-dependent patterns of development are frequently characterized first and foremost by poor accessibility (Ewing 1994).

When the "derived" nature of transportation demand is treated seriously, it becomes clear that congestion is not bad per se. Rather, congestion is bad to the extent that it raises the time and money cost of accessing destinations beyond reasonable levels. Conversely, some ostensible anti-congestion strategies such as extensive highway building can detract from accessibility as well as they encourage travel distances to grow, and land uses to spread and locate in areas reachable by car only. And congestion pricing, if employed primarily as an anti-congestion strategy, can undermine accessibility, promoting (auto)mobility alone. In contrast, accessibility-based congestion pricing policies can be designed to reap the efficiencies of more appropriate pricing of scarce roadway space while simultaneously promoting accessible development patterns and facilitating alternatives to solo automobility, rather than just making it easier to drive a car.

Implications of access-centered transport thinking: the use of toll revenues

Where "congestion pricing" is sometimes referred to as if it were a single implementable policy, in fact the policy maker who seeks to implement a congestion pricing policy faces a number of decisions in policy design: Is the policy to be implemented on selected roadways, or should it be area wide? Should payment be triggered by the crossing of a cordon or should it be implemented on a continuous basis per kilometer traveled? Should it be implemented in selected lanes in an otherwise untolled facility? What should the policy toward high occupancy vehicles be? What should the levels of the tolls be, and how variable should they be in response to congestion conditions or other considerations?

The use of revenues is the most critical decision in implementing congestion pricing. It has often been regarded as a way to buy broader political acceptance

Yet of all the questions that a congestion pricing policy raises, none is more significant than the question of how the revenues of congestion tolling are to be spent. A number of analyses of congestion pricing policies (Small 1992, Gomez-Ibanez 1992, Burtraw 1991, Jones 1991) have elaborated this view. Typically, the centrality of the revenue disbursement issue is explained in terms of political acceptability of a congestion pricing policy. As described above, while congestion pricing has net positive social benefits, it immediately creates groups of losers. Under the standard view, collected tolls, therefore, represent the most significant opportunity to create policy "winners" and hence to build political support. Research in this direction has generally assumed congestion pricing to be a desirable goal per se; a politically acceptable distribution of funds then becomes a tool to pave the way for the initiation of congestion pricing policies. This stance is represented, for example, in a recent Israeli position paper on the topic of congestion pricing, which argues that:[6]

> while theoretical considerations do not require the provision of an alternative to [congestion-priced roads]--in the same way that this is not required in the case of telephone infrastructure, for example, where there is no alternative for those for whom the service is too costly—in practice, because of the notion's novelty, and the fact that it worsens the situation to which the public has become accustomed, the decision-maker will be required to provide such an alternative, in the form of public transport at a better level than currently provided.

Wise use of revenues is actually the central means by which congestion pricing becomes socially beneficial overall

In contrast, we argue that the transportation planning benefits of congestion pricing are themselves conditional on the use of the revenues from such fees. They represent a political tool for facilitating such policies' acceptability, of course, but are much more fundamental to the desirability of the policies than that. These revenues are the "store" of the social benefit that has been accumulated by a measure that overall worsens the situation of citizens, and it is only in their release for public good that the measure can be said to yield a net positive social benefit.

In particular, the distribution of congestion pricing revenues will determine whether the policy is one of improving accessibility, or strictly an (auto)mobility-enhancing policy. Lack of advance planning will tend to lead to a distribution of revenues centered on roadway capacity expansion. This will promote (auto)mobility, but may detract from access. In contrast, we argue for an a priori earmarking of a significant share of revenues from congestion tolls to alternatives to automobility. This is likely simultaneously to allocate road space efficiently and enhance metropolitan accessibility across a range of societal sectors.

If not committed in advance to wise uses, revenues may be captured for simply increasing auto-mobility

Consider, for example, a policy that seeks to implement congestion pricing, but leaves the distribution of the revenues from the tolls to a later political process; that is, there is no *a priori* linkage of congestion pricing policy to any particular distribution of the toll revenue. In all likelihood, the drivers who paid the tolls will clamor for the tolls to be used to benefit them as drivers; i.e., they will agitate for accelerated spending on highway improvements. This is based both on the sense of entitlement that drivers are likely to feel given the fact that it was they who were billed for the congestion tolls, and the fact that drivers as a class tend to wield significant political power.

Under such a policy, where congestion materializes on existing or newly constructed highways, congestion pricing sufficient to dissipate it would presumably be imposed. If revenues collected are primarily recycled back into highway capacity expansion, this will constitute an ongoing mechanism for guaranteeing the long run free-flow mobility of automotive traffic. Thus, mobility-based congestion pricing may well detract from accessibility in general as it hastens metropolitan decentralization, and from the accessibility of people with limited physical or economic capacity to drive cars in particular. The reasons for this are considered in the next section.

Implications of access-centered transport thinking: land use impacts

If, as described above, congestion pricing (absent any distribution of collected revenues) renders most groups worse off, individuals will seek to modify their behavior so as to reduce their exposure to the congestion tolls. This reduced exposure can be accomplished through relocation of origins, selection of new destinations, reductions in numbers of trips, or changes in the trips' routes, modes or times of day. But regardless of the nature of the adjustment, prior to distribution of collected revenues automotive travel in a congested zone is rendered more expensive (in time-plus-money terms) for all but a small slice of the population.

To consider potential land use impacts of such a scenario, we must examine the processes of locational decision making of economic actors in tolled areas. Consider, for example, a retailer or employer within a tolled zone. The individual may calculate as follows: "I depend on the ability to attract customers, or to hire employees at reasonable cost. For this to happen, customers and workers need

accessibility to my location. After congestion tolling, it is true that the traffic flows more smoothly to my location than previously. But for the typical customer or employee, it is now more expensive in time and money terms to reach my location than previously. In terms of sheer numbers, congestion pricing has therefore reduced the flow of vehicles and travelers to my location."

Because it raises the cost of travel to city centers, congestion pricing can be a recipe for accelerated sprawl

Under this reasoning, it would pay some group of firms at the margin to relocate to an untolled area. When this scenario is repeated multiple times, a congestion pricing policy, absent an explicit policy on distribution of the revenues from tolling, can become a recipe for accelerated urban sprawl, as businesses flee tolled areas. If the only relevant externality were congestion, this outward movement might be considered desirable. But transportation's other social and environmental externalities are substantial, so that most, (but not all) observers would identify this acceleration of sprawl as an undesired consequence of a congestion pricing policy. The consequences of sprawl are multifaceted and include: degraded access of weaker populations to employment opportunities in the urban centers; fragmentation of scarce land resources; and erosion of the viability of alternatives to automobility. Rufolo and Bianco (1998) explicitly consider the possibility of perverse outcomes of a congestion pricing policy that fosters metropolitan decentralization and hence undermines transit's viability.

This is not to suggest that centrifugal land use change is the only possible adaptation to congestion pricing. Ideally, congestion pricing alters locational decision making such that individuals seek employment-residential configurations that entail shorter commutes, or combine or reduce the distance of discretionary trips. If these kinds of adjustment are central responses to congestion pricing, they would tend to support metropolitan compactness; by encouraging low automotive travel distances they would enhance metropolitan accessibility.

There are, however, several reasons to believe that absent explicit accessibility-supportive policies, the tendency toward outward movement would dominate. First, the development of significant densification will be blocked by the presence of established neighborhoods in close in areas, that will tend to demand planning protection of their areas from encroachment by new development. Thus, the capacity of households to choose to locate in neighborhoods closer to their major travel destinations is politically limited by restrictions on the capacity to expand the number (and density) of close-in housing units. Second, there is a lag between reductions in travel to congested areas, which would be felt immediately, and the mitigating effect of changing locational decision processes, which would be a much longer term adjustment, and arrive too late to prevent firms deciding to relocate to untolled areas.

