

# Lessons Learned From International Experience in Congestion Pricing

## *Final Report*

*August 2008*

*prepared for*  
U.S. Department of Transportation,  
Federal Highway Administration



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## **Foreword**

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# SI\* (MODERN METRIC) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
<b>AREA</b>				
in <sup>2</sup>	square inches	645.2	square millimeters	mm <sup>2</sup>
ft <sup>2</sup>	square feet	0.093	square meters	m <sup>2</sup>
yd <sup>2</sup>	square yard	0.836	square meters	m <sup>2</sup>
ac	acres	0.405	hectares	ha
mi <sup>2</sup>	square miles	2.59	square kilometers	km <sup>2</sup>
<b>VOLUME</b>				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft <sup>3</sup>	cubic feet	0.028	cubic meters	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.765	cubic meters	m <sup>3</sup>
NOTE: volumes greater than 1000 L shall be shown in m <sup>3</sup>				
<b>MASS</b>				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
<b>TEMPERATURE (exact degrees)</b>				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
<b>ILLUMINATION</b>				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m <sup>2</sup>	cd/m <sup>2</sup>
<b>FORCE and PRESSURE or STRESS</b>				
lbf	poundforce	4.45	newtons	N
lbf/in <sup>2</sup>	poundforce per square inch	6.89	kilopascals	kPa
<b>APPROXIMATE CONVERSIONS FROM SI UNITS</b>				
Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
<b>AREA</b>				
mm <sup>2</sup>	square millimeters	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	square meters	10.764	square feet	ft <sup>2</sup>
m <sup>2</sup>	square meters	1.195	square yards	yd <sup>2</sup>
ha	hectares	2.47	acres	ac
km <sup>2</sup>	square kilometers	0.386	square miles	mi <sup>2</sup>
<b>VOLUME</b>				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m <sup>3</sup>	cubic meters	35.314	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	cubic meters	1.307	cubic yards	yd <sup>3</sup>
<b>MASS</b>				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
<b>TEMPERATURE (exact degrees)</b>				
°C	Celsius	1.8C+32	Fahrenheit	°F
<b>ILLUMINATION</b>				
lx	lux	0.0929	foot-candles	fc
cd/m <sup>2</sup>	candela/m <sup>2</sup>	0.2919	foot-Lamberts	fl
<b>FORCE and PRESSURE or STRESS</b>				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in <sup>2</sup>

\*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.  
(Revised March 2003)

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# EXECUTIVE SUMMARY

## Overview

Large road pricing projects have been implemented in U.K., France, Norway, Sweden, Germany, Switzerland, Singapore and Australia over the past three decades. Additionally, congestion pricing has been analyzed and evaluated through numerous studies in nearly all EU member countries, in Southeast Asia, Canada, Australia and New Zealand.

To further understanding of international pricing, “Lessons Learned from International Experience in Congestion Pricing” provides a summary of selected operational areawide congestion pricing projects outside of the U.S. The report draws lessons from a sample of projects with the richest and most relevant experience, focusing on three comprehensive area wide projects: Singapore, London and Stockholm. Each received in depth attention during planning, design, implementation and operational phases and have been monitored and evaluated carefully. These projects should be of particular interest now that several U.S. cities are beginning to examine similar area wide pricing strategies to address congestion, environmental, energy and funding problems in heavily congested downtown areas.

In addition to the lessons derived from the three key projects, this report includes a summary of available overseas literature on more than the three specific projects, including attention to equity, economic impacts and the acceptability of congestion pricing. Research on acceptability is especially detailed in Europe and United Kingdom and provides valuable lessons for U.S. cities interested in pursuing such policies. The report concludes with overall findings and lessons related to travel, costs and revenues, equity and economic impacts, environmental impacts; and public acceptance.

## Findings & Conclusions

**Mobility:** Without exception, areawide pricing strategies implemented abroad have met their principal objective of reducing congestion and sustaining the relief over long periods. Areawide pricing in Singapore, London and Stockholm resulted in 10 to 30 percent or greater reduction in traffic in the priced zone and has sustained the reductions over time. The speeds increased significantly within the zone as well as outside along approach roads. Ten to thirty percent increase in speed has been realized. Buses in Singapore and London have particularly benefited from speed increases. In the three areawide pricing programs described in Section 2, up to 50 percent of those foregoing car travel to the priced zone shifted to public transportation. In London and Stockholm, the greatest shift was to public transportation while in Singapore it was to 4+ carpools and to the shoulder time just before the start of pricing. The traffic reductions in priced zones have been sustained over thirty years in Singapore and five years in London.

**Revenues/Costs:** The significant revenues generated by pricing have been seen as an important source of benefits in all three projects reviewed in this report. Project revenues in London and Stockholm (as well as in toll cordon projects in Norwegian cities) have been used to cover operating and enforcement costs first and remaining revenues have funded improvements to bus and rail services. In London and Stockholm, the desire and ability to use pricing program revenues for public transportation was a major objective and “selling” point. In Singapore, while the revenues are not directly earmarked for public transportation, the availability of these funds probably has allowed the government more easily to pursue ambitious public transportation programs. Also, areawide pricing projects are generating revenues far in excess of costs. In Singapore’s Area Licensing Program, revenues were more than ten times the operating costs. The revenues under the central area cordon pricing are nearly 14 times the operating costs. If capital costs are included, the revenues are still 2.5 times the costs. For the London charging program, the revenues have been a little over twice the operating costs. Inclusion of capital costs brings this ratio down only marginally.

**Economy and Business:** Arealong congestion pricing applications likely have realized societal economic benefits in excess of costs. Singapore’s 1975 program is estimated to have achieved a rate of return on investment of at least 15%, even without inclusion of realized savings other than the value of time savings. The London scheme is estimated to have generated a B/C ratio of 1.4. Regarding business impacts, in Singapore, surveys suggested that the pricing did not change business conditions or location patterns. Overall, the business community responded positively to the program. Analysis indicates pricing in London has neutral regional economic impacts, though annual surveys suggest businesses in the priced zone have outperformed those outside. A majority of businesses continue to support the charging scheme, provided investments in public transportation are continued. In Stockholm surveys, albeit over a very short time span of trial, no identifiable impacts on retail business or household purchasing power were identified. The long term study of overseas congestion pricing conducted by CURACAO finds “generally low level of measured impact” on regional economies. While the result may be partly attributable to the unique economic vitality and strength of the cities in which pricing occurs, there is no evidence of economic damage.

**Environment:** Better environment has been one of the primary objectives of the Stockholm areawide program, though not a major objective behind London and Singapore pricing programs. However, all three have made attempts at monitoring and measuring air quality implications of changing operating speeds, number and timing of trips or the mode on which trips are taken. Evaluators in Singapore concluded that the tailpipe emissions most likely declined in the priced zone because there was such a large reduction in automobile travel. Regarding smoke and haze, measurements showed declines, but they could not be unambiguously attributed to the pricing. Analysis in London shows changes in air quality within and alongside the Inner Ring Road boundary of the zone. Levels of NO<sub>x</sub> fell by 13.4% between 2002 & 2003, CO<sub>2</sub> by 15%, and particulates (PM10) by 7%. More recent analysis confirms the trend. Some of these reductions are attributed to the effects of reduced levels of traffic flowing more smoothly, but the majority due to improved vehicle technology. Generally, it appears areawide

pricing has had a role in reducing pollution. As well, public transportation expansion, made possible by the congestion charge revenues, has the potential to reduce pollutants and sustain reductions over time.

**Equity:** Equity impacts have received general analytic attention but little project level evaluation. The focus has been on varying concepts of equity, modeling of impacts and pricing designs to address income equity issues. At the level of projects or proposed projects, Singapore has examined equity impacts; Edinburgh has grappled with equity and general fairness considerations and several toll rings in Norway have designed schemes with equity in mind but not done detailed equity evaluations after project implementation. Regarding specific cities reviewed for pricing activity, the perception that congestion pricing is “unfair” to low income drivers has not been a major concern in Singapore, London and Stockholm after implementation. Findings from Singapore are most in depth, though experience in the proposed Edinburgh program also is instructive. In Singapore, the results of modeling analysis based on before and after user survey data suggested that gainers outnumbered losers 52 to 48%. Attitudinal surveys carried out after program implementation show pedestrians, taxi riders and residents outside the priced zone found the impact as neutral or negative while cyclists, bus passengers and residents within the zone judged pricing as favorable. Car drivers and passengers judged the program as mildly unfavorable. Travel evaluations and stakeholder surveys found increases in transit were fairly uniform for low, medium and high income peak period travelers. The evaluators concluded that, overall, there were only small differences among income groups in modal response. There was also no evidence that trip times increased or decreased more for any particular income group. In Edinburgh, issues of revenue distribution and transit improvements were vital to geographic equity considerations. Non-city residents viewed revenue distribution plans as unfair since they would pay the charge but not get any direct benefit. A key institutional issue appears to be neighboring authorities had no legal grounds to support public transport improvements which might have appealed to non-city residents. City residents would also have benefited disproportionately more from the public transport improvements. In short, Edinburgh shows geographic equity and improvement plans can make or break pricing plans. A CURACAO publication reviewing equity issues across programs urges attention to the design of pricing programs, including location, time of day and level of charge; the use of exemptions and rebates; provision of travel alternatives and use of surplus revenues to moderate perceived equity issues.

**Acceptability:** Based on project experience and public opinion studies on pricing, certain key factors emerge as potential determinants of public acceptance:

- The problem addressed resonates. Whatever the mix of problems addressed by pricing proposals, whether congestion, pollution or some combination, acceptability is enhanced where the problem is clear and severe to affected parties. Congestion may or may not be the most central candidate problem for pricing; pollution may be more resonant. Pricing plans enhance implementation prospects when they home in on the most resonant problem or problems.

- **Pricing Is Convincingly Effective:** Acceptability studies suggest the public or decision makers may be skeptical about the effectiveness of pricing in reducing congestion or pollution. The implication is proposals will have better prospects where they can demonstrate effectiveness, perhaps by reference to like projects or through well evaluated test programs or both.
- **Program Design Meets Program Concerns:** Acceptability of pricing is enhanced where pricing program parameters are in line with public and decision maker concerns. Top concerns will vary by area, but planners increase the odds of acceptance by determining the concerns and structuring the program accordingly. Some top concerns may be about “free riders” and enforcement; others may be about complexity of technology; others about specific groups facing hardship or adverse boundary effects. Implementation prospects improve with full attention to specific concerns.
- **Revenue Distribution Follows Preferences:** Gearing revenues toward most favored purposes is important to acceptability. Research shows revenues directed toward transit and/or road improvements may garner support in some locations, but may compete with other preferences elsewhere, including possible tax reductions.
- **Fairness Is Broadly Addressed:** Equity across income groups subject to pricing often leads equity discussions among analysts of road pricing. However, research shows acceptability does not vary greatly across income groups and equity defined more broadly may dominate and deserve more attention. Specifically, these fairness perspectives may be key: fairness of outcomes, i.e. assurance some are not evading the pricing scheme who should be paying; “procedural” fairness, i.e. people feeling full opportunity to participate in developing pricing plans; fairness to special groups, e.g. handicapped or emergency workers; use and spatial fairness where occasional payers reap the same benefit from new roads and transit as frequent users; and ways to moderate different treatment of travelers within or to/from a cordon scheme.
- **Government Planners Are Open, Responsive, Resourceful Solution Partners:** Numerous findings suggest how government pricing planners are perceived may be as important to acceptance as the nature of their pricing proposal(s). It seems if government has at least some favorable image coping with bottlenecks, improving transit, improving traffic management, acceptability of pricing proposals is enhanced – and visa versa. Likewise important is sensitivity to governmental image as a taxing entity with already sufficient resources to deal with congestion. Transparency in pricing planning and decision making also will enhance acceptability, including the degree to which non-pricing options have been examined; and the extent of reference to pricing experience elsewhere. Finally, government as resourceful partner in the solution is important to acceptance, suggesting state and national governmental agreements and matching funds may be a necessary step.

- **Pricing Schemes Operate Over Time:** A consistent finding is acceptance tends to grow the longer pricing programs are in existence. The exact reasons for growing acceptance are not well explored. It may have to do with experiencing demonstrating no harm to business, absence of feared queues at tollgates and the visible, proven link between revenues and transportation improvements. In any case, growing familiarity with successful operations seems to enhance acceptability over time.

In terms of implementing pricing programs, a few key points emerge from overseas experience:

- Areawide pricing often requires new policy and institutional arrangements. Major national level legislative initiatives were enacted before areawide pricing could be implemented in London and Stockholm. The experience shows that formal agreements may be needed for: power to impose and collect charges; use of selected technology to administer and enforce charges; to cite violators and collect fines; make modifications to the pricing scheme; and for the use of revenues from the charges. Experience also shows that policy and institutional arrangements and agreements have profound impact on public and political acceptability of areawide pricing proposals and operational success. Acceptability research shows stakeholder involvement and funding across government levels also are important.
- Successful projects depend on effective outreach and sensitivity to public acceptability. All of the projects overseas have paid considerable attention to measuring public attitudes and reaching out to the public, stakeholders, and elected officials to further understanding of pricing and assess reactions. Outreach efforts as part of initial feasibility studies often find neutral or skeptical opinions, or outright resistance, which is often followed by acceptance as projects get underway. The support of a key stakeholder and/or a senior politician who is able to influence public opinion also seems crucial to furthering implementation prospects. While businesses have not been obstacles to implementation and are generally accepting of pricing, continued support at least in London appears to hinge on continued investment in public transport.
- Effective, reliable and acceptable pricing and enforcement technologies are key to implementation. Technology is important to the success of most pricing concepts, and the technology has been generally up to the task. Various technologies for pricing and enforcement, both low and high end, generally are proving reliable and effective. The Singapore windshield license and manual enforcement system worked well in early stages and the electronic successor using in-vehicle transponders with stored value “Smart Card” technologies is working well. London’s license plate recognition system has been effective, though plans are underway to move to an electronic system to reduce administrative costs and allowing variable pricing schedules.

## **A Look to The Future**

Much has been learned about the promise and potential of areawide pricing over the last several years, but much more remains to be learned. Long-run impacts on land use, auto ownership, business and productivity need to be monitored over time. Continued progress in implementing acceptable, effective and informative pricing programs has required careful planning, coalition building, public education and participation, and sufficient time and resources for the development of well designed and locally acceptable project plans. Given the overseas track record to date, more successful implementations can be expected and these will provide much needed long term lessons.

Areawide pricing holds the promise of reducing congestion, enhancing mobility and economic productivity, reducing environmental and energy costs, and providing new sources of funding for transportation investments. Despite this potential, the concept of congestion pricing remains controversial in many potential applications. It involves a new approach to dealing with congestion problems and charging for road use. Nevertheless, the overseas programs demonstrate favorable outcomes are possible with careful and inclusive planning and outreach and, as the acceptability literature suggests, each new program enhances the prospects for further applications.

The overseas experience provides a valuable guide to planners in exploring the feasibility of future pricing applications and identifying projects for implementation. A particularly important consideration in U.S. cities considering areawide pricing is the use of revenues generated by pricing to address and mitigate equity issues of the most concern within specific area studies. At the same time, operating pricing programs abroad have demonstrated the wisdom of a broad definition of and attention to fairness versus simple income equity. Extensive findings summarized here point to the link between fairness and acceptability.

Finally, overseas experience suggests the need for focusing more on the potential environmental and energy benefits of pricing. Overseas analysts have made limited but important preliminary findings about air quality impacts, and more work can be expected. While the air quality and energy conservation benefits of small-scale U.S. pricing projects implemented to date may have modest effects on overall regional environmental quality, areawide projects beginning to receive attention in the U.S. may have more potential benefit. Planners will do well to pay continued attention to environmental results and evaluation methods from overseas.

# 1. INTRODUCTION

## 1.1. Background

Over the past thirty years, congestion pricing concepts have received considerable attention outside of United States. Compared to the U.S., Britain, Europe, and countries in Asia and the Pacific region have a longer history of interest in exploring the potential of pricing approaches to address congestion, environmental and transportation funding problems. Individual countries, as well as the European Union (EU), have established road pricing initiatives aimed at studying, implementing and evaluating a wide range of congestion pricing demonstrations and operational programs.

Pricing approaches have been considered seriously in nearly all EU member countries, in Southeast Asian countries and in Canada, Australia and New Zealand. Numerous cities across Europe, Asia and Pacific region have set up limited demonstration projects. Additionally, large-scale operational pricing projects have been implemented in Canada, U.K., France, Norway, Sweden, Germany, Switzerland, South Korea, Singapore and Australia over the past three decades. These projects have demonstrated that pricing can be effective means of managing demand and generating revenues and can be politically and publicly acceptable. Pricing reduces congestion on facilities and in priced areas, changes travel behavior, improves utilization of existing road capacity and achieves the goals of demand management, emission reductions and revenue generation. Revenues from pricing have been used to provide funding for transportation improvements.

Much like the U.S experience, overseas pricing projects are breaking new ground and providing important lessons for those interested in exploring the use of market-based approaches in responding to traffic congestion. Projects implemented to date reveal that travelers are willing to pay for improvements in transportation service and that pricing can lead to more efficient use of existing facilities. People respond to price signals when making transportation decisions. Although pricing is operational in a number of locations abroad, it is still a new and innovative concept, one that requires careful planning, coalition building, public education and participation, and sufficient time and resources for the development of well designed and locally acceptable project plans.

All in all, international experience with pricing appears to holds great promise for reducing congestion, enhancing mobility and economic productivity, reducing environmental and energy costs, and providing new sources of funding for transportation investments. However, despite the promise and potential shown in early pricing projects, experience suggests careful planning, design, outreach and evaluation are still important project components.



## 1.2. Purpose and Overview

Some international cities and countries have been successful in implementing congestion pricing, and others have conducted detailed feasibility studies. States and metropolitan area transportation professionals and elected officials in the United States can benefit from an understanding of the key travel, traffic, equity and environmental impacts, and acceptance issues evident from these international pricing projects. These are key issues of interest to those in the United States who are weighing potential congestion pricing proposals and plans.

To further understanding of international pricing, this “Lessons Learned from International Experience in Congestion Pricing” report provides a summary of selected operational congestion pricing projects outside of the U.S. The report draws lessons from a sample of projects with the richest and most relevant experience, as well as from the most relevant literature relating to the acceptability of congestion pricing based on more than past twenty years of experience with adoption (and rejection) of pricing proposals overseas.

Starting in 1975 when Singapore implemented its area wide pricing program, more than twenty pricing projects have become operational outside the United States. While the U.S. pricing programs to date have focused largely on introduction of variable pricing on single facilities, most of the pricing projects abroad have introduced area or region wide congestion pricing. Many of these overseas pricing projects charge for entering or traveling within a congested zone (such as downtown). Some have focused on pricing traffic entering entire urban regions. Others have introduced congestion pricing on expressway networks.

Following this introduction, Section 2 provides a summary of selected projects with lessons most relevant for U.S. officials. Of more than twenty pricing projects implemented overseas, this report focuses on three comprehensive area wide projects that have become operational after long gestation periods. The projects are in Singapore, London and Stockholm. Each received in depth attention during planning, design, implementation and operational phases and have been monitored and evaluated carefully. These projects have been selected because U.S. cities are beginning to look with much interest at similar area wide pricing strategies to address congestion, environmental, energy and funding problems that have become endemic in heavily congested downtown areas. Although the U.S. pricing projects sponsored by the Value Pricing Pilot Program over the past twenty years have generated many important lessons relating to adoption of various pricing concepts, area wide pricing applications have yet to be implemented in the U.S. The overseas experience with area wide pricing projects can help inform this promising pricing concept for the U.S. audience.

In addition to the lessons derived from the three key projects, Section 3 includes a summary of findings from literature on the acceptability, economic and business impacts,

and equity implications of congestion pricing based on more than past twenty years of experience with adoption (and rejection) of over 30 pricing proposals overseas. Much evidence relating to public and political acceptance of congestion pricing has been synthesized in Europe and United Kingdom and can provide valuable lessons for U.S. cities interested in pursuing such policies.

General conclusions and lessons are provided in Section 4. In addition to lessons learned related to mobility (driver behavior under pricing and the impacts on traffic throughput and delay reduction), we also provide lessons related to revenues and costs; equity; environmental benefits and impacts; and public acceptance.

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## **2. SUMMARY OF SELECTED PROJECTS AND FINDINGS**

This section summarizes experience with area wide pricing in Singapore, London and Stockholm. We have described the Singapore experience in greater depth than London and Stockholm because information about the Singapore pricing programs is somewhat scarce and more difficult to access while information about London and Stockholm is relatively more abundant and accessible.

The section provides impact findings for each project relating to mobility, costs/revenues, environment, equity (where available), economic/productivity, business and public acceptance, and outreach.

### **2.1. Singapore Area License Fees and Electronic Road Pricing**

#### **Context**

Singapore is an island nation with land area of 250 square miles. Its population has grown from 2.3 million in 1975 to 4.5 million (3.5 million in the city) in 2005. Singapore's GDP per capita in was US\$30,000 in 2007. The number of vehicles grew from 275,000 in 1975 to 750,000 (430,000 cars) in 1998. Daily trips increased from 2.7 million in 1980 to 7.7 million in 2000. Sixty-three percent of these use public transportation.

The central business area has also experienced fast growth in employment and retail and office space. In short, it has been a rapidly growing developed nation with vibrant economy and high income levels.

The central business area has limited street capacity and experienced heavy congestion as far back as in the early 1970s. In this context, Singapore started pursuing automobile demand management strategies in the early 1970s.

#### **Pricing Program**

##### *Area Licensing Scheme (1975-1998)*

Congestion pricing has been a major component of traffic management and emissions reduction in Singapore since 1975 when a charge of S\$3.0 (~US\$1.30) was introduced for vehicles entering the 2.0 square-mile central business area ("Restricted Zone" - RZ) between 7:30 and 9:30 in the morning. Buses, motorcycles, police vehicles and HOV 4+ were excluded from charges.

The vehicles entering the RZ along any of the 28 entry points during the pricing period were required to display a pre-purchased daily or monthly windshield license. The licenses were sold at retail outlets (banks, stores, service stations) and at roadside booths.

Violators were identified at the entry points by roadside enforcers and citations were sent to vehicle owners by mail. Heavy fines were set up to discourage violations.

Introduction of congestion pricing was accompanied by: provision of new Park-and-Ride lots with shuttle service into the RZ; expanded bus service (33% increase); and a decrease of 30% in RZ parking rates.

The Area Licensing Scheme (ALS) pricing zone is shown in Exhibit 1a.

Since introduction, the Singapore congestion pricing program has gone through several modifications and expansions. Soon after introduction, the charging period was extended to 10:15 AM to reduce travel shifts to the shoulder period (9:30 to 10:15). During the subsequent thirteen years, modifications were made to the daily license rates and the extent of the downtown priced zone. By 1988, the daily rate had gone up to US\$2.50. In 1989, the morning peak period ALS was extended to cover trips in the evening peak period and exemption for 4+ carpools and taxis was eliminated. In 1994, all day congestion charges were introduced for travel within the priced zone with mid-day trips paying a discounted rate of US\$1.50, and windshield license-based pricing was introduced on three motorways outside of the central business zone.

#### *Electronic Road Pricing (ERP) (1998 - Ongoing)*

After extensive field tests during 1995-1997, Electronic Road Pricing (ERP) with charges varying by time of day, location and type of vehicle was introduced in 1998 for vehicles entering the central priced zone and at three points along three motorways. Subsequently, pricing has been extended to many more points on all motorways.

As of 1998, the pricing program (“Electronic Road Pricing”, or ERP) has been fully automated and charges are now collected electronically at more than 50 charge points spread across the city. The “ERP” charge point locations as of 2005 are shown in Exhibit 1b and 1c. Exhibit 1c shows the charge points for controlling access/egress to/from the central business zone (CBZ), while Exhibit 1b shows all of the charge points in operation in the entire city in 2005 – including those in the CBZ, as shown in the inset - roughly corresponding to the original Area Licensing Zone. Other charge points at selected locations along the heavily used principal expressways are also shown in Exhibit 1b.

The ERP program started with operations from 7:00 AM to 7:00 PM. The charges vary by location, time-of-day and vehicle type and are adjusted every calendar quarter to keep the traffic free flowing within the central business zone and to keep speeds on the principal expressways and arterials within the “golden ranges” (45-65 KPH on expressways and 20-30 KPH on other streets). The operating authority continues to expand the number of charge points over time as traffic conditions evolve.

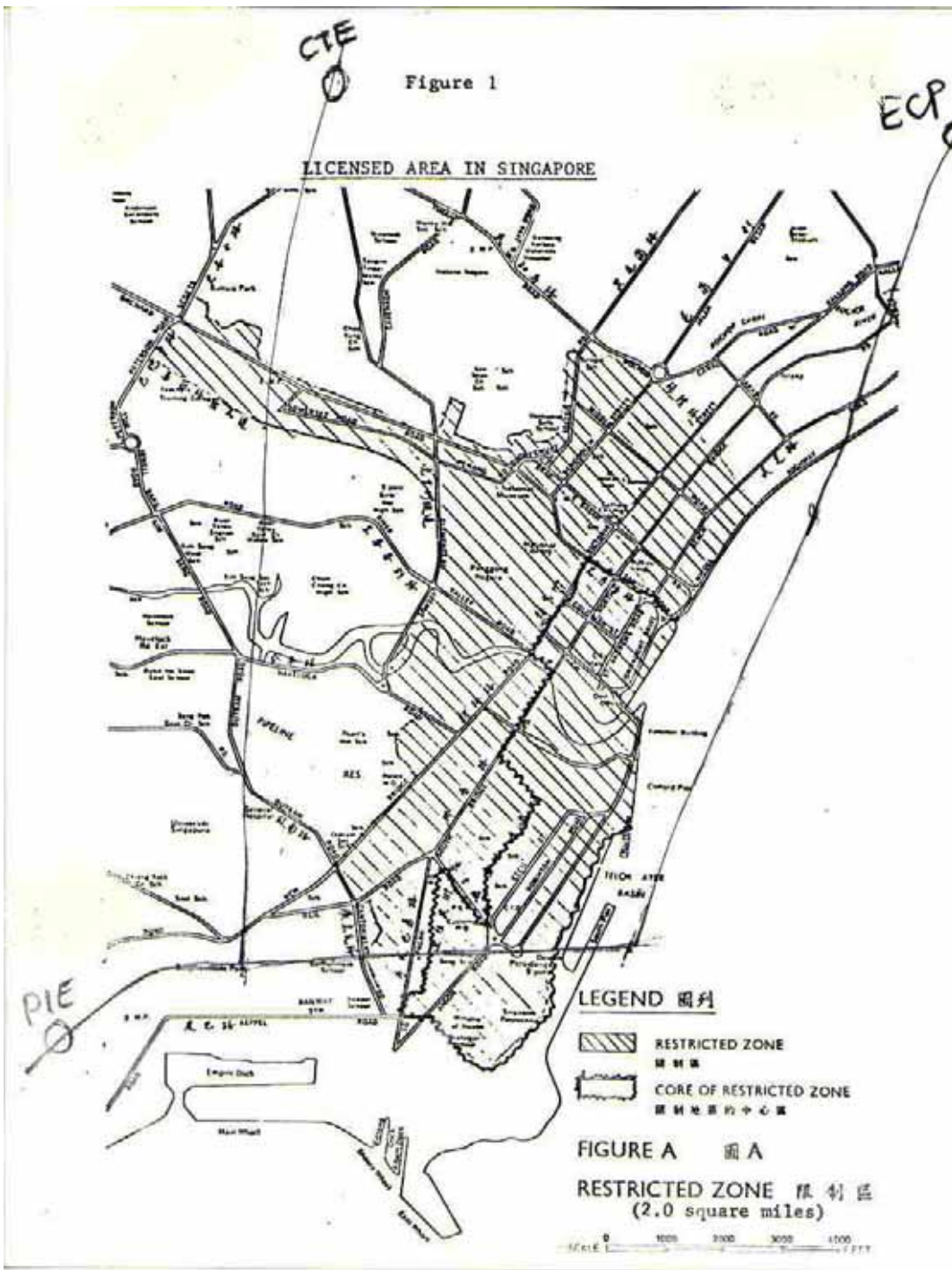
Currently, the charge period in the central RZ is in effect from 7:00AM to 7:00PM (Monday through Friday) and charge rates vary from zero to approximately US\$2.00 per crossing at a charge point. On expressways, the prices are in effect weekdays from

7:00AM to 9:30AM (with additional PM outbound charges on one of the freeways). The rates vary from zero to about US\$4.00. Also, a few of the arterial streets are priced weekdays from 7:00AM to 9:30AM and the prices vary from zero to about US\$0.80.

Any vehicle traveling through a pricing location is required to have a functioning “In Vehicle Unit - IU” (a transponder) fitted on the dashboard with a “stored value smart card” inserted in the IU and with a sufficient monetary amount stored on it. IUs have visual displays and audio signals to inform the driver about deducted charges or low balance. The “smart cards” are issued by a consortium of banks and can be topped off at banks or ATMs. They can also be used at many retail establishments for purchases.

Overhead gantries at the pricing locations, relying on DSRC technology, identify the “health” or functioning of the IU, and IU class to recognize vehicle type, and deduct the appropriate charge amount from the stored value card. Violations and malfunctions are also detected by the gantry at which time enforcement cameras are triggered to capture the license plate number for citation by mail. Vehicles with no IUs face a fine of US\$50 and those with insufficient money in their “smart card” face a US\$6 administrative charge. The violation rates have been kept at around 0.3 percent. The technology allows identification and charging to take place at full freeway speeds (up to 120 KPH) in a multilane open system without tollbooths or lane restrictions and without a need to slow down. Every day there are about 300,000 pricing transactions.

Over the past thirty years, the expansion of the congestion pricing program has been accompanied by major reforms and expansion in vehicle taxation policies as well as significant enhancements to public transportation services including introduction and expansion of mass rapid transit, light rail and bus systems.



**Exhibit 1a: Singapore CBD Priced Zone; Area Licensing Scheme (ALS) (1975-1998)**



**ERP** **Exhibit 1b: Singapore Electronic Road Pricing (2005)**  
**[CBD Priced Zone (Inset) and Expressways (Red)]**



**ERP** **Exhibit 1c: Singapore CBD Priced Zone (2005)**



## Findings

### *Mobility Impacts*

Introduction of ALS in 1975: In the early 1970s, the AM peak period was characterized by bumper-to-bumper traffic on many streets in the downtown business area, which subsequently became the Restricted Zone (RZ). The Area Licensing Scheme (ALS) in 1975 introduced an AM peak charge of about US\$1.30s for vehicles (excluding HOV 4+, motorcycles, buses and police and emergency vehicles) entering the RZ. The program worked smoothly with low violations (1-2%).

Vehicles entering the RZ declined from 74,000 to 41,200 (44% reduction), with car entries declining by 73% (from 42,800 to 11,400). The pricing resulted in shifts to HOV 4+ and bus, shift in trip departure times and some route shifting. Among vehicle owning households with RZ employment, non-SOV share of trips declined from 48 to 27%. HOV 4+ share went up from 8 to 19% and bus share increased from 33 to 46%.

At first there was a surge in vehicles entering just after the charge period ended at 9:30 AM and, in response, the charging time was extended to 10:15 AM. This resulted in an increase, from 28 to 42%, in commuter trips with destinations within the RZ departing home before the 7:30 AM start of charging and. The shift to earlier departure times also reduced auto traffic by a further 5 percent during the charging period. Overall traffic rose 13% in period before 7:30 AM, but did not cause noticeable traffic delays. Through traffic using the RZ in the AM charging period declined by 25 percent.

Congestion inside the RZ was virtually eliminated. Speeds inside the RZ in the AM peak increased by 20 percent or more (including for buses). On most congested streets, the speeds went up from 15-18 KPH to 30 KPH. Additionally, there was a 10% increase in speeds on inbound radials leading to the RZ. However, along with these improvements, the speeds on the bypass route dropped by 20 percent.

Longer Term Impacts Through 1988: HOV 4+ as a percentage of all car traffic entering the RZ in the AM peak increased from 41% in 1976 to 54% by early 1980s, but then declined – likely as a result of major expansion and improvements in the public transportation modes (Buses, Rail Transit and LRT). From the time of introduction of the ALS in the mid-1975 to 1988, the car population in Singapore increased 72%, but the volume of traffic entering the RZ in AM peak only rose 24%. The original ALS program in 1975 had resulted in overall auto share for commuters to the RZ decreasing from 56 to 46%. By 1983, this share declined and stabilized at 23% despite large increase in auto ownership and a 34% increase in RZ employment. Over the same 1976 to 1983 period, the public transportation share of AM peak trips to the RZ increased from 33% to 69 percent.