Thus, the fact of congestion tolling alone (absent pro-accessibility policies) may be sufficient to spur metropolitan decentralization. Such outward movement would be further accelerated if the primary use of the revenues were for highway improvement. This would further reduce the cost of access to the outlying areas,

and the relative attractiveness of central locations would further deteriorate. Thus, in the process of fighting congestion with tolls, policy would have driven development densities down and encouraged the exodus of land uses to the metropolitan periphery. Thus, in its mobility-based form, congestion pricing would actually have brought about deterioration in the accessibility of Israeli metropolitan areas.

An access-driven congestion pricing would reduce sprawl

There is an alternative scenario, however. If the revenues from congestion tolling are hypothecated (i.e., earmarked, or linked to specific purposes) primarily to enhance the quality of alternatives to driving to and within tolled areas, they can lower the cost of access to congested areas while raising the cost of driving to them. For example, a congestion tolling implementation that used toll revenue for dedicated busways or rail infrastructure into the tolled zones could reduce the cost of travel to such areas, and assist them in retaining their desirability for firms needing to attract customers or employees. Because it seeks to avoid inflation of trip distances and increased need for travel, such an implementation would qualify as an accessibility-based congestion pricing scheme.

But investing in transit infrastructure is not the only way to enhance alternatives to driving under tolled conditions. For example, tolling revenues could be invested in planning and measures that enhanced the supply of housing near job sites in order to afford people the opportunity to reduce travel distances under conditions of toll. Such efforts would likely encounter neighborhood opposition as described above; toll revenues could thus help pay for the concerted planning efforts likely to be required to design increases in the stock of close-in housing that allay neighbors' fears about deterioration in local quality of life. Investment in flex-time or ridesharing programs is an additional means to enhance the quality of alternatives to driving under tolled conditions, and keep tolled areas desirable for a range of economic activities.

This is not to suggest that land use change induced by congestion pricing is necessarily entirely bad. For example, low intensity uses may appropriately transfer to the periphery as they are displaced by higher density uses that benefit more from a central location. The danger to the economic vitality of central areas lies in the event that commercial or office land uses, which depend critically on their capacity to attract employees and shoppers, begin to migrate away from areas subject to a mobility-focused congestion pricing. By definition, such a policy works by reducing the number of automobiles into a given congested space at a given time. If compensating policies are not put in place to facilitate the increase of non-automotive travel to and within such areas, a congestion pricing policy threatens to be another in a string of public policies that have fostered urban decline and outward suburban movement. Only an *a priori* linkage of congestion tolling and investment in alternatives to automotive travel to congested areas can alter this dilemma.

Implications of access-centered transport thinking: equity impacts

Part of the reason that mobility has reigned so long as an organizing principle in transportation planning is the simplicity of the concept. Thus, measurement of mobility requires nothing more than an observation of traffic flow along selected links of a transportation network. In contrast, all measures of access require data on the location of desired travel opportunities relative to each locale under study. In this fashion, accessibility measures need to incorporate information about the land use system and the transportation system simultaneously and are more data-intensive than measures of mobility (Handy and Niemeier 1997).

But the attractive simplicity of the mobility concept obscures vital issues for transportation policy. "Level of service" of roads, a key variable in mobility-management, appears on the surface to be a value neutral measure; after all, every vehicle accessing the transportation link in question will experience the same congestion or freedom from congestion. But this apparent value neutrality, achieved by making the vehicle the key unit of measure, factors out the human dimensions of travel. While mobility of cars along a stretch of roadway at a given time is very nearly identical, accessibility varies greatly between societal segments and geographic regions; and transportation policy allocates and reallocates accessibility among societal sectors.

Traditional mobility-based planning allows for simpler measurements, but it factors out critical social dimensions of travel

Because transportation policy necessarily affects the distribution of accessibility among groups there is no value-neutral approach to its formulation. Democratic policy making demands explicit consideration of the distributional impacts of transportation policies, and is hampered in doing so by the traditional mobility measures. For example, while the building of urban expressways may increase accessibility of well-to-do households with high automobile ownership, it may serve to detract from the accessibility of poorer and non-car owning households, especially lower income urban residents, whose neighborhoods are severed or isolated from suburban job growth centers. In such a setting, these issues are made invisible when comfortable “levels of service” are placed at the center of transport policy. Congestion pricing is one means of improving levels of service. But depending on its implementation, it can either harm or help the accessibility of weaker segments of the population. Without explicit *a priori* consideration of these distributional impacts, a more regressive distribution of accessibility is the likely outcome of Israeli congestion pricing endeavors.

The social impacts of congestion pricing can be examined through analyzing its costs and benefits to 5 groups of affected travelers

In order to consider the distributional outcomes of alternative designs of congestion pricing policies, we have delineated five groups of directly affected travelers (Table 2). In this table, we show the various harms and benefits of congestion pricing **to each of these subgroups** in both a mobility-driven and an access-driven configuration. (These costs and benefits are further spelled out in Table 3.) The five key groupings, for the purpose of a congestion pricing impact analysis, are the following:

1. Benefited Non-Shifters: These are individuals with high valuations of time savings who had traveled before under conditions of no toll, and continue to travel under tolled conditions. They are benefited because the value of the time they save exceeds the value of the toll they need to pay.
2. Disbenefited Non-Shifters: These are people who continue to travel under toll conditions, but are worse off after the imposition of a congestion toll. They continue to travel because the benefits of the trip outweigh its costs; yet their valuation of time is such that they would have preferred to suffer the cost of time spent in congestion rather than paying the congestion toll that relieved it.
3. Partial Shifters: These are individuals who had previously traveled the route prior to tolling, but avoid it under conditions of toll for some of their trips.
4. Drastic Shifters: These people had previously traveled the route prior to tolling, but avoid it under conditions of toll for most of their trips.
5. Non Car Users: These are travelers along the route who had used public transit prior to the imposition of the toll.

The "shifters" in groups 3 and 4 could shift from the tolled road to slower non-toll roads, to public transport, to new travel destinations, or cancel their trip.

Mobility-based congestion pricing will tend to benefit the better-off strata, and hurt the worse-off strata

As portrayed in Table 2, and elaborated in Table 3, mobility-centered congestion pricing policy will tend to confer advantages on the first two (socially privileged) groups above, while concentrating costs on the latter two (the socially disadvantaged). Clearly the first group benefits the most, in terms of the value of time savings relative to tolls paid, and improved accessibility due to greater flexibility in the timing of car trips. Thus for example, members of the first group who had previously traveled at inconvenient times in order to avoid congestion are freer to travel in a fashion that more closely matches their preferences. To a lesser extent this benefit accrues to the next two groups, however, it is in most circumstances more than balanced by the value of the tolls paid. Equally importantly, a mobility-centered congestion pricing policy confers benefits on all classes of automobile users by providing a new source of financing for highway expansion and new construction. These benefits are greater among the groups 1 and 2, groups with higher valuations of time.

At the same time, a mobility-centered implementation of congestion pricing entails significant costs, costs that are borne disproportionately by groups 3, 4 and 5. A broadly shared cost is the threat of long-term degradation of the viability and vitality of city centers. A congestion pricing policy that reduces automotive traffic to urban centers but fails to replace the now absent drivers with travelers arriving by other modes threatens to starve these centers for workers, shoppers and entertainment seekers. While all who enjoy the vitality of urban centers would be harmed by such deterioration, people who have less choice in where they reside, work, and shop, would suffer more; similarly, those who make the most use of

public transportation would suffer disproportionately because urban centralization facilitates high levels of service in public transit.

Other social costs of a mobility-centered implementation of congestion pricing include the threat of deteriorated transit service generally. This can happen in two fashions. First, some share of those who shift their travel to avoid tolls may opt for public transit; yet with no additional resources and higher demand, transit service is liable to deteriorate. The greater threat, however is the implication of accelerated decentralization of urban land uses on the viability of the transit option. Where firms suburbanize in order to escape tolled areas, they render transit access increasingly difficult, as transit's economies of scale tend to demand significant concentrations of destinations. These costs are borne disproportionately by those who do not drive or who cannot afford to drive under conditions of toll, and need to rely on transit for some share of their trips.