Post-1988: In June of 1989, ALS pricing was extended to the PM peak period and the HOV 4+ exemption was eliminated. In response, during the PM peak, traffic entering the RZ declined by 54% and the AM peak traffic entering the RZ declined by 14 percent.

Post-1998 Electronic Road Pricing (ERP) Phase: Weekday traffic entering the RZ has dropped 24 percent from 271,000 vehicles to 206,000 vehicles per day. This decline has resulted in average speeds within the RZ increasing from 30-35 KPH to 40-45 KPH.

### *Cost and Revenue Impacts*

Initial capital costs of the ALS component in 1975 were estimated to be S\$500,000 (~US\$210,000). The annual operating costs during the period 1975-1988 were estimated to be S\$600,000 (~US\$250,000). Estimated annual revenues during the period were about S\$6,800,000. Thus, the revenues were about 11 times the costs.

Capital costs of the ERP System have been estimated to be S\$200 million (US\$110 million at the time of implementation in 1998), half of which was purchase and installation of about 1.1 million IU units. In the early 2000s, nearly 300,000 daily transactions were generating daily revenues of about S\$600,000 suggesting annual revenues of more than S\$150 million (US\$100 million at 2005 exchange rates).

### *Environmental Impacts*

Evaluations relied on both direct roadside measurements as well as derivations based on changes in travel. Immediately following the introduction of the ALS in 1975, measured CO concentrations in the morning peak within RZ declined to a level below that prevailing in the middle of the day. At least some of the reduction can be attributed to the pricing scheme (ALS). The measurements of NO<sub>x</sub> showed a decrease in monthly average values. This can be fully ascertained as the result of the ALS. Evaluators concluded that the tailpipe emissions most likely declined in the RZ because there was such a large reduction in automobile travel. Regarding smoke and haze, measurements showed declines, but they could not be unambiguously attributed to the ALS. Subsequent surveys also revealed overall reductions in the RZ as a result of reduced and more dispersed automobile travel patterns.

Evaluators of the ALS program included pedestrian safety and amenities as an “environmental” impact measure. The decreased vehicle traffic within the central RZ was found to have increased perception of pedestrian safety by reducing the conflicts and delays at street crossings.

### *Equity Impacts*

The results of modeling analysis based on before and after user survey data suggested that the losers would include those destined to the RZ who switch from cars to buses or to less desirable times, those encountering increased congestion on by-pass roads outside the RZ, and those who continue to drive, pay the charges but whose value of time saved is less than the charge. On the other hand, transit riders, after some initial increase in crowding, began to enjoy much better service as public transportation was expanded significantly over time. Similarly, HOV 4+, motorcyclists and pedestrians enjoyed

significant increases in travel benefits. This group who likely benefited constituted a majority (52 percent) of the pre-ALS trips to the RZ.

Attitudinal surveys carried out after the introduction of ALS pricing also provide indications regarding equity across various dimensions. Pedestrians, taxi riders and residents outside of RZ found the impact of the ALS as neutral or negative while cyclists, bus passengers and residents within the RZ judged the ALS as favorable. Car drivers and passengers judged the ALS as mildly unfavorable. Overall, middle income travelers felt adversely affected by the ALS.

Several evaluations based on before and after travel data and stakeholder surveys allow some equity related findings to be examined more empirically. The data on shift from cars to buses as a result of ALS in 1975 show that the increases in transit are fairly uniform for low, medium and high income peak period travelers to the RZ – a change of 25, 34 and 28 percent bus share, respectively. A priori expectation would have been a higher percentage of low income travelers shifting to buses as compared to the higher income groups. The evaluators concluded that, overall, there were only small differences among income groups in modal response to the ALS. There was also no evidence that trip times increased or decreased more for any particular income group. All in all, the evaluators did not find that low income travelers suffered more than high income ones due to the ALS pricing.

Addressing the fairness of pricing in Singapore, supporters claim that without pricing there was, and would be, a great imbalance between the travel conditions enjoyed by car drivers (a minority of travelers) compared to the majority who use alternative modes. The ALS is perceived as far from unfair because it is said to have redressed a greater inequity and has allowed much greater increase in public transportation and road efficiency.

#### *Economic Productivity and Business Impacts*

Productivity: Benefit-cost analysis by World Bank economists in 1978 suggested that the ALS pricing produced net benefits. The estimated rate of return on investment taking into account only the benefits of time savings was 15 percent. Realized savings in operating costs, fuel and accidents would increase the realized rate of return, as would exclusion of the large capital costs of unsuccessful park and ride lots.

Other economic assessments of the ALS program from 1975 through 1988 suggested that pricing not only reduced congestion dramatically, but also kept the RZ mostly free of congestion over the entire period even as the income, employment and business activities were growing dramatically. Thus, the ALS pricing has allowed Singapore to defer or cancel major investments for roads. The savings have been estimated to be on the order of S\$1.50 billion (more than US\$1.0 billion at current exchange rates).

In the public transportation sector, bus operators increased their revenues due to the significant increase in patronage. According to many analysts, increased ridership and faster speeds have almost certainly resulted in increased productivity of operations.

Business Impacts: An objective assessment of business impacts based on long-term economic data was not carried out. Instead, stakeholder surveys were conducted to derive plausible impacts of the ALS on certain dimensions of business productivity.

In the absence of time series data, the analysis of surveys suggested that ALS pricing, by itself, did not appear to be a factor in rents and does not seem to have had a negative impact on office development in the RZ. Other factors appear to be much more important to investment decisions.

Regarding retail sales, in 1976, it appeared that the ALS had a minor impact on sales in the RZ compared to other economic and developmental factors. Hotel representatives did not see any appreciable negative impact of the ALS. Overall, the ALS, by itself, was not perceived as a negative factor. In contrast, when ALS was modified in 1989 to cover PM peak travel, some retail shops reported sharp declines in afternoon trade and some resorted to offering ALS fee reimbursements.

Post-ALS implementation surveys also found that the ALS apparently did not adversely affect labor availability, though this may have been more due to improved public transportation. Over several years, when employment in the entire state of Singapore increased by 32 percent, employment in the central area increased by 34 percent.

Overall, it appears that the ALS did not, by itself, initiate changes in business conditions or location patterns. Overall, the business community responded positively to the ALS, probably believing that the combined package of actions by the government was necessary and beneficial in the long run.

#### *Public Acceptance and Outreach*

Given the governmental structure in Singapore, authorities could have implemented congestion pricing with little or no public involvement. Instead, authorities carried out a year-long intense assessment and education program. They responded to public reaction by making adjustments to the pricing program before implementation. The Government has continued to modify and expand the pricing program incrementally ever since its beginning in 1975.

The government also packaged the pricing program to enhance acceptability. Leaders introduced broad improvements that both preceded and accompanied the introduction of pricing. Among other things, congestion pricing reforms have been packaged with major expansion in public transportation modes and services and reductions in certain vehicle purchase and ownership taxes. As well, pricing came on board at the same time as other highly visible and welcome government actions such as large-scale provision of modern, new, subsidized housing outside the central area replacing old dilapidated “slum” housing in the center. The evolution of pricing since its start in 1975 has accompanied major developments of rapid transit, light rail and deluxe bus services.

The public has continued to be made aware of the success of efficiently performed and highly beneficial government functions and programs (safety, welfare, health, income security, job opportunities, etc.) and congestion pricing is portrayed as another such policy necessary to ensure long-term economic growth and quality of life.

Generally, people in Singapore reacted favorably to the pricing and accompanying package of improvements. Early skepticism has been addressed effectively via information and on-ground experience. It seems the public has come to accept and respect bold policy initiatives like pricing and have largely trusted the authorities as purveyors of effective public services.

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## **2.2. Central London Congestion Charging**

### **Context**

Much of the information provided in this sub-section is extracted from TfL (2004, 2005, 2006, 2007), CURACAO (2007) and Wikipedia (2008).

Congestion pricing has been on the agenda in London since the Smeed Committee Report proposals in 1964. Greater London Council supported a preliminary feasibility studies of areawide application of congestion pricing in 1965 (“Supplementary Licensing Study”) and a subsequent detailed 1973 Study which concluded that congestion pricing in central London will improve traffic and environment and raise revenues. A decision was made, however, to reject the plan in favor of greater investment in public transportation. In 1995, another research program concluded that city’s economy would benefit from congestion pricing.

In 1999, a national legislation conferred powers to the Greater London Authority to introduce road user charges. Also, for the first time in Britain, the revenues from such charges were made available to the local authorities. Mayor Livingston was elected as the first Mayor of newly empowered Greater London Authority in 2000 with central London road user charging as the top item in his manifesto. His stated objective was to promise implementation of central London charges to reduce traffic, improving the speed of buses, making revenues available for public transportation and enhancing the quality of life in Central London. 18 months of public consultation was carried out in 2000-2002. A high court challenge by Westminster City (just to the west of the charging zone) was defeated in 2002.

The Mayor had stressed the fact that the roads in and outside the area were heavily congested all day. He said the transportation system had been starved of investment for decades. Effective road and public transportation capacity had fallen well behind the growth in travel. Despite the fact that nearly 95% of the 1.0 million trips to the central zone used public transportation, the travel costs had increased, average speeds had below 11 MPH (50% of vehicle time in central London was spent in traffic queues). The business was being harmed and quality of life was deteriorating. It was estimated that delays were costing people and businesses \$7 to 10 million per week in time and money.

### **Pricing Program**

The Congestion Charging program commenced in February 2003. It covered the 8.0 square mile, heavily congested central business district shown in Exhibit 2 (The Eastern zone shown with darker shading was designed as the “charging zone”). The charging zone represented less than 1.5% of the total area of Greater London with a population of about 7.0 million. Subsequently, the charging zone was extended to the west to cover additional 8.0 square miles including Westminster, Kensington and Chelsea (shown in lighter shading in Exhibit 2). The overall program package included 40% increases in capacity of buses and train by 2011 starting immediately with expansion of bus service.



**EXHIBIT 2: THE CENTRAL LONDON CONGESTION CHARGING ZONE**

2003 Original Charging Zone - Eastern Dark Shaded Area

2005 Expansion Zone Added - Western Light Shaded Area  
(Excludes North-South Edgware/Park/Vauxhall Roads)

2003 Original Charge Zone ~8.0 Square Miles

(Inset: Charge Zone Within Greater London Area)



London's cordon, or areawide, road pricing program was launched in February 2003. The program entails a flat weekday fee (initially set at £5, the fee was raised to £8 in 2005) for vehicles crossing into, leaving, or traveling within the charging zone. The charging is effective between 7:00 AM and 6:30PM (modified in 2007 to 7:00-6:00). Numerous exemptions and discounts are allowed, including substantial discounts for residents of the pricing zone (90% discount). Buses, taxis, emergency vehicles, hybrid cars, and motorcycles are exempt. Initially designed to reduce weekday congestion in a central city zone bounded by a ring road, the charging zone was extended westward in February 2007, creating a single enlarged congestion charging zone (Through traffic along Edgware, Park and Vauxhall roads continues to be exempt).

More than 650 closed-circuit cameras set up at the cordon and within the zone and moving vans police the zone, capturing live video images of the license plates of all vehicles. Any applicable daily charge must be paid for a vehicle that is on a public road in the Congestion Charge Zone during the charging period. Drivers may pay the charge via a website, by SMS text message, in shops equipped with a PayPoint, or by phone. The charge may be paid the day after at an increased cost of £10. Penalty for non-payment by the next day is £40 if paid after mail receipt of the notice, but goes up to £120 if not paid within four weeks.

## **Findings**

London Congestion Charging has accomplished its stated objectives.

### *Mobility Impacts*

Traffic adjusted rapidly to the introduction of pricing. After the first year of operation, traffic circulating within the charging zone was reduced by 15 percent during charging hours. The number of vehicles entering the charging zone was reduced by 18 percent. Although there were increases in traffic on the inner ring road (a possible diversionary route around the charging zone), these were less than had been predicted and no operational problems were observed. There was no clear evidence of significantly increased traffic outside the charging hours or in the area surrounding the charging zone. Traffic approaching the charging zone was reduced and no significant change in traffic levels was observed on nearby local roads. According to Transport for London (TfL), the local governmental body responsible for the charging program, "...the balance of evidence was pointing to an overall 'background' decline in traffic in central and inner London."

In addition to reduced traffic inside and outside the zone, traffic delays were cut by 25%. Travel speeds increased by 30% in the zone. Travel time reliability went up significantly. Bus reliability and journey time improved. Bus use increased by 40%. The shift in mode from car to bus was significantly more than the shift of cars to the ring road.

TfL (2003) reported that the average number of cars and delivery vehicles entering the central zone was 60,000 fewer than the previous year. Around 50–60% of this reduction

was attributed to transfers to public transport, 20–30% to journeys avoiding the zone, 15–25% switching to car share, and the remainder to reduced number of journeys, more traveling outside the hours of operation, and increased use of motorbikes and bicycles. Journey times decreased by 14%. Variation in journey time for a particular route repeated on many occasions also decreased.

Traffic levels observed in 2003 were essentially maintained in 2004 and 2005, with some evidence of modest overall reductions in traffic coinciding with the increase in the congestion charge in July 2005. By 2006, key traffic measures were being maintained, with the balance of evidence suggesting further small declines in total traffic in and around the central London charging zone. The TfL reports that, "...overall patterns of traffic established following the introduction of the scheme in 2003 have again remained largely unchanged." Traffic entering the central London charging zone during charging hours in 2006 was 21 percent lower than before charging began in 2002. According to TfL, "as in previous years, available traffic indicators outside the central London charging zone have continued to indicate small background declines to overall traffic levels, with no evidence of significant adverse effects."

#### *Cost and Revenues Impacts*

According to a report issued in February 2007, the initial costs of setting up the scheme were £161.7 million.

TfL (2007) shows that revenues from the congestion charge were £250m over the financial year, representing 8.5% of TfL's annual revenues. More than half of this was spent on the cost of running the charge scheme at £130 million. Once other charges were deducted, the congestion charge brought in an annual operating net income of £89m for TfL (which, by law, must be spent on Transportation in London).

The June 2005 increase in charges by 60% only resulted in a relatively small rise in revenues, as there were fewer penalty payments. The anticipated start up costs of the Western extension were £125 million with operating costs of £33m; expected gross revenues were expected to be £80 million resulting in net revenues of £50 million.

#### *Environmental Impacts*

The reduction of airborne emissions wasn't listed as one of the reasons for introducing the congestion charge. The pre-commencement report from TfL noted that the scheme wasn't expected to significantly affect air quality, but that offering a discount to encourage the use of greener fuels would be a positive measure. However, TfL has reported changes in air quality within and alongside the Inner Ring Road boundary of the zone. Levels of NO<sub>x</sub> fell by 13.4% between 2002 & 2003, CO<sub>2</sub> by 15%, and particulates (PM10) by 7%. TfL (2007) states that between 2003 and 2006, NO<sub>x</sub> emissions fell by 17%, PM10 by 24% and CO<sub>2</sub> by 3%, with some being attributed to the effects of reduced levels of traffic flowing better, with the majority being as a result of improved vehicle technology. In total, the rate of fall in CO<sub>2</sub> has been 20%. The TfL report makes it clear, however, that

only the initial reduction of emissions could be expected from the introduction of the charge. Further reductions are unlikely to be as a result of the charge. Although no areas within the Congestion Charge Zone reported NO<sub>2</sub> levels above an upper limit of 200 µgm-3 (105 ppb), some monitoring areas near the zone boundary experienced very long periods at such levels. TfL reports that emissions may not necessarily feed through into improvements in air quality and that vehicle emissions are only one contributor to total emissions of a particular pollutant along with weather conditions and industrial use. It was also reported that pollutant concentrations were being affected by the change in the make up of the vehicle fleet. Further studies are being undertaken into the air quality effects.

### *Equity Impacts*

Equity implications of the London pricing program have not been assessed in-depth. However, it has been argued that the equity consequences have been positive since public transportation users have enjoyed significant benefits resulting from the program. A very large proportion of prior trips to the priced zone used (and continue to use) public transportation and have benefited through significant improvements resulting from pricing. A majority of businesses also perceive the charging scheme as a plus overall and have continued to support it.

### *Economic Productivity and Business Impacts*

Using early impact data from the charging program, Raux (2005) and Mackie (2005) estimated that the charging program produced a benefit to cost ratio of 1.4 and that the ratio would have been higher if prices varying by level of congestion were charged instead of the flat rate in effect.

London Authorities have monitored the impacts of the area charging since its start in 2003 based on business surveys, employment data, property values and information on business turnover and profitability. TfL (2006, 2007) report that the pricing seems to have had broadly neutral economic impacts. Annual surveys do suggest, however, that businesses in the charging zone have outperformed those outside and a majority of businesses continue to support the charging scheme, provided investments in public transportation is continued.

The experience from the Congestion charging scheme in London shows that business support for congestion charging is generally positive but relatively mixed. Businesses were, on the whole, more supportive of the scheme than opposed to it. A majority of businesses continue to support the scheme, provided that there is continued investment in public transport. When analyzed by sector, the leisure, financial and retail sectors were the most supportive of the scheme, whilst the distribution and restaurant sectors were the least positive. The increased level of support from the retail sector in 2005, compared to the previous year, is the most positive trend of all the sectors (TfL, 2005).

CURACAO (2007) report provides additional discussion on this issue area as summarized later in Section 3.2.

### *Public Acceptance*

Nearly four decades passed after congestion pricing was first proposed for central London before finally it became a reality in 2003. The intervening forty years generated several feasibility studies and impact estimates and the merits of congestion pricing was debated at length many times over. So, the public had developed a decent perspective on the concept, its plausible impacts (both positive and negative), implementation hurdles and its potential role in London's transportation plans. Then, in 1990s, London was granted authority to adopt pricing and have full ownership of the toll revenues. Funding for public transportation was uncertain and congestion had reached epic proportions. Pricing technology was also now available. As these conditions, so conducive to pricing, were evolving, London found a political champion in the new Mayor in 2000. He was able to garner enough support from business community bearing the brunt of the economic costs of congestion and, especially, from large proportion of the public that was highly dependent on public transportation services.

As CURACAO (2007) reports, "The level of acceptability of road user charging before the introduction was rather stable about 40%. This also holds true in comparison with other scenarios such as workplace commuter tax schemes. After the introduction acceptability has risen above 50%. Unfortunately, no time series data is available later than October 2003 to observe any long-term trends in acceptability and the influence changes to the schemes, such as the western extension, might have. The re-election of the Mayor in June 2004 with the western extension already announced suggests that London residents accepted this change as part of their future government as well.

"There are two main reasons for this rather high level of acceptability before as well as after the introduction. First, traffic levels in London had reached unacceptable levels and Londoners felt some radical measure was needed. Evidence for this is cited in the ROCOL report (2000): 90% of London residents, polled in 1999, thought that there was too much traffic in the capital, and were concerned about its impacts on travel times and air pollution. Some 41% of a representative sample polled for the ROCOL report also felt that a congestion charge was the best way to raise money for improved public transport in London. A consultation on congestion charging carried out by TfL for the Mayor in July 2000 found that, of 400 key "stakeholders", six times as many supported the concept of a central London congestion charge as opposed it.

"Second, in London the concentration of power in the hands of the Mayor meant that "local" political concerns were less important, and thus resources could be concentrated on key projects, such as the implementation of congestion charging. In doing that the TfL and the mayor himself did an excellent job of engendering trust through open communications, a clear and well-composed presentation of the problem and the proposal, and the development of first-rate communication tools, including a highly

effective website. In this way consultation as well as promotion of the scheme and its benefits was achieved.

“The legislation that permits the Mayor to implement congestion charging in London meant, the decision rested with the Mayor, without reference to a higher level of government. Another factor that might have helped is the political stability. For example, no sustained and organized opposition to the proposal has emerged. Furthermore, the fact that congestion charging was implemented early in the Mayor’s term of office gave it more chance to succeed. In summary, a high level of public acceptability together with strong political commitment made it possible to introduce congestion charging in London.”

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## **2.3. Congestion Charging in Center of Stockholm**

### **Context**

Cordon pricing has been under consideration in Stockholm for over three decades. It has been proposed and studied with the goal of reducing congestion, improving the environment and generating revenues for transportation improvements. In 2002 the Green Party came to power and in coalition with the Social Democratic party, announced to introduce a full-scale congestion pricing program. The law authorizing congestion taxes was enacted in 2004 with focus on demand management and environmental protection [CURACAO (2007)].

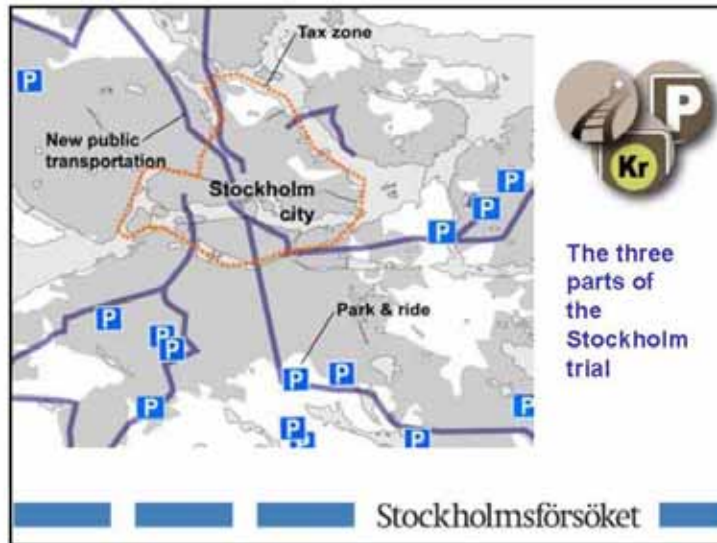
In order to achieve political consensus and public support, it was agreed that a six-month trial project would be implemented and decision about permanent program would be made after evaluating the experience of the trial application and holding a referendum. The stated goals were to reduce congestion and enhance public transportation to increase accessibility, and improve the environment. A full-scale six-month trial was operated from January through July of 2006 and detailed evaluation was carried out.

A referendum was held in September 2006 in which 51 percent supported making the pricing program permanent and 45 percent opposed it. Despite a change in central government where “conservatives” replaced the ruling “liberal” parties’ coalition, the decision was made to reintroduce central area pricing on a permanent basis starting in mid-2007.

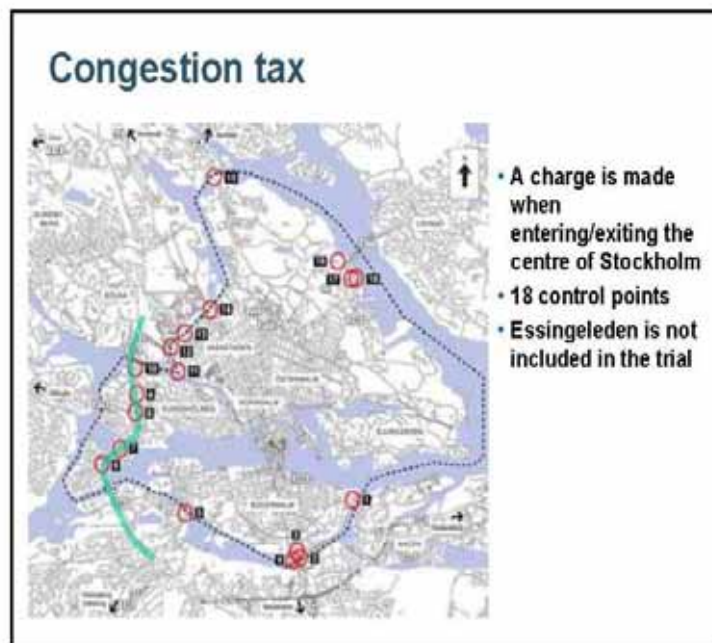
### **Pricing Program**

The central city area of approximately 20 square miles (including about 10 square miles of the river and sparsely developed land) was designated as the priced zone. It covers the central city and constitutes but a small part of the urbanized county area. The population of the city area is 756,000 out of the total county population of 1.8 million. The three elements of the program are shown in Exhibit 3a (Charging Cordon, Expanded Transit Routes and New Park-and-Ride Lots) Charging cordon around the central Stockholm and the 18 pricing points are shown in Exhibit 3b.

The charges were effective weekdays from 6:30AM to 6:30PM and the price was set at 10, 15 and 20 SEK (US\$1.33, 2.00 and 2.67 at 2006 rates) for off-peak, shoulder and peak period, respectively. The charges were collected when entering or exiting the zone at 18 barrier free “control points” encircling the city center. The daily maximum charge, for multiple crossings was set at 60 SEK (US\$8.00).



**Exhibit 3a: Stockholm Priced Zone Shown Within The Inner County (Expanded Transit Routes and PAR Facilities Also Shown)**



**Exhibit 3b: Stockholm Priced Zone Cordon With Charging Locations**



Taxis, hybrid cars, buses, foreign cars, handicap tagged cars, diplomats and police and emergency vehicles (a total of 30%) were exempted from charges. Vehicles traveling through the priced zone without stopping were also exempted.

Three overhead gantries at each charge point electronically identified the passing vehicle if equipped with On-Board Transponder Unit (OBU – unique for each vehicle) and allowed automatic charge deductions from pre-set accounts. License plate photos (front and rear) were captured for all vehicles with and without OBU. Vehicles without pre-set accounts or those without transponders had until noon time the next day to post payments that could be made on the web, at retail outlets, banks and kiosks. Fines for non-payment were set at 70 SEK (US\$10) for the first reminder and went up to 500 SEK (US\$70) for the second reminder.

## **Findings**

### *Mobility Impacts*

The congestion charging scheme met or exceeded expectations and project goal of 10-15% reduction in traffic. Overall traffic to and from the inner city declined by 10 to 15 percent (with declines ranging from 9 to 26 percent in different sectors. Traffic dropped further out in the county as well. Congestion was reduced dramatically and traffic speeds went up. The worst queues in and near the city center decreased by 30 percent and more. The biggest decline was during the PM peak period. Traffic also declined in the evening after the charge period ended. There was no significant increase in bypass routes. At the end of the six-month trial period, the traffic volumes increased to about the same volume as before the trial began.

There was a 14% reduction in vehicle miles traveled in the charged zone and 1% reduction in VMT outside the zone. There was an increase in travel time reliability and traffic volumes on most congested roads dropped by 20-25%. Road safety improved.

Public transportation use increased by 6 to 9 percent, though this increase could not be all attributed to congestion charges. It appears that less than 50% of car users who gave up trips during the charge period shifted to transit. Few changed time of departure. No significant increase was observed in cycling, carpooling or telecommuting.

Recent data show that the permanent charging program, reintroduced in 2007 August, appears to have reduced traffic by 18 percent. The proportion of exempted “green” cars has risen to 9%. Access to the city has again improved considerably with a reduction in travel times on city streets and approach roads.

### *Cost and Revenues Impacts*

The capital investment totaled 3.0 billion SEK (\$410 million), and the operating costs were incurred at the annual rate of 220 SEK (\$30 million). The revenues from charges were running at the annual rate of 760 million SEK (\$100 million) implying annual

operating profit rate of 500 million SEK (\$70 million). These data would suggest a “payback” period of about 4 years. In terms of economic welfare, Eliasson (2006) estimated that the trial program would have produced net annual benefit of nearly 700 million SEK (\$90 million) against the investments and annual operating costs listed above. It was also estimated that more conventional measures to reduce traffic (e.g., ring roads to divert traffic away from the center) would require far greater investments to achieve comparable traffic reduction goals.

### *Environmental Impacts*

Achievement of environmental objectives was supported by the observed reduction in the inner city of 10-14% in Carbon Dioxide (2-3% in the County), 7% in NO<sub>x</sub> and 9% in particulates. Furthermore, emissions declined near population centers. There was no measurable change in noise impacts.

### *Equity Impacts*

Equity implications of the Stockholm pricing program have not been assessed. However, like in London, it has been argued that the equity consequences have been positive since public transportation users have enjoyed significant benefits resulting from the program. A very large proportion of prior trips to the priced zone used (and continue to use) public transportation and have benefited through significant improvements resulting from pricing.

### *Economic Productivity and Business Impacts*

It is recognized that many of these impacts take time to show up. The Stockholm trial was too short to have significant influence on land use, real estate prices and regional economy. Surveys of business leaders suggested that charges are likely to be a minor factor in influencing these dimensions. Also, no identifiable impacts on retail business or household purchasing power were identified.

CURACAO (2007) report provides additional discussion on this issue area as summarized later in Section 3.2.

### *Public Acceptance*

Congestion pricing has been on the political and planning agenda in Stockholm for over twenty years. During this time numerous feasibility studies were carried out and pricing proposals were modified and abandoned. Finally, the government succeeded in implementing the current program on a trial basis in 2006 and then on a permanent basis in 2007. The intervening period saw much public consultation, education and outreach effort. This period also saw worsening congestion, environmental degradation and transportation funding prospects. Furthermore, the success of the London pricing project, implemented in 2003, probably acted as a major catalyst in bringing together officials

with diverse political leanings to try out pricing on a trial basis in 2006. The success of this trial has now culminated in permanent adoption of congestion pricing.

CURCAO (2007) provides a summary of the public attitudes toward Stockholm charging scheme before and after the six-month trial in 2006:

“Public acceptability has been measured before and throughout the trial period. The pattern of response is quite similar to what is known from London and the Norwegian cities). Attitudes to the Stockholm Trial have become more positive during this time. In autumn 2005, about 55% of all county citizens believed that it was a “rather/very bad decision” to conduct the congestion-tax trial. Since the congestion tax was introduced in January 2006, this percentage has continuously fallen. In April and May 2006, 53% of all citizens believed that it was a “rather/very good decision” while 41% believed that it was a “rather/very bad decision”. Significantly, even those travelling by car to/from the inner city during the charge period in the most recent two 24-hour periods have become more positive by several percentage units. In May 2006 car driver were approximately equally for and against the road pricing trial.

The following referendum resulted in a 51.3% support for the charging scheme. 45.5% voted against the scheme [City of Stockholm, (2006a)]. Municipalities surrounding Stockholm were not satisfied with the fact that their residents were not eligible to vote. A substantial number of them travel to and from work through the congestion tax area. Therefore several of these municipalities, especially those governed by at that time opposition party have decided to hold an advisory referendum. Here the majority of residents decided against the permanent introduction of congestion charging in Stockholm. It seems that those people who benefit most from urban road pricing can be convinced if they experience in a trial the positive outcomes. However, not all municipalities held an independent referendum and the wording of the question there was different from the official Stockholm referendum. These could also be reasons for the differences in the referendum results.”

Nevertheless the program was made permanent in August of 2007.

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### **3. SUMMARY OF PERTINENT STUDIES AND LITERATURE**

#### **3.1. Acceptability of Congestion Pricing**

There are a number of sources relating to the acceptability of congestion pricing proposals and programs in Europe and United Kingdom. The studies can be divided into results from (1) general attitudinal surveys (most public, some decision maker) not based on implemented pricing programs (2) surveys related to implemented programs and (3) overview or synthesis papers drawing on 1 or 2 or both. [A brief synthesis of acceptability of pricing can also be found in Curacao (2007)].

##### **General Attitudinal Surveys**

Jens Schade and Bernhard Schlag (2002) investigated public and political acceptability in Athens, Como, Dresden and Oslo by a questionnaire directed at 952 motorists across the cities; phone interviews in Como and Dresden with 14 politicians; and interviews with business associations in the four cities. Two packages of strategies were tested. The first was a “strong” package of cordon pricing, parking pricing and fuel taxes with revenue “hypothecation.” A second “weaker” package had the same pricing but a lower extent of revenue hypothecation. Findings suggest low public understanding of the concepts across cities, higher rankings of potential effectiveness but less than majority acceptability for either package, though higher for the weaker than stronger package (39 vs. 20%). Higher acceptability is associated with perceptions of higher potential effectiveness, personal advantage and importance of societal goals advanced by pricing. These results held across income groups with only small differences. Politicians reject the stronger measure but find the weaker measure “rather acceptable.” Business perceptions were highly variable across cities gaining only some support in Oslo and Como. All business respondents favored other than pricing measures, such as park and ride, improved transit, greater parking and traffic management. Overall, the authors conclude acceptance is generally tied to major and urgent traffic and related social and environmental problems; pricing must be perceived as effective; revenues must be tied to transport and environmental improvements.