An access-based congestion pricing will tend to spread benefits more evenly, and has fewer harmful effects

In contrast to the concentrated benefits of a mobility-centered congestion pricing policy, an access-driven implementation promises to spread benefits more evenly across affected groups. The benefits of reduced travel times on decongested highways still accrue to groups high on the list; yet these benefits are conferred to other groups as well though improved level of service in public transit.

An access-based policy of replacing automobile travelers who have been tolled out of congested areas is not strictly modal but should also include land use policies to enable compact residential development of such locations. If some congestion pricing revenues are dedicated to such efforts, a significant benefit of such a policy would be an improved accessibility due to enhanced opportunity for locational adjustments.
By offering more people the opportunity to live close to work, school, shopping or social opportunities, such a policy can enhance accessibility without loading excess kilometrage on the highway system. Such a benefit would be generally shared, but could be of particular use to groups such as 3, 4 and 5 who are unable to afford unrestricted driving.

Finally, even the benefits of improved roadways themselves would be more broadly spread under an accessibility-based congestion pricing policy because of the impacts of such enhancements on the functioning of public transit. With policies in place to maintain the viability of urban centers, roadway improvements *per se* need not threaten these areas. Similarly harms such as degradation of service on parallel untolled roads, or the inconvenient scheduling of trips to avoid tolls are mitigated under an access-driven congestion pricing scenario, since people who cannot afford to drive wherever and whenever they want are offered improved alternatives to driving under congested conditions.

That the distribution of toll revenues is key to the political acceptability of any congestion pricing scheme has been long recognized. This report has sought to extend that thinking by distinguishing "access-driven" and "mobility-driven"

strategies in congestion pricing. The latter threatens accelerated metropolitan decentralization and an inequitable distribution of costs and benefits of congestion pricing across groups. In contrast, *a priori* attention to ensuring improved accessibility in an implementation of congestion pricing can simultaneously strengthen urban cores while distributing the benefits of congestion pricing across a wide societal range. Thus the question to be asked is clearly not "congestion pricing – good or bad?" Instead, policies must be designed so that the potential of congestion pricing is reaped without triggering unwanted side effects of accelerated metropolitan decentralization and increased gaps between the accessibility haves and have-nots.

Table 2. Preliminary Comparison of Potential Impacts of Congestion Pricing in Mobility- versus Access-driven Configurations

	Mobility-driven congestion pricing					Access-driven congestion pricing				
	Benefited non-shifters	Disbenefited non-shifters	Partial shifters	Drastic shifters	Non car users	Benefited non-shifters	Disbenefited non-shifters	Partial shifters	Drastic shifters	Non car users
BENEFITS										
(Re)vitalized city center						+	+	+	+	+
Improved accessibility due to enhancement of modal choice by improved transit								+	++	++
Improved accessibility due to enhanced opportunity for locational adjustments							+	++	++	+
Improved accessibility due to greater flexibility in timing of trips	++	+	+				+	++	++	+
Reduced travel times on decongested highways	++		+			++	+	+	+	+
Improved roads, financed by toll revenues	++	++	+			+	+	+	+	+
HARMS										
Long-term degradation of city vitality	-	-	-	-	--					
Possibly degraded transit system • more passengers with same level of subsidy • transit less able to serve dispersing land-uses			-	--	--					
Travel on the non-tolled roads parallel to tolled roads is degraded by "tolled off" travel			-	--				-	-	
Decreased access due to trips forgone or inconveniently timed in response to tolling			-	--				-	-	

Table 2. A mapping of the impacts for various groups of mobility- versus access-driven congestion pricing configurations. The mobility-driven configuration preferentially benefits stronger groups, while harming weaker ones. The access-driven configuration spreads benefits to all groups, and reduces the harms to weaker groups.

Legend for Table 2

Implementation scenarios:

Worst case (mobility-driven) implementation: devoted to congestion relief and revenue generation. Revenues entirely dedicated to road construction and improvement with little consideration of land-use, equity, and long-term access changes. No structural measures to allow shifts in housing/job location and worktimes. No tax-shifting compensation for affected businesses; no life line toll subsidies.

Best case (access-driven) implementation: part of an integrated package of measures to improve access and environmental conditions over the long term. Revenues substantially devoted to improved public transport and pedestrian/bicycle measures. Structural measures to allow shifts in housing/job location and worktimes. Tax-shifting compensation for affected businesses. "Life-line" subsidies for lowest income groups with no public transport alternatives. Tolls structured so as to reduce the more seriously polluting forms of travel.

Affected groups:

Benefited non-shifters: are happy to pay the toll in order to save time for almost all trips--a net gain in benefit.

Disbenefited non-shifters: for almost all trips the time savings do not outweigh toll, though almost all trips remain worthwhile overall

Partial shifters: Tolling renders a minor but significant portion of trips no longer worthwhile overall, and these are forgone, substantially rescheduled, or made on more congested untolled roads

Drastic shifters: Tolling renders the majority of trips no longer worthwhile, and these are forgone or substantially rescheduled

Users of adjacent roads: suffer from more congested travel due to traffic deflected off or out of tolled roads or areas.

Businesses: businesses inside tolled areas may be adversely affected, while those just outside a toll-cordoned area may benefit from fleeing business. These impacts were too complex to be included in the tables.

Non-users: Carless because they can't afford to drive; or, are carless because their travel needs are easily met without owning a car.

Table 3.

Overview of impacts of mobility- versus access-centered congestion-pricing to various groups

Group name	**Financial well-being of each group is such**	**Impacts to group of worse case implementation**	**Impacts to groups of best-case implementation, *relative to worst***

	that		***case implementation***
ALL GROUPS		**Harms:** *Long-term degradation of city's vitality.* *Inefficiencies of dispersing land-uses.*	**Benefits**: *City vitality increased.* *Widened travel choices enabled by improved transit and pedestrianization.* *More compact cities.*
Benefited non-shifters	*Group members are happy to pay the toll in order to save time for almost all trips: a net gain in benefit.*	**Benefits:** *Travel on decongested highways for negligible tolls.* *Toll revenues finance road improvements.*	**Benefits** *Creation of travel alternatives for poorer travelers may further clear congestion on tolled road.* **Harms** *Some toll revenue goes to modes they seldom use.*
Dis benefited non-shifters	*For almost all trips the time savings do not outweigh toll, though almost all trips remain worthwhile overall.*	**Harms**: *Travel more expensive (in time and money) with little alternative* **Benefits** *More and improved roads.* *Travel on tolled road faster (but not enough to outweigh toll).*	**Benefits** *While they continue to use the tolled roads as before, transport and structural alternatives allow greater choice of modes for other trips and rearranging of locations or schedules in order to reduce exposure to tolls if they choose to. In other words, a shift to one of the groups becomes a more desirable transport choice.*