Milenko Vrtic et.al. (2007) report on public attitudes in Switzerland about the acceptability of road pricing schemes, including the influence of three types of pricing:

- Distance based charges for Swiss motorways
- Distance based charges for all travel
- Time dependent charges on main roads
- Cordon charges for cities but not time dependent

Revenue allocation options included abolition of the fuel tax and motorway vignette (annual fee window sticker), reduced income tax, investment in public transport and an annual equal distribution to Swiss adults. Results are based on a sample of 2290 surveyed with 1005 respondents. Results show the most acceptance for motorway and km tolls, less for cordon and time dependent tolls. The authors conclude distance based tolls on motorways are more familiar to respondents from France and Italy. However, the authors also speculate the cordon and time dependent options were not well explained in the survey. Environmental coalitions were more likely to favor the cordon; auto clubs prefer time dependent pricing as it attacks congestion important to the clubs. Inhabitants of cities are more likely to be against cordon fees, but favor all other forms of pricing by over 50%. Residents of mid to small sized towns prefer all road pricing options by over 55%, including cordon. The authors suggest pricing would affect their commuting less than other groups. Residents of large cities prefer motorway tolls and the authors conclude this is because they commute within cities and depend on their cars for many work trips. Rural residents dislike distance based tolls and favor none of the pricing approaches by more than 50%. Regarding revenues, highest preference was for investment in public transit and return of revenues to all Swiss residents. Abolishing fuel taxes and motorway vignette are not preferred. A regression analysis sorting out independent effects of factors on acceptability found the most important factor for acceptability is the toll level; highest preference goes to motorway and km tolls versus the cordon; and acceptance goes up as hypothetical increased speeds increase due to pricing. No correlation could be found between acceptability and income.

Jen Schade (2004) reviews several European studies and finds groups perceiving congestion as one of the biggest problems tend to reject road pricing whereas groups sensitive to environmental problems are more willing to accept it. He also finds acceptance depends on clear and compelling definition of the problem addressed, the belief that pricing will be effective in addressing the problem and a credible demonstration of how pricing can be implemented. Well known measures tend to garner more acceptance, suggesting pricing can gain in acceptance as it becomes more familiar to the public. The author indicates in general people do not like pricing as a way to distribute public goods, preferring first-come-first-serve. However, what the author calls “procedural fairness” is as important as distribution equity, i.e. how much public participation is involved in arriving at pricing plans. Participation may not lead to economically optimal solutions, but may obtain acceptable options. The perceived locus of responsibility for congestion also is important to acceptability. Where government is perceived as the main reason for the problem versus the individual, acceptance of pricing or other demand management measures diminishes. Consequently, how the problem of congestion is framed and the degree to which government is putting forth good faith efforts to address the problem are important. As in other research, the author’s review of studies suggests income is not strongly related to acceptance.

The importance of perceived effectiveness and relation of pricing to environmental problems again appears in a German study, by Bamberg and Rolle (2003), of the medium sized town of Reutlingen (110,000) and two villages (below 9,000). A mail back questionnaire administered to 5,000 at random explored a fuel price increase with

revenue returned to price discount for public transit. While not focused on road pricing per se, the study did find perceived effectiveness is “central determinate” in acceptability, equally strong with fairness. Likewise, the more respondents were convinced car use causes grave environmental problems, the more they perceived the proposed pricing measure favorably (and supported it).

Jaensirisak, Wardman and May (2005) analyze results of a stated preference survey in two UK cities. As part of the study, they review previous acceptability findings from British studies demonstrating the importance of specifying the use of revenues, showing a jump from 30 to 55% from no explicit revenue plan to revenues dedicated to auto options. The finding appears to be roughly consistent across cities. Another finding was areawide pricing nearly doubles in acceptability (from 34 to 60%) where local residents are exempted. Reviewing findings in the Netherlands, they find perceived effectiveness of pricing strongly related to acceptance but with no relation to income. They also find acceptance in Oslo came as experience with road pricing increased. Only 30% were positive before the ring in 1989, but increased to 36% after implementation and up to 46% in 1998. Likewise in Bergen, only 13% were in favor before, but 50% one year after. The result parallels Stockholm where 80% were opposed before implementation, and then in July 2006, 53% of the city residents voted to keep the implemented program [Streetsblog (2007)]. How pricing is presented also appears important. Where suspicion of the government or its proposed plans for revenue use is present, local referenda may be helpful, as in a Swiss example cited (Saas Fee). In this case, an areawide pricing plan was accepted in 1998 by popular referendum after widespread discussion, though not implemented due to purely legal reasons [Bruno, Frey (2003)].

The authors then give findings from stated preference surveys in Leeds and London, 2000 and 2001, with 830 respondents total. They found pricing acceptance related to problem perception, with more acceptability among those perceiving pollution and congestion to be very serious and those considering current traffic conditions “unacceptable.” As well, acceptability correlated with perceptions of greater potential effectiveness of congestion pricing, with a majority of car users not convinced that pricing would be effective in reducing congestion and pollution. Directing revenues to tax reductions received preference and the authors surmise the result is due to the sample containing both car and non-car users. There is preference for a limited rather than expansive areawide scheme, probably stemming from a sense of need, fairness and effectiveness. Possibly for the same reasons, preference goes to peak pricing. Charge variations by distance or time within the peak or by delay (“dynamic” pricing) were not favored compared to a fixed charge. Through modeling, the authors examine possible program designs for Leeds and London to find how majority support could be reached. They find majority support can be reached assuming certain charge levels (up to £5 in London, less in Leeds), type of charge (fixed preferred), size of charge area (smaller preferred) and where environmental and travel delay benefits are large.

Of course, since the author’s research, a London road pricing scheme has been implemented. A key acceptability finding is while initial reaction to the Mayor’s proposal was mixed, surveys by Transport for London three years after start showed that more



than 70 per cent of Londoners said the system was effective and twice as many supported the charge as opposed it. Also, the business association First London found that 49 percent of Central London businesses believed congestion charging was working. Only 2 percent of companies say they would consider relocating to a site outside the zone because of it [Streetsblog (2007)].

In a random survey of 1022 German residents, Olof Holzer (2003) explores the importance of how pricing objectives are stated. Holzer first asked all respondents about pricing and investment options for purposes of solving traffic problems. As expected, pricing was not favored compared to building new roads or encouraging auto alternatives (when asked to rank the less preferred pricing strategies, parking fees are favored over tolls). However, when the objective emphasized is solving traffic problems by investment with pricing as a means to that end, not the means itself, then support for pricing increases. The author speculates people feel they are “getting something” when pricing and new investment are tied together, whereas pricing alone and its promised traffic reduction do not hold the same allure. While the effect is not “overwhelming” at least in the hypothetical case explored in this national survey, the research suggests leading a pricing plan with an investment objective is helpful to public acceptance.

Another study from Germany examines how people’s perceptions of fairness bears on acceptability of general traffic restraint policies [Ittner et.al. (2003)]. Relying on a study of 369 respondents in Trier and another of 313 nationwide, the exploratory research is not intended to be representative of any population, but is nevertheless useful for understanding how perceptions of fairness affect acceptability. Examining measures such as limits on inner city parking and car-free zones, a key finding is acceptance hinges on perceived effectiveness. Even people highly motivated to behave in environmentally friendly ways may reject measures if they believe they are among the few who will comply. The greater the perceived “free-rider” problem, the less the acceptance and the greater the sense of “betrayal.” The authors contend such a dynamic even may lead people to accept restrictive and obligatory measures and a certain loss of freedom as long as there are no or minimal free riders. The authors go on to contend perceived fairness is vital not only in how auto restraint is implemented but how it is planned. Acceptance of a plan is more likely when people perceive a fair decision-making process leading to plan implementation (“procedural fairness”).

A few studies are of interest for attention to decision maker attitudes either exclusively or in combination with general public surveys. One of interest by Ison (1993), while dated, focuses on acceptability among decision makers about a proposed road pricing scheme for Cambridge, England as considered in 1993. The proposed scheme involved meters attached to vehicle odometers sensitive to speed and travel distance so as to impose a charge based on real time congestion. Charges were to be deducted from a driver smart card and visible by display within the vehicle. A total of 21 interviews were conducted with officials in city, county and district councils. Key findings include reactions to the proposal based on:

- The severity of traffic and pollution problems (congestion considered not bad enough, though pollution was more resonant)
- The complexity of the pricing scheme (simple permit preferred over in-vehicle system)
- Presence or absence of a champion (all acknowledged the Director of Transportation as such a person and his retirement retarded momentum)
- Turnover in politicians by election (non-election time preferred)
- Clarity of program, objectives and revenue scheme (good detail preferred)
- The degree to which other options had been examined or compared (pricing needs favorable comparison)
- Accompanying transit improvements (vast improvement preferred)
- Degree of experience and modeling elsewhere (more experience the better – “snowball effect”)
- Degree to which proposal feels “sprung” on people (coming from grassroots planning preferred)

A study of decision makers and public reactions comes from Link (2003a). Link examined public and decision maker perspectives about road pricing along with other pricing and taxation measures. Research entailed 104 stakeholder interviews with planners, interest groups and decision makers in 9 European countries, focus groups with the general public in 3 European countries and a Delphi survey in 5 European countries, as well as an extensive quantitative survey of public attitudes in 6 European countries (1,300 individuals). Stakeholder interviews found acceptability is enhanced if:

- Pricing is not viewed as another form of tax
- Detailed information is provided to the public, including winners and losers
- Pricing is demonstrated to be effective and any program carefully monitored

In a supporting paper, Link (2003b) adds detail on policy maker perspectives. Link finds policy makers consider the “right of mobility” as one of the major arguments against pricing, paralleling public opinion findings elsewhere in the paper showing people consider roads and public transport as basic services to which they are entitled. Link also finds the most acceptable pricing purpose for policy makers is infrastructure cost recovery with demand management ranking second. On revenues, decision makers favored using revenues to reduce general taxes (transit managers and planners favored revenues designated for transportation improvements). Comparing road pricing to other pricing and taxation measures, decision makers prefer fuel taxation followed by interurban road and parking pricing. For road pricing, policy makers preferred differential charges (by time, area, emissions, service quality) to flat rates and agree to the principal of price reflecting the “real” cost of transport. However, once the real cost

issue is phrased in terms of lower charges for “green modes,” policy makers are divided, perhaps aware of strong public egalitarian sentiment about road use as a right for all.

The public survey in Link’s work revealed skepticism about reducing congestion through pricing, support for pricing of trucks and discounts for “green modes,” and support for revenues spent on transport. On equity, the public gave little support for user pay principles. There also is suspicion of government motives in proposing user charges, belief the real purpose may simply be money raising and concern government is not transparent in decision making. Regular car users are reluctant to support the use of revenues outside transport (roads and transit), except to reduce income taxes. In two countries, acceptability of pricing was largely determined by use of revenues. Support for pricing varied strongly by country, with only 10% support in France to 55% support in Sweden where pricing was tied to environmental rationales and where workplace parking charges are especially supported. Forty one percent of the Dutch and 56% of the Austrian respondents supported road pricing. Generally, road pricing was less preferred than workplace parking charges or charges aimed at environmental and air quality improvements. Other findings include less than a majority of respondents believe pricing would lead to reduced pollution; while public transit is supported, it is considered too expensive or infrequent to compete with the auto; privacy was not a concern in pricing.

### **Surveys Related to Implemented Programs**

Tretvik *et.al.* (2003) examine growing acceptance of pricing after implementation. In Bergen, Tretvik speculates the shift in support may have resulted in absence of queues at the tollgates, the clear link between revenues and improvements and availability of seasonal passes. In Oslo, increasing public support after implementation dropped markedly 2001 after an increase in tolls, but the overall upward trend remains. The Oslo results are based on an annual stratified random telephone survey of residents conducted since 1989. The most important reason for support (except in the first year) was “generates funds for road construction” followed by “environmental considerations.” Oslo funded several road projects financed with toll funds. The most important reason against the Oslo scheme was “unfair economic burden on motorists.” Since 1995, another prominent objection is “already pay enough tax/duty.” In Trondheim, the pricing system is the closest to pure congestion pricing with a time of day charge, fully electronic charging and only a pay per trip option, though here too a major aim was to finance transportation improvements. Again, opposition dropped after implementation (70% before, down to about 50% two months after implementation, 32% by 1993, then rising some to 43% in 1994). Absent detailed surveys as in Oslo, the author speculates respondent reactions are due to funds going to transportation improvements and the ease of non-stop pricing points.

Harsman (2003) reviews experience in Oslo, Rotterdam and Stockholm to draw conclusions about political processes important to acceptance among policy makers and eventual implementation. After summarizing public acceptance in Oslo, he suggests financial support from the national government was vital to acceptance among local politicians. The national government supplemented toll revenues to support transportation

improvements. In Rotterdam, Harsman says the city reached an agreement with the national government in 2000 to manage traffic and finance new infrastructure. He indicates a “key factor” in the agreement was an agreement that toll revenues would be matched (within limits) by state funds. While the planned program was not implemented, the author concludes local, state and national government agreements may be an important necessary but not sufficient step toward successful implementation. Reviewing initial agreement among political parties in Stockholm leading to a withdrawn proposal in 1997 and reemergence in 2002, the author portrays the importance of specific infrastructure improvements to various political parties at least in a setting where such improvements are a driving force behind pricing plans. In order to get the pricing proposal toward serious consideration, each party (Conservatives, Liberals and Social Democrats) required assurances their favored road projects would be funded. Again, the conclusion appears to be active actors and agreements struck across local, regional and national governments are important to political acceptance and eventual passage of pricing proposals.

### **Overview & Synthesis Reports**

Peter Jones (2002) reviews “typical UK findings” and finds highest public support for public transportation and park and ride; medium support for access restrictions (car bans) and parking enforcement; and lower support for road pricing. However, “charging for driving and parking” in a London study is supported over increased income tax, car tax, fuel tax, transit fares when the question put is how should money be raised for better public transport in London. Jones concludes support is best where road pricing revenue is devoted or “hypothecated” for road and public transit improvements and is additional to existing support revenues. In reviewing acceptability findings from Oslo, Jones finds acceptance increases after implementation. Other conclusions offered by Jones include acceptance depends on:

- The problem addressed must be severe so “pain” is worth “gain”
- Highly visible traffic related problems (congestion, air pollution, accidents, etc.)

Jones also points up some typical public perceptions about traffic and pricing which can be barriers to acceptance:

- Pricing will not reduce traffic in part because drivers “have to have” their cars
- Very large traffic reductions are needed to reduce congestion
- Pricing will create potential spillover parking and diversion traffic
- Pricing technology may breakdown and lead to abuse and non-compliance
- “Spatial inequity” may result depending on whether one travels in or outside an areawide or cordon scheme

- “Use inequity” may result where occasional payers will reap the same benefit from new roads or transit as frequent users (in Trondheim, more cordons were added over time to address the issue)
- “Social inequity” may result since not everyone has sufficient income to benefit equally from pricing
- Pricing is unfair because roads already have been paid for and pay isn’t so much for a new service as a failure (congestion) in the system
- Alternatives to auto use are poor or will not be much improved

Jones concludes acceptance hinges on a good investment package with revenues; selective exceptions and concessions (e.g. reduced off peak charges, “free” shopping periods, improved on-street loading, reduced one-way streets); targeting of pricing to groups and trips least likely to equate to “hardship;” up-front improvements in alternative modes and traffic management; attention to boundary effects; campaigns with good information on congestion, air quality and related problems; strong consultation with stakeholders and affected parties in collaborative planning rather than take it or leave it style.

The importance of decision makers to devising acceptable schemes also is stressed by Jones (2003) in a review of Oslo and Trondheim ring road pricing. He observes “support was greatly enhanced by the inducement of matched funding from the central government.” In both cities, Jones indicates city politicians formed a cross-party alliance and were willing to go forward in spite of opinion polls of the electorate showing opposition. Jones also emphasizes the importance of returning revenues to transportation. He indicates successful Norway programs emphasized revenue for improving transportation versus traffic reduction, though Trondheim differential pricing by time of day recognizes travelers may switch travel times due to pricing.

Jones also stresses the importance of problem perception in the acceptance of pricing. He suggests pollution may be a more compelling problem for motivating the public toward acceptance of pricing than congestion. He claims the public is more likely to view congestion as caused by others, a kind of victim mentality, whereas pollution is regarded more as the personal responsibility of all. He also asserts the public may be fatalistic about congestion, believing drivers “must have” their cars and large if not impossible reductions in traffic volumes are needed to reduce congestion.

Finally, Jones suggests program design is vital to acceptance. He points to Norway where the concern about nobody paying a disproportionate amount were met by defining a period in which only one charge is made irrespective of the number of cordon crossings (Trondheim); limiting the number of charged crossings per month (Trondheim); providing “season tickets,” allowing unlimited used in a given period (Bergen, Oslo). He also suggests attention to discounts for residents inside priced zones, exemptions for disabled or exemptions for high priority workers, such as hospital employees.