Partial shifters	*Tolling renders a minor but significant portion of trips no longer worthwhile overall, and these are forgone, substantially rescheduled, or made on more congested untolled roads, or different modes to the extent they exist and are convenient.*	**Harmed**: *Usual highway trips more expensive.* *Parallel routes are more congested due to toll-deflected traffic.* *Decreased access because of forgone or inconveniently timed trips.* *Possibly degraded service on public transport (overload, dispersing land uses).* **Benefits** *Travel on tolled road faster (but not enough to outweigh toll).*	**Benefits** *While a substantial portion of trips remain on the tolled roads, they enjoy a greater range of modal choices to substitute for some of the "tolled-off" trips. In addition, enhanced flexibility in rearranging locations or schedules in order to reduce exposure to tolls if they choose to.* *Encourages transfer to group below.*
Drastic shifters	*Tolling renders the majority of trips no longer worthwhile, and these are forgone or substantially rescheduled.*	**Harms** *Most trips relying on tolled roads are foregone, rescheduled, or rerouted.* *Trips that continue to use tolled roads are more expensive.* *Public transport may be degraded (overload, dispersing land-uses).* *Parallel routes are more congested due to toll-deflected traffic.*	**Benefits** *The majority of trips are no longer done on the toll roads, and can now be done by other modes with greater convenience. Lowest income groups still able to use "life-line" travel for critical trips.* *Greater flexibility in location and in timing of trips that still depend on tolled roads.* *Encourages transfer to group below.*
Users of adjacent roads		**Harms** *Transit less able to serve dispersing land uses.*	**Benefits** *More options.* *Less diversion (not just diversion but other modes).*
Non -users	*Carless because they can't afford to drive.* *Carless because their travel needs are easily met without owning a car.*	**Benefits** *Public transport using tolled roads is faster.* **Harms** *Public transport system-wide may be overloaded.* *Transit less able to serve dispersing land uses.*	**Benefits** *Improved access due to improved public transport, as well as flexibility in location, work times, etc.* *More compact land-uses.*

A special case of congestion pricing: High Occupancy Toll (HOT) lanes

HOT lanes have been proposed as a means to gain political acceptance for congestion pricing "one lane at a time"

High Occupancy Toll lanes were proposed by Fielding and Klein (1993) as a method to "phase in congestion pricing one lane at a time." Travelers, they argue, are quite wedded to the *status quo* under which driving in congested areas is nominally free. As a consequence they are averse to congestion pricing, despite its demonstrated benefits in economic efficiency. For this reason, a phased implementation, Fielding and Klein argue, is the only politically feasible approach to ultimate full adoption of congestion pricing. Their proposal dedicates a single lane of a roadway--the authors recommend either use of existing high occupancy vehicle lanes or construction of new facilities--to both toll-free use by vehicles used by three or more travelers,[7] and to use by single occupant vehicles on the basis of a toll. Such toll would vary with congestion conditions on the remaining lanes of the roadway, and would be set at a level to keep the tolled lane operating at reasonably free-flow conditions. .

We approach HOT lanes as a means to increase access and enhance priority of surface transit

The primary rationale the authors suggest for the use of the HOT lane concept is explicit in their title, "Phasing in Congestion Pricing a Lane at a Time"; HOT is justified as a stepping stone to an end-state of full area-wide congestion pricing. In contrast, we argue for benefit of the HOT concept quite independently of its asserted capacity to pave the way (quite literally) for political acceptance of more general congestion pricing. Instead, our support is based on: (1) the transportation imperative of managing highway facilities so as to maximize throughput of persons per hour, rather than throughput of vehicles per hour; and (2) a desire for a politically workable scheme to provide physical priority for surface transit to enable it to bypass automotive congestion.

What traveler- rather than vehicle-focused transport planning tells us about HOV and HOT lanes

The transportation planning and engineering professions have sometimes fallen into a fundamental error of methodology: viewing the relevant unit of analysis as the vehicle rather than the traveler. Under this perspective, the flow to be accommodated is that of vehicles; a successful facility is one that transports the maximum number of vehicles per hour. Where there is a one-to-one correspondence between traveler and vehicle--i.e., all the vehicles are solo occupant automobiles, there is no conflict between the two goals. But where vehicle occupancy ranges from a single individual in cars to scores of travelers in fully laden buses, an alternative paradigm presents itself: offer priority to high occupancy vehicles in order to increase the **person**-throughput of the system, even if this reduces the number of **vehicles** that can get through during any period.

We can expand the range of areas in which such lanes are viable by allowing additional (non-HOV) traffic onto the HOV lane

This is the fundamental concept behind the High Occupancy Vehicle (HOV) lane, which allows entry only to cars, trucks and buses with at least two or three occupants. It should be noted that while granting of such priority may have the effect of inducing people to form carpools or take transit, such induced behavioral modification is not a prerequisite to the lane's efficient operation. Rather, the sole criterion for success of operating a lane as HOV must be that the entire facility--general purpose lanes plus HOV lanes--carries more passengers per hour during congested periods of the day than without the designation of a lane as dedicated for HOV. The ability of an HOV-equipped roadway to meet this criterion is not dependent on the lane's ability to induce carpool formation; rather it is a function of the volumes of passengers in high occupancy vehicles. One can think of the principle of HOV lanes as sorting traffic into different streams in which the stream consisting of "packets" (vehicles) containing more people is allowed to move faster so as to maximize throughput of people. A HOV arrangement could be considered successful even if it only achieved this greater throughput through this sorting process of existing "packets" without inducing any behavioral change. If behavioral change is induced, that encourages people to travel in larger packets (carpools, buses), so much the better.

The problem is that the geographic range over which HOV lanes can actually match this criterion of increased overall throughput is rather limited. In many areas, light use of lanes taken for HOV purposes would cause the person-throughput of the entire roadway to fall rather than rise—the volume of people carried on the HOV lane does not compensate for the loss of the lane to general traffic (or justify the construction of a new lane). But one can increase the range of contexts in which HOVs are feasible, by a move which is the functional equivalent of phasing in a congestion-free HOV lane gradually, rather than taking or building an entire lane. This is possible through utilizing the excess capacity that goes unused even in some successful HOV lanes. Excess capacity in this context is defined as space to accommodate additional vehicles without interfering with the free flow of high occupancy vehicles in such lanes. Where traffic flows are such that they do not justify the taking of a full lane for HOV purposes, the remaining capacity can be given to ordinary low occupancy vehicles. (To our knowledge this has only been proposed in a form in which this excess capacity is sold, i.e. through a HOT lane, though this is not necessarily the only option).

It is important to note that excess capacity in a HOV lane is not simply a lost opportunity to increase traveler throughput, but also a formidable political obstacle to the spread of the HOV lane concept. Drivers in the congested general purpose lanes resent the apparent waste of capacity they observe in the HOV lane and clamor for its reversion to general use. Thus the ability to allocate in some fashion the excess capacity in an HOV lane is key both to its political acceptability and to the breadth of geographic range over which such facilities may be successful. In this fashion one may view the HOT less as a stepping stone to full congestion pricing than as the key to a widespread granting of priority to high occupancy private vehicles and public transit. In other words, the HOT variant expands the geographic and political range over which the HOV concept can work.

Physical priority for bus public transit

Transportation researchers since Meyer, Kain and Wohl (1965) have advocated use of the dedicated bus lane concept as a highly cost-effective transit option. The fundamental logic of this transit design is its flexibility: buses can circulate around neighborhoods and business districts, picking up and dropping off passengers, then get on to a dedicated bus lane, offering passengers a transit trip that both bypasses automotive congestion and offers passengers from dispersed origins and destinations a no-transfer trip.

HOT lanes can expand the network of congestion-free priority bus lanes

Despite its demonstrated success in cities such as Curitiba, Brazil, Ottawa, Canada and Adelaide, Australia (which uses a guided busway variant) (Cervero 1998) , the bus lane concept has caught on in relatively few locales. We argue that the HOT concept may be a vehicle to enhance the political acceptability of the bus lane idea in areas where it has not caught on. Advocates of high quality public transit--defined here as transit with the capacity to bypass automotive congestion--would generally welcome the deployment of extensive networks of bus lanes crisscrossing the country. (Improved emissions-levels of the bus fleet—entirely diesel in Israel—is required before such an expansion can be wholeheartedly endorsed.) Using the excess capacity in a HOV lane for ordinary (i.e. low occupancy) vehicles considerably boosts the feasibility of these lanes in three ways:

1. It allows greater throughput;
2. It raises the political feasibility of the scheme by adding the additional potential car-users of the lane to the pool of people who would endorse the scheme; and
3. In the event that this additional capacity is sold to the highest bidder, rather than given freely, the funds raised can finance costs associated with the lane's construction and operation. (The equity implications of this are discussed below.)

Thus while in its original formulation, HOT was justified as a stepping stone to area-wide congestion pricing, it may be viewed as desirable in its own right from the viewpoints of (1) a traveler-focused (as opposed to vehicle-focused) transportation planning and (2) of the deployment of an effective public transportation option.

Equity considerations in HOV and HOT

The threat of increasing inequity in the access among different groups represents a major problem for transportation pricing schemes in general, and HOT lanes are no exception. The issue requires careful consideration, both to work out impacts of

any given scheme and, more fundamentally, to clarify and evaluate the criteria of fairness that we employ in considering the equity implications of these impacts. We begin with the latter: reflecting on the criteria for equitable interventions.

A possible standard--one implicitly endorsed wherever cost-benefit analysis is applied--is the Kaldor-Hicks criterion, based in utilitarian philosophy: a move is desirable from a societal standpoint whenever it generates sufficient benefits that the winners from that move could afford to compensate the losers. The rationale for this principle is the maximization of net benefit across society, which under utilitarian philosophy is no more than the sum of the benefits of each of society's individual members; thus the distribution of benefits between various members of society is irrelevant.

Clearly this criterion fails to meet the ethical standards of most observers. Under the Kaldor-Hicks criterion, a move that enriched the already rich but made the poor poorer would be acceptable, so long as it created sufficient surplus that the beneficiaries could, in principle, compensate the losers (though there is of course no requirement that such compensation actually occur!) While this criterion may appear logically compelling, most would find it intuitively repugnant.

Yet an ethical alternative to utilitarianism based in an explicit philosophy--rather than intuition alone--remained elusive until the writings of John Rawls (1973). Rawls begins with a hypothetical exercise. Imagine that humans had the task of designing a societal distribution of resources, but without knowledge of where they would fall within the society that they were designing. Would they design a society that maximizes total wealth, regardless of its distribution? Surely not, argues Rawls, since having to live with the outcome, members of society would worry about finding themselves at the bottom. But it does not follow from this that they would insist on strict egalitarianism either. Rather, Rawls argues that such individuals would accept deviations from an equal distribution of resources only if such deviations improve the lot of the worst off. Thus a society with wealth differences would be chosen over an egalitarian society only if the worst off of the former were better off than members of the latter society. Having argued that this principle would be adopted by societal designers who were unsure of their future position in society, Rawls posits this notion as a guiding principle of distributional fairness.

An HOT scheme is equitable to the degree it improves the situation of the worse-off in society

This framework allows a principled consideration of issues that arise with HOT schemes. Without a doubt, such schemes would benefit wealthy individuals with high values of time and great ability to pay for access to the time-saving lanes. In order for this benefit to the wealthy to be justified, it would need to be closely linked to a benefit that would be conferred on the worst-off people as well. In the case of the transportation environment, these individuals are reasonably readily identified; they would be the transit dependent, or those people who have needs to travel in the areas under consideration but cannot afford automobiles. Clearly their accessibility is raised by the significant improvement in the quality of public transportation service offered by free-flowing transit through congested areas. On

the surface, then, it would seem that as long as transit is a significant enough presence in the corridor under question, the opportunity to confer benefits on transit users would ensure that an HOT implementation answers Rawlsian criteria of equity.

But an *ad hoc* tying of benefits to the worst off group with a proposal that significantly benefits the wealthy would seem to be a disingenuous approach to meeting Rawlsian equity criteria. If selling excess capacity to the wealthy does not improve the lot of the worse off, it should not be done, for it merely increases polarization of privilege. There is no moral imperative to further privilege the wealthy in order to improve the position of the worst off, if the two can be unlinked. In this realm, observers of the HOT concept will differ. Some may argue that provision of dedicated lanes to transit and high occupancy vehicles should occur without enabling single occupant vehicles to buy their way into these facilities; in other words, HOV is justified from an equity standpoint, but HOT is not.

The taking of an existing lane entirely for HOV purposes (in the limited places where this is justifiable by passenger throughput considerations), is clearly an equity enhancing move. It not only raises the general good (a greater throughput), but does so in a way that preferentially benefits the worst off people in the transport system: those who travel by public transport, or who are likely to shift from their cars to a public transport whose relative competitiveness has increased. However, the removal of a lane in this way is likely to be politically difficult if not infeasible. The construction of a new lane entirely for HOV purposes is similarly hampered.

We suggest that eliminating the option of selling excess HOV capacity to drivers willing to pay will tend to limit the geographic range over which the HOV concept can work, and thus ultimately confer fewer benefits on the worst off population. As described above, this limitation works in two dimensions: engineering (i.e., system throughput) and political. Where bus use is light, and ridesharing is rare even with HOV provision, such lanes will be lightly used and may end up reducing the person throughput of the entire facility. In circumstances such as these, these lanes will legitimately be judged to have failed in their goals. The ability to sell the lanes' excess capacity can be an effective technique to forestall this failure and create successful transit priority lanes in areas where it would otherwise not be possible.

Relatedly, the ability to sell off excess capacity can forestall political failure of HOV lanes. The sight of an underused HOV lane adjacent to congested general purpose lanes is virtually guaranteed to prompt drivers to political mobilization to return the lane to general use. In contrast, selling off excess capacity--i.e., the HOT concept--can forestall this mobilization both by physically utilizing the capacity of the lane and by offering drivers the outlet of buying into the lane as their circumstances warrant.

For these reasons, we argue that the linkage between the benefits conferred upon wealthier drivers (i.e., the ability to travel congestion-free in a single occupant vehicle) and the benefits conferred on poorer travelers (i.e., improved service for the transit-dependent) is not tenuous or simply a fig-leaf. Rather, these two benefits are intimately bundled within the HOT concept, and as a consequence this innovation deserves serious consideration as improving, rather than detracting from fairness in the overall distribution of accessibility.

But does the allocation of excess capacity of HOV lanes need to occur on an ability-to-pay basis? It is clear that allocating this excess capacity on a non-paying basis is also an equity-positive move, since it further increases the good of transit users, while not preferentially benefiting any particular class of ordinary car drivers. For example, there was a period in which excess capacity on a Boston HOV was allocated by a scheme in which cars with an even numbered license could travel in the HOV lane on even numbered days, and odd numbered on odd days.[8] This random allocation of capacity is too crude to open the HOV lane to precisely the number of low occupancy vehicles that can be added to HOV flows without degrading their quality of service, which would require more sophisticated (i.e. expensive) technical solutions. More fundamentally, such access would be deemed inefficient by the economist's criteria of allocating scarce goods to those who value (are willing to pay for) them most highly, i.e. those who have a high value of time.

The economists' hesitations would be satisfied were this extra capacity to be sold (for a price that ensured few enough buyers to ensure no congestion), rather than given out on a random or "first-come-first-served" basis. This, however, is where equity concerns grow stronger. After all, we would have replaced a situation under which low income and high income drivers all have access to the same (congested) roads, with a scheme whereby premium service is offered to those willing to pay. Thus, the HOT lanes in Southern California are derided by some as "Lexus lanes" that cater unfairly to the desires for congestion-free travel of those able to pay for the service.

Thus, a HOT lane would seem to expand the realms in which income stratification affects the opportunities and qualities of people's lives. Do the added benefits of the HOT arrangement (of charging for the surplus capacity on HOV lanes) outweigh this apparent equity liability? Specifically, does this move pass the Rawlsian criteria of increasing the uneven distribution of resources only if this improves the lot of the less well off?