## Summary

Several conclusions can be derived from the review of acceptability research in Europe and the UK. Clearly not all the influences on acceptability are within the control of planners and policy makers. The retirement of an important political champion may slow or sink a planned program, as Ison notes. Demographic variables such as residential location or interest group affiliation may be important determinants of acceptability among the public, as Vrtic finds. However, planners and decision makers working on pricing plans have little control over such variables. Most important are conclusions with implications where planning and decision making around pricing can be better informed. In particular, the review suggests public and/or stakeholder acceptability may be enhanced where:

*The problem addressed resonates.* Whatever the mix of problems addressed by pricing proposals, whether congestion, pollution or some combination, acceptability is enhanced where the problem is clear and severe to affected parties. Jones puts the point well saying the “pain” must be worth the gain. A corollary finding is congestion may or may not be the most painful candidate problem for pricing. In some settings, the more resonant problem may be pollution. As Schade for OECD finds, as well as Bamberg and Ison, groups sensitive to environmental problems may be more accepting of pricing than groups more sensitive to congestion. The point is not which problem leads, but that the pricing proposal finds and explicitly targets the most resonant problem or problems.

*Pricing Is Convincingly Effective:* Acceptability studies suggest the public or decision makers may be skeptical about the effectiveness of pricing in reducing congestion or pollution. Schade for OECD finds acceptance is dependent on effectiveness perceptions, and such perceptions vary considerably. Vrtic finds acceptance strongly correlated with increasing effectiveness of proposed plans, in this case increased speeds. Bamberg calls perceived effectiveness “central” to acceptability. Jaensirisak finds the same reviewing experience in the Netherlands and Link in his stakeholder interviews.

*Program Design Meets Program Concerns:* Acceptability of pricing is enhanced where pricing program parameters are in line with public and decision maker concerns. Top concerns will vary by area, but planners increase the odds of acceptance by determining the concerns and structuring the program accordingly. Ittner finds in one German city strong sensitivity to compliance and fear of “free riders” with implications for emphasis on enforcement strategies. Ison in interviews with decision makers around a proposed Cambridge scheme finds simplicity in technology preferred to the more complex. Likewise, Jaensirisak et. al. in London and Leeds assessments found acceptability hinges on limited rather than expansive areawide schemes; fixed rather than dynamic pricing; and fees under certain limits. Holzer in the survey of German residents finds the importance of pricing designed as a means to investment not an end in itself. Jones emphasizes selective exceptions, targeted pricing to groups and trips least likely to raise hardship concerns, up front improvements in alternative modes, and attention to boundary effects (traffic and parking diversion).

*Revenue Distribution Follows Preferences:* Gearing revenues toward most favored purposes is important to acceptability. Research shows revenues directed toward transit and/or road improvements may garner support in some locations, but may compete with other preferences elsewhere. Planners need to understand and pay heed to such preferences. Tretvik et.al. find support in Oslo explained mostly by revenues devoted to road construction and observe the same support in Trondheim largely is due to funds for transportation improvements. Jones for MC-ICAM shows support for road pricing in early London surveys hinges on support for better public transport. He echoes Tretvik in concluding emphasis on revenue for improved transportation versus traffic reduction was vital in Norway. However, Vrtic et.al. find a return of revenues to all Swiss residents competes with transit investment for high preference. Link's work across European countries shows policy makers preferring revenues for general tax reductions, and car users preferring revenues to roads and transit, but closely followed by reductions in income taxes. Confirming the importance of revenue distribution, Link finds acceptability "largely determined" by use of revenues in two countries among his sample.

*Fairness Is Broadly Addressed:* Equity across income groups subject to pricing often leads equity discussions among analysts of road pricing. However, research shows acceptability does not vary greatly across income groups and equity defined more broadly may dominate and deserve more attention. Schade for OECD reviews several European studies to find income is not strongly related to acceptance. With Schlag in his four city review, Schade finds acceptance of potential pricing schemes varied but not by income. Reviewing findings from the Netherlands, Jaensirisak, finds no relation between acceptance and income. Vrtic likewise found variation in acceptability of pricing options varied by rural versus city residence and by city size, but not income. Most important are more general concepts of "fairness." Already mentioned is Ittner's finding related to fairness of outcomes, i.e. assurance some are not evading the pricing scheme who should be paying. "Procedural" fairness is highlighted by Schade in OECD, meaning whether or not people feel full opportunity to participate in developing pricing plans. He notes some efficiency and optimality may be sacrificed in devising plans with full public participation and resulting compromise, but this outcome is better than plan rejection. As mentioned, Jones for MC-ICAM suggests the importance of targeting groups and trips least likely to create perceptions of "hardship." Exempting the handicapped or emergency workers are examples he cites to combat this sense of unfairness. He also urges attention to "use inequity" where occasional payers reap the same benefit from new roads and transit as frequent users; and "spatial inequity" depending on travel within or to/from a cordon scheme. He points up several design considerations to meet these equity concerns: Norway policies defining a period in which only one charge is made irrespective of the crossings; limits on the number of charged crossing per month; season tickets and allowances for unlimited use in certain periods.

*Government Planners Are Open, Responsive, Resourceful Solution Partners:* Numerous findings suggest how government pricing planners are perceived may be as important to acceptance as the nature of their pricing proposal(s). Already mentioned is Schade for OECD pointing to procedural fairness in the planning process. In the same paper, Schade finds when government is perceived as the main reason for the congestion problem

versus individuals, acceptability suffers. Thus, presumably, if government has at least some favorable image coping with bottlenecks, improving transit, improving traffic management, acceptability of pricing proposals is enhanced – and visa versa. Jaensirisak points to suspicion of government motives in pricing for revenue raising purposes may be a block to proposals. He cites a Swiss referenda process as one way to counteract doubts about government pricing planning. Tretvik echoes the finding about government revenue raising. He finds the main objection among opponents of the Oslo scheme was “already pay enough tax/duty,” pointing to the importance of governmental image as a taxing entity with already sufficient resources to deal with congestion. Link also found suspicion of government motives in public surveys across nine European countries, belief money raising may be the real motive. Link also finds concern government is not transparent in pricing planning and decision making and Ison too finds acceptance linked to how government conducts the planning process. Link cites as important to the planning process the clarity of program objectives; the degree to which non-pricing options have been examined; the extent of reference to pricing experience elsewhere. Overall, the degree to which pricing proposals feel “sprung” on people in planning appears key to acceptance. Finally, government as resourceful partner in the solution is important to acceptance. Harsman reviewing Norway experience says local, state and national governmental agreements and matching funds may be a necessary step. Jones agrees in his review of Norway programs, finding the “inducement” of matching funds from the central government important to decision maker acceptance in these cities. As well, he cites cross party alliances and compromises as important.

*Pricing Schemes Operate Over Time:* A consistent finding is acceptance tends to grow the longer pricing programs are in existence. Tretvik et.al. points to growing acceptance over time in the early Norway programs. Most recently, experience in Stockholm and London suggests the same finding. The exact reasons for growing acceptance are not well explored. London surveys suggest proven effectiveness may be central and in the case of business support in London, one can only surmise businesses perceive no harm to commerce. Tretvik speculates not only effectiveness is at work in growing acceptance of Norway programs, but absence of queues at tollgates and the visible, proven link between revenues and transportation improvements. Schade finds acceptance and preference for well known versus new pricing measures, and Ison notes the “snowball effect” of growing program experience is important to decision makers. Thus, growing familiarity may be another reason for increased acceptance over time.

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## 3.2. Regional Economy and Congestion Pricing

There is much agreement that areawide congestion pricing is likely to have significant impact on economic activities within the affected zone(s) as well as in surrounding areas. Pricing changes affect costs of travel for cars, competing modes and freight traffic. All of these changes could be expected to influence the costs of doing business and, with time, influence land uses and development patterns in profound ways. Pricing could be expected to have impacts on business costs as well as on land values, rents, availability of labor and locational decisions.

The uncertain economic impacts are frequently cited as one of the main reasons for cities' reluctance to introduce road pricing. Unfortunately, there is paucity of data about impacts of areawide congestion pricing on economic activities. Apart from Singapore, other areawide programs are either too recent (London and Stockholm) to pick up long term effects, or represent unique local program dimensions and conditions (Norwegian toll rings). Broad economic impacts of Singapore pricing programs have not been studied carefully, despite their longevity. The impacts on economy of London and Stockholm programs are expected to surface over a long period of time, though some preliminary results suggest neutral or small impacts on at least business trade, and likely no significant negative impacts. Much analytical effort will be needed over time before definitive conclusions can be drawn for London and Stockholm.

The purpose of this sub-section is to provide a brief summary of the current state-of-knowledge on this topic. Much of the material below is taken from the discussion on the subject included in the EC's CURACAO (2007) report:

The economic and relocation impacts of transportation are difficult to identify and measure. These impacts often take long time to materialize and it is difficult to separate out the effects of pricing from other influences. The lack of empirical evidence makes the impact estimation problem worse. After the Singapore ALS pricing was introduced in 1975, the businesses were asked for their assessment of the pricing scheme. Their response was largely positive. However, as Curacao points out, "this may well have reflected a general view in Singapore at the time that government was making the right decisions. Ten years later an attempt was made to assess the impacts retrospectively. It was concluded that there was no evidence of adverse impacts on economic activity in the city centre (Armstrong-Wright, 1988). However, this assessment was made difficult, both because parking restrictions had been introduced at the same time, about which businesses were much more critical, and because the Singapore economy had expanded rapidly in the intervening period, masking any impact of road pricing."

A study in three U.K. cities - Cambridge, Norwich and York – asked businesses what they expected to be the impacts of a road pricing scheme which charged £3 per day to enter the city centre in the morning peak (Gerrard, 2000). "The majority anticipated positive impacts on the environment and congestion, but negative ones on the economy and tourism, and on their own staffing and profitability. When asked whether road

pricing would influence their next location decision, 53% said it would, and 26% that it might.”

Forecasts based on models suggest smaller impacts. A 1996 analysis of the impacts of congestion charging in London by May et. al., (1996) using the MEPLAN model, which reflects the effects of changes in accessibility on location, predicted that a £4 charge to enter central London would result in an increase of 1.0% in Central London employment while Inner and outer London employment would fall by 0.5%. The model also suggested that the number of households would fall by 0.2% in central London and 0.1% in outer London, and rise slightly in inner London. Higher income households in central London were also predicted to increase.

Curacao also cites a subsequent study in Edinburgh that, “using the START/DELTA model, which includes responses to both accessibility and environment (Bristow et al., 1999), indicated that a £1.50 charge to enter or leave the city centre would increase city centre population by 2.2%; an earlier study with a similar model, but with different parameters, (Still et al., 1999) had suggested a 1.8% reduction in city centre population, and a 3.1% reduction in city centre employment. Both studies suggested that the impacts of changes in accessibility were larger than, but opposite in sign to those of changes in environmental quality.”

Transport for London (TfL) has looked at the impacts of congestion charging in London. It found that congestion charging did not have a significant impact on several different indicators of economic performance, including measures of business population and turnover and shops within the inner core of the charging zone had their rental values increased. TfL’s business surveys conducted in 2004 showed a continued recognition of the transport benefits associated with congestion charging. It should be mentioned, however, that the introduction of charging in February 2003 coincided with a temporary economic slowdown, as well as a wider set of local, national and international conditions that were not favourable to general economic performance.

“Other work conducted in London during 2005 found that trends in business registrations for VAT remained strong and that within the charging zone, the retail sector has increased its share of enterprises and employment since 2003. A majority of businesses in the congestion charging zone recognised that decongestion has created a more pleasant working environment and easier journeys for employees using public transport for work. Ernst and Young were commissioned to undertake an independent review of the monitoring of the business impacts. Their work reasonably concluded that the (then) £5 charge has had a broadly neutral impact of the central London economy. However, as charging had only been in place for 2½ years (the date of the review), this had made it difficult to draw definitive conclusions on the long term impact.”

The London Mayor’s original business case for the charging scheme suggested that congestion costs the London economy around £2 - £4 million per week in lost time. TfL has also predicted that the range of public transport services available is saving Londoners in the region of £3.5 million per week.

However, TfL's view about 'concerns over the detrimental impact of congestion charging on economic activity appear to be misplaced' is not shared by all business organizations. London Chamber of Commerce and Industry's two surveys found that 85% of the retailers who took part considered the charge had 'failed to improve their productivity'. One department store conducted its own research and concluded that charging had led to an estimated sales reduction of 7.3% at their Oxford Street store.

"Work undertaken by Ernst and Young suggests that all TfL's work and conclusions are broadly in line with their own but that further quantification of all the benefits and costs arising from the scheme should be explored further to support the view that the charge delivers overall economic benefit even when all costs have been taken into account."

In London, early claims were made that retail sales had dropped by 10% due to congestion charging. However, "Transport for London's early assessment was that retail firms were reporting reductions in turnover of around 2% in the first half of 2003, with food shops reporting reductions of 6%. However, much of this appeared to be due to other factors such as the decline in international tourism (TfL, 2004). The most recent assessment suggests that the impact of the £5 charge on the London economy has been broadly neutral (TfL, 2006)."

Evaluation work completed in Trondheim by the Chamber of Commerce between 1991 and 1992 indicated that there was some evidence that businesses located within the toll ring had lost trade during the early part of 1992. However, based on data from the summer of 1992, no significant negative impact on business trade could be found. The Chamber of Commerce concluded that there was no significant effect of the toll ring on trade.

"Tretvik (1999) reports an analysis of the impacts on turnover within, and outside the Trondheim toll ring. Before implementation, a shopping survey concluded that 25% of shoppers were likely to change the location or timing of their shopping activity in response to the toll ring. A second survey in 1992, a year after implementation, recorded that 10% had in fact changed destination or timing of their shopping trips. However, the impact on retail turnover did not reflect this downturn in activity. In 1992 the Chamber of Commerce concluded that there had been hardly any effect on trade as a result of the toll ring. Longer term time series data from 1987 to 1997 on Trondheim's share of county retail sales and on annual turnover in different parts of Trondheim showed that Trondheim as a whole, and the CBD in particular, had been losing market share between 1987 and 1990, but that the city's market share within the county grew in most years from 1991 to 1997, and that the toll ring's share was maintained throughout that period. While turnover will be affected by a wide range of factors, there is thus no evidence to suggest that the toll ring adversely affected trade within the ring."

In Stockholm, the congestion tax likely has had two opposite and opposing effects on companies' transport costs. Clearly the congestion tax has led to increased out-of-pocket costs for transportation. On the other hand, the introduction of the congestion tax has

resulted in a reduction in traffic, implying that all traffic is moving faster. The reduction in congestion is likely to have produced benefits like quicker loading / unloading times for delivery vehicles. The effect of the charge on local consumer purchasing power will depend to a large degree on whether consumers continue to drive after the charging system begins or whether they either begin or continue to use public transport.

In terms of the congestion tax and its impact upon consumer purchasing is thought to be very slight as the revenue from the tax represents no more than approximately 1% of the total GDP for the whole of Stockholm County.

CURACAO (2007) states that, “in the case of the Stockholm Trial, sales and consumer surveys show that the congestion tax had minor or no effects on retail trade. The business community is dependent on a well-functioning road transport system and before the start of the trial there was a sense of worry that the congestion tax would change consumer behaviour and have a negative effect on the economic situation in the region. However, during the Stockholm Trial the retail trade increased by approximately 7 % within the zone, which should be compared to an equivalent rise in the trade outside the zone and in the whole country. The consumer durables trade in department stores and shopping malls rose by 7.5 % and 8.2-8.6 % outside the zone and in the whole of Sweden. The growth of consumer durables trade in street-facing shops climbed to 7 % during the trial. Moreover, sales of non-durables within the tax zone increased by 6.3 % compared to 8.8 % outside the zone and 6.6 % nationwide. The differences between growth rates is principally due to special events such as the creation of new retail areas outside the zone and renovation and rebuilds of department stores and malls inside the zone. Trend related changes in the retail trade also had an impact.”

CURACAO (2007) goes on to say, “At an aggregated level it seems that the congestion tax had little effect on the companies total transport cost and the households disposable income and purchasing power. However the situation vary for individual households and companies. The total production of goods and services in the county (the gross regional product) amounted to an estimated SEK 750 billion in 2005. Compared to this the contribution made by the Stockholm Trial (SEK 1 billion) is minimal.”

A model based analysis of a permanent congestion tax in Stockholm shows that there will be an effect on the appeal of certain areas effect measured by falling housing prices. However, the effect on housing prices were extremely modest compared to the changes that normally occur on the property market. The model also assumed the effects on traffic and accessibility to be worse than what was actually measured during the trial. Most likely it will be other factors than congestion tax that determine housing price trends in the various part of the county.

Model calculations of the effect on the location of residential premises and places of work also show that over the long term the inner city area and the surrounding area would fall by 1 % as a result of the change in accessibility with a permanent congestion tax. However, over the 20-30 year prediction period this is not a great change. Therefore the

conclusion is that congestion charging most likely will not have any great effects on the future expansion of residential or commercial areas.”

## **Summary**

The generally low level of measured economic and business impacts appears to refute the perception that road pricing will lead to substantial out-migration of residents and business.

*Available evidence suggests small, neutral or no significant negative impacts on business activity:*

- In London, congestion charging did not have a significant impact on several different indicators of economic performance, including measures of business population and turnover and shops within the inner core of the charging zone had their rental values increased. TfL’s business surveys conducted in 2004 showed a continued recognition of the transport benefits associated with congestion charging. The most recent assessment suggests that the impact of the £5 charge on the London economy has been broadly neutral.
- The London Mayor’s original business case for the charging scheme suggested that congestion costs the London economy around £2 - £4 million per week in lost time. TfL has also predicted that the range of public transport services available is saving Londoners in the region of £3.5 million per week.
- In the case of Trondheim toll rings, based on data from the summer of 1992, no significant negative impact on business trade could be found. The Chamber of Commerce concluded that there was no significant effect of the toll ring on trade.
- In the case of the Stockholm Trial, sales and consumer surveys show that the congestion tax had no negative effects on retail trade.
- At an aggregated level in Stockholm it seems that the congestion tax had little effect on the companies total transport cost and the households disposable income and purchasing power.

*Continued evaluation is much needed and will tell more:*

- Congestion pricing has been implemented only in a few cities and they are characterized by dominant centers, and probably subject to only limited economic competition. It may well be that smaller centres with closer competing centers would experience greater impacts.

Economic and business impacts can also have substantial impacts on equity; poorer households are more likely to have to move if residential areas become more attractive, and are more vulnerable if they become less attractive; those without good public transport access are more vulnerable if shops and facilities close or leave an area.

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### 3.3. Equity Implications of Congestion Pricing

Congestion pricing will differentially affect different population segments. The benefits received and costs borne might differ significantly by population subgroups. Real or perceived concerns about inequitable incidence of impacts of pricing can influence the success or failure in moving forward with implementation.

The definitions and perceptions of equity or fairness differ across locations and population segments within a city making for challenging equity assessments. Nevertheless, analysts have attempted to assess equity impacts variously defined and derived findings accordingly in some of the cities subject to this review as well as in more general literature on the subject.

The purpose of this sub-section is to provide a brief summary of the current state-of-knowledge on this topic. Much of the material below is taken from the discussion on the subject included in the EC's CURACAO (2007) Report.

#### *Definitions and Concepts*

Equity assessment involves identification of winners and losers of pricing policies and estimating the differential incidence of benefits and costs (Langmyhr, 1997). The two principal dimensions are vertical and horizontal equity. The vertical equity looks at distribution of impacts by income and socio-economic characteristics and is concerned with perceptions of “fairness” and “affordability” across these dimensions. The horizontal equity looks at the impact on people living in different areas or making differing types of trips with the premise that those who occasion costs and/or receive benefits should pay accordingly. There are also issues of equity between firms, but these are covered under economic impacts in the previous sub-section.

To quote CURACAO (2007), “Road pricing will change the costs of travel by car and by competing modes. These will differ by type and location of journey. Vertical equity impacts are, as a result, complex. Lower income car users in the charged area will be adversely affected, but lower income residents are more likely to use buses, which will benefit, and walk and cycle. Horizontal equity impacts depend on the location and nature of charges. With a charge to cross a cordon, differences are marked, with those making short journeys across the cordon experiencing the greatest proportional cost increase, and those within the cordon benefiting from reduced congestion and a better environment. With multiple cordons or distance-based charges, the differences are less acute, but more complex. There is also a set of horizontal equity considerations which concern the nature of the user or journey. Disabled drivers are an obvious category of concern. So, to a lesser extent, are those travelling when public transport is less available and those carrying bulky loads.”

CURACAO (2007) also points out: “Economic impacts can have substantial secondary impacts on equity; poorer households are more likely to have to move if residential areas

become more attractive, and are more vulnerable if they become less attractive; those without good public transport access are more vulnerable if shops and facilities close or leave an area; conversely, inequities are less likely to have serious impacts on the economy, since those who are likely to be adversely affected are typically less economically active.”

An assessment of the distributive effects of road pricing must take into account how revenues are spent. Road pricing attracts much equity based opposition on the basis that high-income motorists and commercial traffic constitute the “winners” predominately. Those likely to lose out on the grounds of equity are predominately those who are low income and car-dependent families. The most commonly used solution here is to use pricing revenues to improve public transport. Trondheim’s experience has been to earmark revenue not only into public transport improvements but also to walking and cycling.

Exemptions from pricing and the use of pricing revenues to provide rebates and fund expansion of alternative modes of transportation can and have been adopted in London and Stockholm to mitigate some of the real or perceived inequities resulting from congestion pricing. The allocation of revenues is a particularly important issue affecting perceived or real equity/fairness. The allocation of revenues plays a key role in enhancing acceptability, mainly via fairness considerations, which may influence the distributional impacts in the desired direction.

Concern over equity has been frequently cited as one of the main reasons for rejecting many early road pricing proposals. More recently these concerns appear to have been less frequently mentioned as successful pricing projects come on board and as equity concerns are addressed carefully.

#### *General Research on Equity Issues*

Referring to May and Sumalee’s 2003 paper and, with some selective updating of literature on the London Congestion Charging Scheme, CURACAO (2007) states, “Early attempts in dealing with the equity issue mainly involved analysing the impact of road pricing on vertical equity (See Anderson and Mohring, 1995; Fridstrom et al., 2000; Giuliano, 1994; Gomez-Ibanez, 1992; Langmyhr, 1997). A general conclusion from various studies was that low-income car users or less-flexible car users (e.g. based on gender or flexibility of working schedule) are likely to be the worst-off groups as a result of road pricing. If revenues are not redistributed in any way, road pricing generally results in gains for higher-income groups and losses for lower-income groups (Else, 1986; Cohen, 1987). However, as noted above, where lower income users are more likely to use bus services than drive, they may be better off (May, 1975). The way the revenues are distributed has a significant impact on the equity issue.”

Fridstrøm *et al* (2000) looked at the spatial impact (horizontal equity aspect) of road pricing cordons using spatial accessibility for each zone segregated by modes as the indicator. They suggest that the major horizontal equity impacts depend on the location of the cordon. A small cordon would negatively affect residents inside the cordon most

whereas those outside the cordon would be the main losers for a wider cordon scheme. In an assessment of the Singapore ALS, Holland and Watson (1978) indicated that the cordon pricing may have given more advantage to the commercial firms outside the cordon. It is argued by some analysts that this problem may be reduced by the introduction of time-based, distance-based, or delay-based regimes (Jones, 2002). Halden (2003) also used the accessibility ratio between car and non-car from different zones for different purposes. The results showed a great diversity of the impacts on different areas in the city and classes of users.

Other recent research has been looking at the ways to address the equity aspects in the design of road pricing systems. “Mayeres and Proost (2001) have proposed a weighted welfare indicator giving more weight to the benefit/cost ratio occurring to less advantaged groups. The test results showed that road pricing is an important element of the tax reform even when there is a greater emphasis on equity. Meng and Yang (2002) have proposed a framework for calculating the optimal road toll (to maximise social welfare) with constraints on the spatial equity impact. Sumalee (2003) has proposed an analytical method to identify the optimal location for a charging cordon with spatial equity constraints. The results for Edinburgh are shown in Sumalee et al, 2005. Jones (2002) proposed a simple approach to address equity concerns through scheme design, exemptions, and discounts.

Research by Jose Viegas of Instituto Superior Técnico; and TIS.pt, Transport, Innovation and Systems (Lisbon, Portugal) found that road pricing can lead to financial success in cities and towards the reduction of congestion and better quality of surface public transport in cities like London and Stockholm. The improved quality of surface based public transport presumably would reduce inequities from a position ex-post whereby non-car owners would have experienced lower quality public transport before pricing.

Analysts have also assessed the equity consequences of pricing in comparison with the current practices of transport revenue usage for Oslo, Warsaw and Edinburgh (EC “DG-TREN” and “REVENUE” projects).

### *Case Studies*

A case study conducted in Edinburgh looked at both the economic impacts and cross-boundary impacts and acceptability issues for the proposed scheme. A two-cordon scheme was proposed, including one inside the outer ring road, and one outside of the historic city centre. Those living outside the outer cordon would have been exempt from the charge. This was of considerable concern to the residents of neighbouring authorities, who would not have been exempt from the charge and hence there was a concern over whether all residents would be receiving “fair” treatment. Public transport improvements had been promised, however they were not planned before the start date of charging, hence no real benefit from the improvements would have been experienced prior to charging. Bus service improvements should have been planned earlier in order to demonstrate the degree to which all communities would benefit. The Edinburgh’s neighbouring authorities opposed the concept of road pricing as proposed.

Three of the neighbouring authorities outside Edinburgh opposed the charge because the plans were perceived to be not equitable. Plans for revenue ownership by the city were viewed as unfair to non-city residents who would have been expected to pay the charge, yet not receive any benefit through the revenues. The neighbouring authorities had no legal grounds on which to secure any of the public transport improvements they needed. The scheme was contested on the premise that city residents would receive huge exemptions but would be the main benefactors. City residents would also have benefited disproportionately more from the public transport improvements. The issue of the exemption given to outer city residents of Edinburgh was a critical acceptability problem, controversial in terms of the specific outer cordon exemptions.

Norwegian Toll Ring experience also underscores the importance of modifications to the “optimal” boundary design and crossing policies aimed at reducing opposition. The following “sub-optimal” attributes were included in the Edinburgh toll ring: a “one-hour rule” whereby one would only get charged once per hour regardless of the number of crossings of the cordon made; free crossings of the toll ring for disabled drivers; and a system allowing free passage after 5:00pm and all day at the weekends. There was an equity argument here, which was to avoid charging for “social travel.” Similarly, London changed the charge period end from 6:30 PM to 6:00 PM to respond to objections from the entertainment industry and their patrons.

In Norway, formal equality issues attracted less importance in Kristiansand where the choice of toll stations on two sides of the city was considered to be a ‘fair’ solution.

## **Summary**

Equity concerns have surfaced at nearly all pricing projects at the time of proposal development and pre-implementation phases. Some proposals could not move to implementation because of opposition based on the perception of “unfairness”. Once the pricing projects are operational, however, public opposition based on equity concerns has diminished significantly and the issue has taken a back seat. Unfairness of pricing appears to have become a less dominant concern than it once was. At the same time it could be expected to continue to affect decisions about adoption of pricing. It therefore remains important to understand the scale of both vertical and horizontal inequities, and this will require a disaggregated analysis by person type, income level, journey type and specific person and journey characteristics.

The solutions to equity problems lie in many factors including: the design dimensions (location, time of day and level of charge); the use of exemptions and rebates; the packaging of complementary policies, particularly to provide alternatives; and the use of surplus revenues to provide direct or indirect support. Based on research findings and empirical evidence, key findings are:

- In the future it may be possible to assess equity issues further through additional empirical research. In the meantime equity research will have to rely on the results of predictive studies.
- Rigorous equity assessments need to be given greater attention than in the past during project design and implementation phases.
- Findings show predictive models are the analytic approach used in some cases and have some stated merit but certainly weaknesses. They are still useful since empirical work via surveys across both vertical and horizontal issues have been scarce.
- As described in earlier discussions, equity is variously defined, will have more or less importance depending on site specific perceptions, actors, interests, and program design. In other words, equity impacts, underlying equity concerns and resulting design responses to inequities are likely to differ between cities; little is known about these impacts as yet.
- Experience from the London Congestion Charging program, Norwegian toll rings, the unsuccessful project attempt in Edinburgh and related research on the equity issues underscores the need to be flexible in setting the pricing program design dimensions. It is important to consider modifications in design (including location, time of day, level of charge, exemptions and rebates, complementary instruments and use of revenues) in order to address and mitigate many equity concerns.
- Economic impacts can have substantial secondary impacts on equity. Past research and project evaluations have devoted less attention to equity consequences of economic impacts than on equity impacts on residents and drivers. Singapore and Edinburgh devoted a small effort to this issue while London and Stockholm are expected to attend to the issue in the future.

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## 4. CONCLUSIONS AND IMPLICATIONS

More than three decades of experience overseas with pricing programs and studies provides a rich body of knowledge about how travelers respond to price, the technology associated with implementing these concepts, the determinants of public acceptance, and other policy considerations. Much like experience in the United States, some of the work done under these overseas pricing initiatives resulted in actual implementation. Other work involved studies that did not result in implementation, but often provided valuable insights into potential user responses and policy issues needing attention.

This section ties together the lessons learned from the projects and experience syntheses described in the preceding Sections 2 and 3 – experience focusing on areawide pricing that has yet to be tried in the United States. The discussion of lessons learned includes the effects of areawide pricing on: travel and traffic, costs and revenues, economy and business, equity and the environment. In addition, lessons are drawn relating to the successful adoption of areawide pricing and public acceptance requirements; and issues relating to the adequacy of technology for the administration and enforcement of pricing programs. Lessons are followed by implications of the lessons learned for U.S. officials and planners interested in pursuing areawide pricing programs.

### 4.1. Effects of Pricing

#### Mobility Impacts

- *Pricing Reduces Congestion Significantly and Sustains It Over Time*

Without exception, areawide pricing strategies that have been implemented abroad have met their principal objective of reducing congestion and sustaining the relief of congestion over long periods. Areawide pricing in Singapore, London and Stockholm resulted in 10 to 30 percent or greater reduction in traffic in the priced zone and has sustained the reductions over time. Pricing has encouraged travelers to change their behavior by changing modes of travel, times, routes, or trip frequency. In the three areawide pricing programs described in Section 2, up to 50 percent of those foregoing car travel to the priced zone in the priced periods shifted to public transportation. In London and Stockholm, the greatest shift was to public transportation while in Singapore it was to 4+ carpools and to the shoulder time just before the start of pricing. The traffic reductions in priced zones in Singapore and London have been sustained permanently (over thirty years in Singapore and five years in London). The bypass routes in Singapore and London have seen modest but not overwhelming increase in traffic. The nature and magnitude of impacts on travelers and traffic has been found to depend on many factors including: price levels and schedules, coverage, pricing periods, the existing traffic levels and demographic characteristics.

Delays due to queues declined dramatically. Speeds increased significantly within the zone as well as outside along approach roads. A ten to 30% increase in speed has been realized. Buses in Singapore and London have particularly benefited from speed increases that now allow them to operate faster and enjoy operational productivity gains. Travel time reliability also has increased in the three cities for trips to the center. Again, this allows buses to offer more reliable service.

The success of areawide pricing in reducing congestion has raised questions regarding the many exemptions that have come to be seen as diluting the benefits. Singapore has eliminated many of the exemptions over time.

### **Cost and Revenue Impacts**

- *Areawide Pricing Has Been an Important Source of Revenue For Transportation*

Although the primary rationale for areawide pricing projects has been to improve mobility and efficiency, relatively large net revenues from pricing clearly have been of major interest to the sponsors. The significant revenues generated by pricing have been seen as an important source of benefits in all three projects reviewed in this report. Project revenues in London and Stockholm (as well as in toll cordon projects in Norwegian cities) have been used to cover operating and enforcement costs first and remaining revenues have funded improvements to bus and rail services. In London and Stockholm, the desire and ability to use pricing program revenues for public transportation was a major objective and “selling” point. In Singapore, while the revenues are not directly earmarked for public transportation, the availability of these funds probably has allowed the government to more easily pursue ambitious public transportation programs.

Areawide pricing projects are generating revenues far in excess of costs. In Singapore’s Area Licensing Program, revenues were more than 11 times the operating costs. The revenues from the central area cordon pricing component are nearly 14 times the operating costs. If capital costs are included, the revenues are still 2.5 times the costs. These numbers imply very attractive financial “pay back” periods. For the London charging program, the revenues have been a little over twice the operating costs. Inclusion of capital costs brings this ratio down only marginally (to slightly over 1.8) because of the relatively low capital costs of the inexpensive technology adopted. In the Stockholm trial, the revenue to operating cost ratio was 4:1; and when capital cost were included, it was 2.5:1.