The benefits of the HOT arrangement--as opposed to other schemes to allocated the excess capacity of an HOV lane--would seem to be the following:

- The economic efficiency argument, mentioned above, argues that overall good is improved when scarce resources are allocated according to willingness to pay

- While wealthier drivers can use the lane regularly, all drivers benefit from the **option** of having an ensured congestion-free trip on those occasions when they need it badly (rushing to the airport, for example, or to an important appointment)
- Income from tolls might further extend the range of locations at which construction of the HOT lane is feasible, hence widening the network of physical priority bus transit lanes, benefiting the worse off.
- The income derived from the tolls could be used to directly benefit the worst off, through other forms of access improvement (rail subsidies, pedestrianization schemes, etc.), or through non-transport related expenditures and subsidies.

Only the latter two benefits would seem to justify this move in Rawlsian terms. The use of toll income to improve non-car access has the additional benefit of coinciding with the access-centered transport planning perspective described earlier in this report, strengthening further the emphasis we placed there on how toll revenue is spent. With revenues used to improve access, HOT lanes can simultaneously improve economic efficiency, sustainable transport planning goals, and equity criteria.

Potential land use implications of the HOT concept

We have argued above that a strictly mobility-based congestion pricing design can have the unwanted impact of accelerating metropolitan sprawl. Absent policies and investments to replace the reduced driver-flow to such areas with increased traveler-flow, congestion pricing can have the effect of diminishing the commercial viability of location in tolled areas, and induce outward movement of office or retail uses. What are the potential land-use implications of the HOT variant of congestion pricing?

Because HOT lanes can increase total person throughput, they are less likely to be sprawl inducing than area-wide congestion pricing

As described above, under **area-wide** congestion pricing the average traveler who remains on a roadway after the imposition of tolling is worse off than in the pre-tolled situation. These travelers continue to use the facility because their trips are of high enough value that they justify paying the toll; yet they would have preferred the toll-free situation, even with its associated congestion. In this way, congestion pricing increases the time-plus-money cost of driving in congested areas for the average driver. For this reason, it can make travel to such areas less desirable.

The HOT concept, however, though sharing several outward similarities with area-wide congestion pricing, differs markedly from it in this regard. The key difference is in the dimension of added choice. If we assume that drivers make informed decisions about the amount of time they stand to save by opting for travel in a tolled lane, then it becomes apparent that only trips for which such a decision

reduces the sum of time and money costs of travel will be taken in such a lane. In other words, in contrast to areawide congestion pricing that creates significant classes of losers (compared to the untolled situation), people will only opt for HOT travel if they stand to gain from the decision. If it is assumed that travel on existing lanes is not harmed by the HOT designation, then the HOT concept, in contrast to areawide congestion pricing, unambiguously lowers the time and money cost of all travel into congested areas. By encouraging such travel, the concept can help maintain the economic viability of such areas, rather than accelerating their decentralization.

Of course, there is no guarantee that service on existing lanes will not deteriorate as a result of the HOT designation. But where the criterion of greater observed throughput of travelers per hour on the facility as a whole is met, the conclusion must be that overall time plus money costs of travel per person have been reduced by the innovation. By enabling an increased traveler flow to congested central locales, the HOT innovation may become a significant tool for maintaining and enhancing the economic vitality of these areas.

Applying an access-driven analysis: evaluating the proposed HOT pilot project at the entrance to Tel Aviv

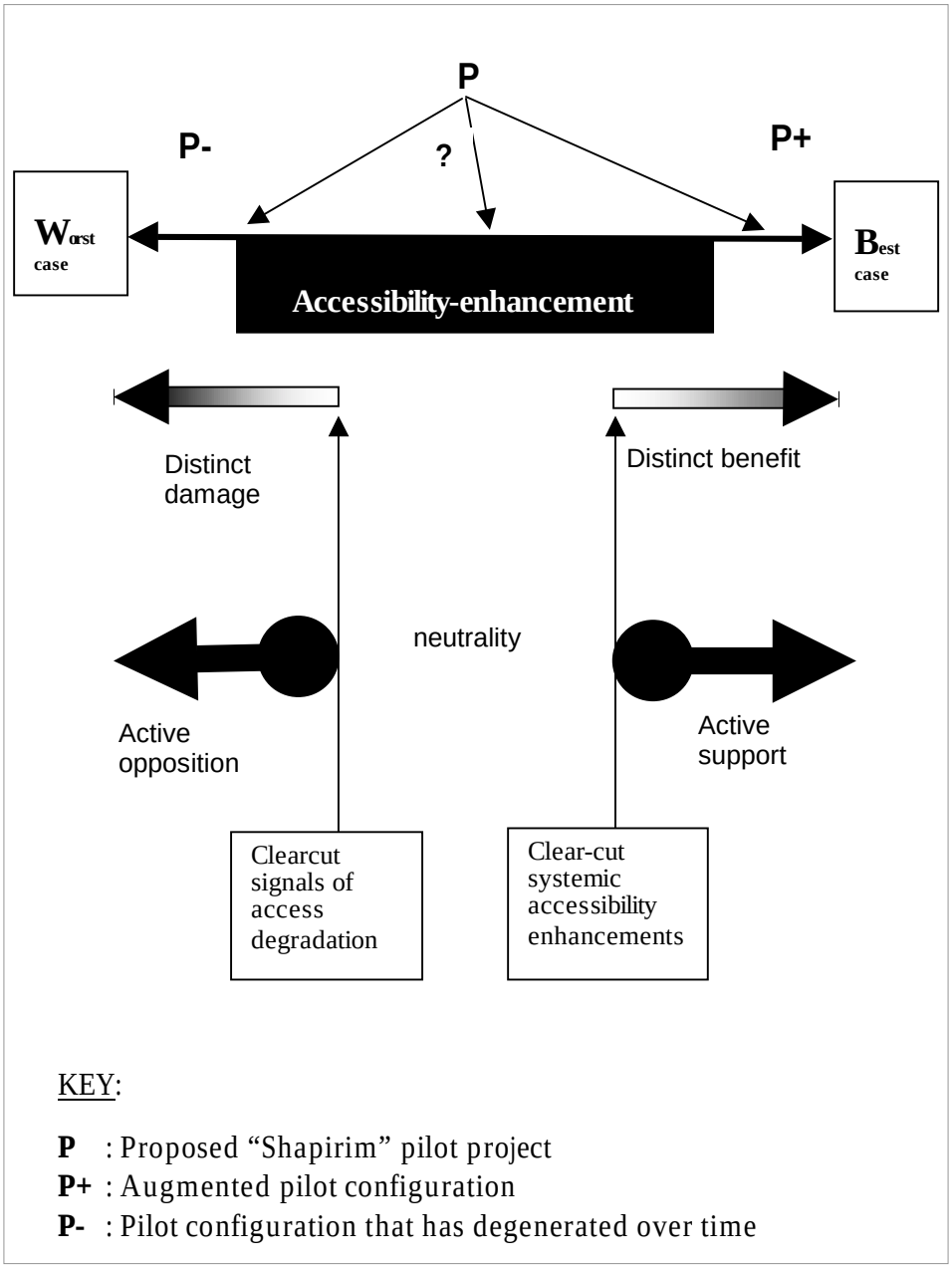
Evaluating congestion pricing: doing harm, doing good, and in-between

Congestion pricing is not *a priori* a helpful or harmful measure. As a powerful intervention within a complex system, its contribution depends on the broader goals and context of its application. In this paper we use the access/mobility distinction as a way to organize consideration of the various goals, implications, promises and hazards of congestion pricing. Access-enhancement becomes the central goal directing the implementation of congestion pricing, and the criterion for judging a given implementation.

A worst-case implementation of congestion pricing (the point W on the spectrum of figure 1) is one that degrades access--both in terms of overall amount, and in terms of its equitable distribution. Imagine, for example, an implementation whose goal was to clear enough congestion so that drivers who can pay are ensured a reliable fast drive to their destination. This could be done by tolling an entire area or corridor, by building a new lane open only to toll-paying passengers, or even taking an existing lane for use as a HOT lane. In each case, no compensatory access-improvement would be provided for the “tolled-off” or the “tolled-onto,” nor would compensatory access-boosting measures be applied. This kind of congestion pricing would redistribute mobility in a regressive way, and in the long term could degrade accessibility by reducing the total number of people into the tolled area (a city), and over time encourage the flight of land uses, encouraging

changes in urban form that increased VKT. This implementation, which we are unlikely to see in its worst form, would actually harm public interest, and as such warrants active opposition from those concerned with creating a more sustainable transport system.

Figure 1. Public policy consideration for various congestion pricing implementations.



What are the "warning signs" that a congestion pricing implementation may be degrading access (see Fig. 1)? These must be examined within their specific context, but in general we would regard the following as clear signs that systemic harm is probably being done:

- Toll income is not structurally and firmly dedicated to improving access by means other than cars
- The project necessitates or facilitates new road infrastructure for single occupancy car use
- The project allows a greater number of cars, as opposed to a greater number of people, to enter city areas
- The project does not demonstrably improve the situation of the worse off (and in particular, those who rely entirely on public or non-motorized transport)
- The project worsens access to an area in a way that might encourage the long-term drift of land-uses out of tolled urban areas.

Depending on how it affects access, a congestion pricing project may be harmful, helpful, or neither

As depicted in Fig. 1, there will be a range of congestion pricing implementations that are not actively harmful, but nor do they distinctly contribute to improved accessibility. As long as they cover their own revenues, there is no reason to oppose these implementations of congestion pricing. Nor is there any reason to actively forward them.

Finally, there will be congestion pricing implementations that clearly enhance accessibility. These implementations are likely to be one element of a larger package of measures designed to improve access, restrain the growth in VKT, and revitalize city centers. Such implementations merit public expenditure and active support.

The axis of "accessibility" thus serves as a basis for debate and evaluation for a given implementation of congestion pricing, such as the proposed pilot project described below.

The proposed HOT pilot project at the entrances to Tel Aviv

The system chosen as the pilot project for congestion pricing in Israel is for three tolled HOT sections on main entrances into Tel Aviv. The first tolled section would run on Route 1 for just over a kilometer, on either side of the Degan junction. A right-turn-only lane on Route 4 northward would allow traffic from the Rishon Lezion/Holon area to enter this HOT lane. The two other HOT sections would be short stretches on the exits from the Ayalon Freeway at Hashalom and Rakevet junctions. All three stretches are chronically congested in rush hour. The HOT lanes would be taken by removing an existing lane in each of these stretches. They would be open to public transport, with any excess capacity sold to private cars at rates dynamically adjusted so as to ensure continually congestion-free travel. Tolling and enforcement technology will be the same as the Trans-Israel Highway.

At the south-east end of the Degan HOT lane, about 0.5 kilometers east of the Shapirim junction, a large park-and-ride structure would be constructed in the area

where the north-bound and south-bound lanes of Route 1 separate. (This area is currently a 100 dunam orchard between the lanes). This park-and-ride lot would be served by two frequent shuttle lines to dense commercial centers on the Ayalon, utilizing the congestion-free HOT lanes: one serving the Kirya area (west of Hashalom junction) and the Rail Station, and the second serving the Diamond Exchange area in Ramat Gan and the Rail Station. Travelers would be able to exit from Route 1 and Route 4 (on an overpass and underpass constructed for this purpose from these highways), and park in this lot in order to take the shuttle or other public transport (the park & ride lot will be open to bus service providers and is adjacent to a stop on a commuter rail line). These shuttles are proposed to be free and high frequency (less than 5 minutes apart), and provide a pleasant link to and from highly accessible destinations.

Thus, travelers approaching the Ayalon from the south will have three options: (1) traveling for free on the remaining and normally congested lanes, (2) of paying to travel on the uncongested toll lane, or (3) of parking their car and taking the shuttle or other form of public transport. Public transport will be able to use the congestion-free HOT lanes, reducing their travel times considerably.

According to the modeling of this pilot project done by on behalf of the Cross-Israel Highway Company, the shuttle's high level of service will be attractive enough to draw from car use a number of drivers equivalent to the capacity of the taken lane, thus ensuring that conditions on the remaining lanes do not deteriorate. These projections predict that 2300 cars will accumulate in the parking lot in the morning, and that toll revenue will be around 13 million NIS a year.

Analysis and suggested augmentation of the pilot project

The proposed pilot project is ambitious, and does not light any of the "warning lights" described above. Thus,

- It uses an existing lanes, rather than requiring new ones. This ensures that the system cannot deteriorate into a harmful measure over time through political pressures. Were a new lane built, tolling could be gradually relaxed or abandoned, so that the project reverted simply into an expansion of highway capacity. This phenomenon has already occurred with HOV lanes in the United States, to the extent that the HOV concept has been seen as a "Trojan Horse" for road expansion that might have been legally indefensible under federal law (Vuchic 1999). Under the existing lane plan, such erosion would, in the worst case, lead to a reversion to the starting point situation.
- A high quality public transport (shuttle) is an essential part of the project, and toll revenues will be dedicated to its operation—an access-enhancing measure.

- Buses travel free, or will be charged as one vehicle. This ensures that the scheme gives public transport the competitive advantage of being both cheap and congestion-free, and helps expand the network of dedicated right-of-way for public transport. This will benefit bus travelers using the corridor. Thus a bus traveler from Jerusalem might have a substantial wait taken of their journey by bypassing the most chronically congested stretches near Shapirim and again in turning off the Ayalon Freeway at the Shalom or Alozorov interchanges.

The pilot project is packaged with features that, if implemented, will prevent it from damaging the city's viability and accessibility

Thus, the project will probably not harm accessibility on the Tel Aviv region, and has significant promise as a politically-acceptable way to begin achieving a real advantage for public transport by giving buses a congestion-free right-of-way in the most congested parts of the road system. (This right-of-way is "bought" by allowing drivers to buy their way in, and the provision of an alternative.). A degraded form of the project, marked by "P-" in Fig. 1, such as would occur if the shuttle service deteriorates, would do harm.

While it doesn't harm accessibility, does the pilot project pass some significant threshold of accessibility-enhancement necessary to merit active public support? The necessary support will, after all, be substantial; the expected revenues will only cover the operation of the shuttle service and park & ride—not the construction of the parking area and the ramps to and from it, the purchase of shuttles, the purchase of 100 dunam of private farmland in a prime area, nor the technology and infrastructure for the lanes themselves, all of which will require government funding. This is a question open to debate, in which project proponents must convince decision-makers and the public that the package they offer is sufficiently to the right along the axis of Fig. 1.

Several additional measures would markedly contribute to the project's access-promotin g functions, and thus considerably bolster its claim for broad and enthusiastic public support

In the remainder of this section we offer a series of suggestions about ways to augment and improve the proposed package, augmentations that would place the project firmly out of the zone of public-interest neutrality into the zone of active support ("P+" in Fig. 1).

The suggest reworking of the project is both conceptual/paradigmatic, and in a series of quite concrete opportunities for augmentation. At the conceptual level, the project's commitment to accessibility-enhancement could be made clearer. Currently, one senses that project proponents see congestion as the transport problem for the country,[9] and that the pilot project's goals are—in this order of priority— (1) ensuring a congestion-free entrance to Tel Aviv for car drivers; (2) providing a high-quality shuttle so that level of service in remaining lanes is not degraded by the project; with a nice side effect of (3) giving public transport a free boost out of congestion.

What concrete changes to the pilot project might a shift to an accessibility emphasis yield? Consider, for example, some of the following:

- The HOT could be more clearly framed as a step in expanding the network of dedicated right-of-way for public transport (and paratransit and HOVs, rather than a first step in congestion pricing.
- As currently proposed, the pilot is not a true HOT in that 3 and 4 passenger cars do not travel for free. Project proponents argue that counting passengers would require human supervision, rather than electronic on-the-fly tolling, but random checks with high fines could achieve the same effect. It is true that high occupancy vehicles will have their toll divided by the number of occupants, but it could be an important political statement to have this be a full fledged HOT lane with free travel.
- Public transport utilization of the facility should be actively encouraged and coordinated, with the Park and Ride lot become a intermodal terminus. Thus, local bus lines should be encouraged to and from the parking & ride lot, so that people could make their entire trip without a car. (From an air-pollution perspective, it is the short "cold start" trips from home to the park & ride lot that are most harmful, and these should be avoided if possible.) Existing operators should evaluate their lines and if necessary reroute these in order to take advantage of the congestion-free HOT.
- The proposed park & ride lot is a few hundred meters from the Kfar Habad rail station, which could run trains as frequently as needed with very little investment. Unfortunately, there is no easy access from the Route 1 highway to the rail station, preventing its operation as a southern park-and-ride rail facility. Coordination of the congestion-pricing pilot with the Rail Authority's plans could bring great benefit for both, allowing travelers access to the entire rail network from south of Tel Aviv. The limit case should be explored, of a very frequent rail connection to Tel Aviv replacing the bus shuttle, with fast shuttles from the destination rail stations.
- The use of the shuttles should be encouraged by expanding the range of access at their Ayalon destinations. The catchment areas of the destination shuttle stops can be expanded considerably by attention to adjacent comfortable pedestrian and bicycle paths and bicycle lockup facilities.
- The kind of synergistic measures that were originally bundled with the congestion-pricing law proposal (mandatory parking cashout and taxation of employee car allowances) should be supported. This bundling is a natural opportunity, and is important for the operation of the toll lanes, since many drivers will pay their congestion tolls with employee allowances.
- The proposed HOT lane law says that revenues will be dedicated first to the operation of the lane and shuttle service, and second to the relief of other forms of taxes paid by drivers. This second clause should be removed—other access-enhancing uses of the revenues have far higher priority.
- Arrangements should be considered whereby travelers on the shuttle receive a ticket that is good for continued bus/light-rail travel within Tel Aviv.

- Since this is a short run, frequent and self-contained line within a highly populous area, it is an opportunity for vehicles fueled by something far cleaner than diesel.
- Modeling and financial projections for the project should be open to the public.

This range of added measures would situate the pilot project at location "P+", and clearly warrant strong public support (see Fig. 1).

Proponents of congestion pricing, and especially in a field this young, might argue that they cannot risk this breadth of concerns. That they want to get a minimum framework up and running, and not be distracted by discussions with bus companies and rail authorities, bicycle facilities and parking cash-out. Yet, we would argue: to expand the accessibility-centeredness of a project is to expand the breadth of the coalition of its supporters. Politically, it may be worth the extra effort.

To conclude, congestion pricing is only one measure among those many urgently needed by Israeli transport. These include demand management (especially through alterations in land-use), the improvement of public transport (and especially rail) facilities and rights of way, the construction and improvement of pedestrian and bicycle paths, the rational pricing of travel to reflect its social and environmental costs more fully, and others. Considerable political will and institutional integration will be necessary to implement this broad suite of oft-recommended measures.

Accessibility-driven congestion pricing can act synergistically with these measures, and as such merits considerable public support. However a congestion-pricing scheme that is mobility-driven, and isolated from these broader measures, is far less deserving, and may actually be harmful. If considerably augmented, the proposed pilot project would unambiguously belong in the former group.

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Appendix A. Policy context of congestion pricing in Netherlands Second Transport Structure Plan

Below is a segment of a document on The Netherlands Second Transport Structure Plan (1990)[10], describing the context in which initial consideration of congesting pricing measures (**highlighted**) took place in the Netherlands for the Randstad region. It is included as an example of the framing of congestion pricing as part of a larger package of access-enhancing policies and measures.

Strategic Goal

Sustainable development with a balance of individual freedom, accessibility and environmental amenity, achieved in stages by

⇒ Limiting external effects
⇒ Ensuring accessibility
⇒ Managing mobility

Target scenarios

By category, to achieve established targets in the following key policy areas

Managing mobility

- Location planning—concentration of housing, employment, leisure and other public facilities in relation to transport networks
- Parking norms for commercial and public facilities
- Urban remodeling—road network layout and car-free areas to discourage car use
- Application of telecommunications
- Socio-economic developments—spread of working and opening hours
- Pricing—**raising variable costs of motoring; application of tolls on certain access roads**; realignment of public transport fares and decreasing public transport user costs relative to that of private car trips

Enhancing accessibility

Passengers

- Collective transport—improvement of the travelling time and reliability of public transport
- Provision of cycleways
- Road network—elimination of bottlenecks and optimizing use of existing link capacity
- Encouragement of car sharing
- Information technology-travel information and traffic management systems
- Transfer facilities, e.g. park-and-ride facilities

Freight

- Road haulage—increasing the use of the existing road capacity (vehicle loads and freight lanes)
- Dedicated rail freight lines
- Upgrading waterways
- Combined transport—integration and container handling
- Information technology—introduction of a management information system

Within the transport plan, a series of measures was outlined that would need to be achieved in order to implement the goals of the above policies. These include:

- Establishment of effective regional frameworks for administrative collaboration in the form of transport regions
- Cooperation between transport organizations
- Establishment of an infrastructure fund

Appendix B. Maps of the proposed pilot project

(With permission of the Cross-Israel Highway Company)

[5 maps, ID numbers: 10, 14, 12, 13, 11]

Notes

[1] The authors are especially grateful to Philip Warburg (who provided most thoughtful and extensive comments—while disagreeing with many of this report's normative evaluations) and Nitzan Yotzer (who discussed the Tel Aviv pilot project with us extensively). We appreciate their comments, as well as those of Yoram Shiftan, Arza Churchman, Emily Zilberman, and Shlomo Hasson, and of the students in Yaakov Garb's Fall 2000 courses at Hebrew university and the Arava Institute for Environmental Studies on a draft version of this paper.

[2] הצוות לתמחור השימוש בתשתית - הועדה הבינמשרדית לנושא התמודדות עם הגודש בדרכים, דוח ביניים, 17.08.1999.

[3] Our treatment here relies on the presentation of the project given at the Israeli Institute for Transport Research and Planning on Sept. 8, 1999, on extensive subsequent discussion with Nitzan Yozer, Chief Financial Officer of the Trans-Israel Highway Company over Fall 1999 through January 2000, and on a review of relevant documents.

[4] A position paper on pricing policy for land transport prepared for the Israeli Democracy Institute hosted annual economic meetings at Caeseria, June 1999.
"הסדרת מנהלית ומדיניות מחירים בענף התחבורה היבשתית", עבור כנס הכלכלי השנתי, קיסריה 28-29 ביוני, 1999, VII.

[5] The theorem was formulated by Lipsey and Lancaster. See Phil Goodwin, "Road Pricing or Transport Planning" (p. 149), in Johansson et al, for a brief discussion of its relevance for congestion pricing.

[6] Translation from a position paper on pricing policy for land transport prepared for the Israeli Democracy Institute hosted annual economic meetings at Caeseria, June 1999.
"הסדרת מנהלית ומדיניות מחירים בענף התחבורה היבשתית", עבור כנס הכלכלי השנתי, קיסריה 28-29 ביוני, 1999", VII.

[7] The justification for setting the threshold for free travel at three travelers per vehicle is the finding that a substantial minority (43 percent) of ride sharers in two-occupant vehicles are from the same household; the assumption is that the vast majority of these would have shared a ride even absent the incentive of premiere service in a congestion-free lane.

8 Yoram Shiftan, personal communication, June 2000.

9 The project's central proponent, Nitzan Yotzer, begins presentations on the HOT project by underscoring "congestion" as the country's key transport problem. In fact, when asked in a recent Knesset-sponsored symposium on transport to identify Israel's three top-ranking transport problems, he declared these to be: "congestion, congestion, and congestion!"

[10] Government of the Netherlands, Den Haag. After Table 22 in Nigel Lewis.