### **Economic Productivity and Business Impacts**

- *Areawide Pricing Has Generated Positive B/C Ratios and Small Or Neutral But Evidently No Significant Negative Economic Impacts*

Areawide congestion pricing applications likely have realized societal economic benefits in excess of costs (implying positive benefit to cost ratios and reasonable rates of return).

Singapore's 1975 ALS program is estimated to have achieved a rate of return on investment of, at least, 15%, even without inclusion of realized savings other than the value of time savings and without the exclusion of the costs of expensive and poorly utilized PAR facilities. Some believe that the returns would have been higher also if the price had been somewhat lower. The economic returns also would have been much greater had variable instead of flat pricing had been used.

London scheme is estimated by TfL to have generated a B/C ratio of 1.4. Again, it is believed that a different charge and/or variable prices tied more closely to congestion levels likely would have achieved higher B/C ratio.

Regarding business impacts, in Singapore, surveys suggested that the ALS pricing did not, by itself, initiate changes in business conditions or location patterns. Overall, the business community responded positively to the ALS, probably believing that the combined package of actions by the government was necessary and beneficial in the long run.

TfL (2006, 2007) reports that the pricing in London seems to have had broadly neutral economic impacts. Annual surveys do suggest, however, that businesses in the charging zone have outperformed those outside and a majority of businesses continue to support the charging scheme, provided investments in public transportation is continued.

In Stockholm surveys, albeit over a very short time span of trial, no identifiable impacts on retail business or household purchasing power were identified.

CURACAO (2007) summarizes the implications of regional economic impacts by finding a "generally low level of measured impact." While the result may be partly attributable to the unique economic vitality and strength of the cities in which pricing occurs, there is no evidence of economic damage. CURACAO calls for continued research on the impacts of road pricing on local and regional economies.

## **Environmental Impacts**

- *Areawide Pricing Has Shown Some Positive Environmental Impacts and Energy Benefits*

Better environment has been one of the primary objectives of the Stockholm areawide program. Environmental improvement has not been a stated major objective behind London and Singapore pricing programs. However, all three have made attempts at monitoring and measuring air quality implications of pricing recognizing that pricing would alter the operating speeds, number and timing of trips or even the mode on which trips are taken. These changes, in turn, could be expected to lead to reductions in fuel consumption and consequent reductions in vehicle emissions, resulting either from fewer vehicle trips being taken or smoother traffic flows under less congested conditions.

Evaluators in Singapore concluded that the tailpipe emissions most likely declined in the RZ because there was such a large reduction in automobile travel. Regarding smoke and haze, measurements showed declines, but they could not be unambiguously attributed to the ALS pricing. Subsequent surveys also revealed overall reductions in the RZ as a result of reduced and more dispersed resulting automobile travel patterns.

TfL in London has reported changes in air quality within and alongside the Inner Ring Road boundary of the zone. Levels of NO<sub>x</sub> fell by 13.4% between 2002 & 2003, CO<sub>2</sub> by 15%, and particulates (PM<sub>10</sub>) by 7%. TfL (2007) states that between 2003 and 2006, NO<sub>x</sub> emissions fell by 17%, PM<sub>10</sub> by 24% and CO<sub>2</sub> by 3%, with some being attributed to the effects of reduced levels of traffic flowing better, with the majority being as a result of improved vehicle technology. In total, the rate of fall in CO<sub>2</sub> has been 20%. The TfL report makes it clear, however, that only the initial reduction of emissions could be expected from the introduction of the charge. Further reductions are unlikely to be as a result of the charge.

Achievement of environmental objectives was supported by the observed reduction in the inner city of 10-14% in Carbon Dioxide (2-3% in the County), 7% in NO<sub>x</sub> and 9% in particulates. Furthermore, emissions declined in the “right” areas near population centers. there was no measurable change in noise impacts.

The results from all three areawide pricing projects indicate that areawide pricing may have some potential for reducing pollution. Except for CO<sub>2</sub>, other pollutants may be one-time reduced at the start of the program. On the other hand, indirect effect of public transportation expansion, made possible by the congestion charge revenues, has the potential to reduce all pollutants and sustain reductions over time.

### **Equity Impacts**

- *Especially Income Equity Impacts Have Received General Analytic Attention, But Little Project Level Evaluation. Still, Available Findings Suggest Income Equity Is Manageable*

Equity issues occupy a considerable literature as reviewed above, with focus on concepts of equity, modeling of impacts and pricing designs to address income equity issues. At the level of projects or proposed projects, Singapore has examined equity impacts; Edinburgh has grappled with equity and general fairness considerations and several tollrings in Norway have designed schemes with equity in mind but not done detailed equity evaluations after project implementation.

Research reviewed points out that equity issues are ever-present, but project evidence suggests they can be successfully dealt with. Any change, in the way charges are made for road use, will result in winners and losers. Some road users will value time savings and reliability more than the cost of the toll, others will not. Those who are “tolled off” the priced facility may shift to off-peak times or alternative routes, decide to carpool or switch to a different mode of travel, or simply make fewer trips. Changes in trip making

behavior may also change patterns of commerce and affect businesses differently. Researchers also note the perception of fairness depends on how the revenues are used and what alternative policies are considered as ways of dealing with congestion.

Regarding specific cities reviewed for pricing activity, the perception that congestion pricing is “unfair” to low income drivers has not been a major concern in Singapore, London and Stockholm after implementation. Findings from Singapore are most in depth, though experience in the proposed Edinburgh program also is instructive.

The Singapore Area Licensing (ALS) project explicitly looked at equity implications by modeling, attitudinal surveys and before/after travel analysis. The results of modeling analysis based on before and after user survey data suggested that gainers outnumbered losers 52 to 48%. Attitudinal surveys carried out after the introduction of ALS pricing also provided indications regarding equity across various dimensions. Pedestrians, taxi riders and residents outside of RZ found the impact of ALS as neutral or negative while cyclists, bus passengers and residents within the RZ judged the ALS as favorable. Car drivers and passengers judged the ALS as mildly unfavorable. Overall, middle income travelers felt adversely affected by the ALS.

Travel evaluations and stakeholder surveys in Singapore also examined impacts across income groups. The data on shift from cars to buses as a result of ALS in 1975 showed, somewhat counter intuitively, that the increases in transit were fairly uniform for low, medium and high income peak period travelers to the RZ. The evaluators concluded that, overall, there were only small differences among income groups in modal response to the ALS. There was also no evidence that trip times increased or decreased more for any particular income group. All in all, the evaluators did not find that low income travelers suffered more than high income ones due to the ALS pricing.

Addressing the fairness of pricing in Singapore, supporters claim that without pricing there was, and would be, a great imbalance between the travel conditions enjoyed by car drivers (a minority of travelers) compared to the majority who use alternative modes. ALS is perceived as far from unfair because it is said to have redressed a greater inequity and has allowed much greater increase in public transportation and road efficiency.

In Edinburgh, issues of revenue distribution and transit improvements were vital to geographic equity considerations. Non-city residents viewed revenue distribution plans as unfair since they would pay the charge but not get any direct benefit. A key institutional issue appears to be neighboring authorities had no legal grounds to support public transport improvements which might have appealed to non-city residents. City residents would also have benefited disproportionately more from the public transport improvements. In short, Edinburgh shows geographic equity and improvement plans can make or break pricing plans.

In light of Edinburgh findings, certain CURACAO (2007) conclusions appear especially relevant: “It therefore remains important to understand the scale of both vertical and horizontal inequities, and this will require a disaggregated analysis by person type,

income level, journey type and specific person and journey characteristics.” And, “The principal solutions to equity problems lie in the design of the scheme itself, including location, time of day and level of charge; the use of exemptions and rebates; the application of complementary policies, particularly to provide alternatives; and the use of surplus revenues to provide direct or indirect support.”

## **4.2. Feasibility and Implementation of Pricing**

A number of factors influence the prospects for successful implementation of pricing, including policy and institutional issues, public outreach and acceptance programs, and technological factors.

### **Public Policy and Institutional Issues**

- *Areawide Pricing Projects Often Require New Policy and Institutional Arrangements*

Major national level legislative initiatives were enacted before areawide pricing could be implemented in London and Stockholm. The experience shows that formal actions agreements may be needed for: power to impose and collect charges; use of selected technology to administer and enforce charges; to cite violators and collect fines; make modifications to the pricing scheme; and for the use of revenues from the charges. Experience also shows that policy and institutional arrangements and agreements have profound impact on public and political acceptability of areawide pricing proposals and operational success. Acceptability research shows stakeholder involvement and funding across government levels also are important.

### **Acceptability of Areawide Pricing**

- *Successful Projects Depend on Effective Outreach and Sensitivity to Public Acceptability*

Public opinion is perhaps the most critical determinant of the prospect for successful pricing project implementation. All of the projects overseas have paid considerable attention to measuring public attitudes and reaching out to the public, stakeholders, and elected officials so that they understand the new concepts in transportation that pricing represent. As described in Section 2, projects typically are initiated after considerable public outreach and stakeholder involvement, and many have made changes in response to or anticipation of certain public attitudes and reactions. Outreach efforts as part of initial feasibility studies often find neutral or skeptical opinions, or outright resistance, but this is often followed by acceptance as projects get underway. The outreach efforts, often using focus groups, surveys, and public forums, have resulted in a better understanding of public concerns that have been incorporated into project designs and public education materials. The support of a key stakeholder and/or a senior politician

who was able to influence public opinion also was crucial for the successful implementation of several projects.

The evidence suggests that acceptability of areawide pricing schemes increase after implementation but business support for congestion charging may continue to be relatively mixed. Businesses in London are more supportive of the scheme than opposed to it. A majority of businesses continue to support the scheme, provided that there is continued investment in public transport.

Based on project experience and public opinion studies on pricing, certain key factors emerge as potential determinants of public acceptance of pricing as highlighted in the Section 3:

- *The problem addressed resonates.* Whatever the mix of problems addressed by pricing proposals, whether congestion, pollution or some combination, acceptability is enhanced where the problem is clear and severe to affected parties. Congestion may or may not be the most painful candidate problem for pricing; pollution may be more resonant. Pricing plans enhance implementation prospects when they home in on the most resonant problem or problems.
- *Pricing Is Convincingly Effective:* Acceptability studies suggest the public or decision makers may be skeptical about the effectiveness of pricing in reducing congestion or pollution. The implication is proposals will have better prospects where they can demonstrate effectiveness, perhaps by reference to like projects or through well evaluated test programs or both.
- *Program Design Meets Program Concerns:* Acceptability of pricing is enhanced where pricing program parameters are in line with public and decision maker concerns. Top concerns will vary by area, but planners increase the odds of acceptance by determining the concerns and structuring the program accordingly. Some top concerns may be about “free riders” and enforcement; others may be about complexity of technology; others about specific groups facing hardship or adverse boundary effects. Implementation prospects improve with full attention to specific concerns.
- *Revenue Distribution Follows Preferences:* Gearing revenues toward the most favored purposes is important to acceptability. Research shows revenues directed toward transit and/or road improvements may garner support in some locations, but may compete with other preferences elsewhere, including possible tax reductions.
- *Fairness Is Broadly Addressed:* Equity across income groups subject to pricing often leads equity discussions among analysts of road pricing. However, research shows acceptability does not vary greatly across income groups and equity defined more broadly may dominate and deserve more attention. Specifically,



these fairness perspectives may be key: fairness of outcomes, i.e. assurance some are not evading the pricing scheme who should be paying; “procedural” fairness, i.e. people feeling full opportunity to participate in developing pricing plans; fairness to special groups, e.g. handicapped or emergency workers; use and spatial fairness where occasional payers reap the same benefit from new roads and transit as frequent users; and ways to moderate different treatment of travelers within or to/from a cordon scheme.

- *Government Planners Are Open, Responsive, Resourceful Solution Partners:* Numerous findings suggest how government pricing planners are perceived may be as important to acceptance as the nature of their pricing proposal(s). It seems if government has at least some favorable image coping with bottlenecks, improving transit, improving traffic management, acceptability of pricing proposals is enhanced – and visa versa. Likewise important is sensitivity to governmental image as a taxing entity with already sufficient resources to deal with congestion. Transparency in pricing planning and decision making also will enhance acceptability, including the degree to which non-pricing options have been examined; and the extent of reference to pricing experience elsewhere. Finally, government as resourceful partner in the solution is important to acceptance, suggesting state and national governmental agreements and matching funds may be a necessary step.
- *Pricing Schemes Operate Over Time:* A consistent finding is acceptance tends to grow the longer pricing programs are in existence. The exact reason for growing acceptance are not well explored. It may have to do with experiencing demonstrating no harm to business, absence of feared queues at tollgates and the visible, proven link between revenues and transportation improvements. In any case, growing familiarity with successful operations seems to enhance acceptability over time.

### **Technology For Areawide Pricing**

- *Effective, Reliable and Acceptable Pricing and Enforcement Technologies Are Key*

Technology is important the success of most pricing concepts, and the technology has been generally up to the task. Different technologies for pricing and enforcement, both low and high end, generally are proving reliable and effective.

Singapore Area License Scheme (ALS) windshield license and manual enforcement system worked well. The Electronic Road Pricing (ERP) system, based on Direct Short Range Communication (DSRC) and In-vehicle Unit (IU) transponders with stored value “Smart Cards” technologies, is working seamlessly. It allows open road, multilane variable tolling at 120 KPH speeds and addresses privacy concerns.

London's Automatic Number Plate Recognition (ANPR) charge collection and enforcement system has been effective, though TfL is proposing to move to an electronic system over the next few years in order to reduce administrative costs and allow variable pricing schedules. The DSRC and IU based system, supplemented by ANPR also worked well in the six-month trial.

### **Steps To Areawide Pricing**

The areawide pricing programs abroad parallel several lessons stemming from U.S. pricing programs about how to conceptualize, plan, discuss, and carry out a successful pricing project:

*Define the problem* - Proposals for pricing solutions need to focus on the costs of severe congestion, including traffic delay, air quality problems, accidents, lost productivity, or other locally perceived problems. Proposals need to show how pricing will address these problems, and how pricing compares to alternative potential solutions. The revenue raising aspects of pricing programs are also important considerations and these need to be compared (in terms of revenue productivity, equity, etc.) to more traditional transportation financing approaches.

*Take time to include all interests* - Pricing is a significant departure from existing practices, and it may have far reaching impacts and necessitate realignment of existing institutional relationships. Several public and private interests and agencies are likely to have a stake in the workings and outcomes of pricing proposals. All these stakeholders and interests need to be involved in project development. This takes time but will make for a much more successful outcome.

*Consider a full range of alternatives* - Pricing should be viewed in the context of a range of strategies for addressing congestion and related problems. Alternative applications of pricing should be considered and an incremental strategy with continuous evaluation and potential broader applications should be contemplated.

*Carefully attend to the estimation of impacts* - The estimation of a variety of potential impacts of pricing is both difficult and essential. Impact estimation difficulties stem from the lack of experience with road pricing and limitations of forecasting tools. Fortunately, as findings summarized here indicate, impacts of pricing strategies are documented and can aid planners and local decision makers in estimating potential ranges of impacts.

*Introduce pricing as a part of a package* - Alternative travel mode enhancements and travel demand management programs should be considered along with pricing. Alternative uses of pricing revenues should be proposed and assessed.

*Focus on customer relations* - Public outreach and education have been a critical determinant of acceptance of pricing programs by public and decision makers. Focus groups, public opinion surveys and media campaigns have all contributed to project

successes and should be attended to all through planning, implementation and evaluation of future pricing programs.

### **4.3. A Look to The Future**

- *Interest in Areawide Pricing is Growing*

Pricing projects overseas are breaking new ground and providing important lessons for those interested in exploring the use of pricing to address traffic congestion and transportation funding problems. The implemented projects have shown that pricing can lead to more efficient use of existing roads. Theorists have predicted this for decades, but the implemented projects have confirmed that people respond to price signals when making transportation decisions, just as they do in other aspects of their economic lives, and those responses can help diminish congestion and support alternatives to driving. The projects have also been a test-bed for the technologies that enable pricing to be used, as well as a discussion forum for important issues related to economic and environmental impacts, equity and public perceptions.

Whereas areawide pricing was once something talked about by a small corner of academia, it is now front-page news all over the World, and is openly discussed by transportation professionals, interest groups, and elected officials. Areawide pricing has come to be viewed as an innovative way of coping with recurring congestion problems and as a source of funding and an effective complement to existing transportation improvement programs.

- *Revenue-generating Effects of Pricing Provide Important Stimulus*

Although the primary rationale for areawide pricing is that it improves mobility, the revenue-generating effects of pricing have also been an equally important reason for interest overseas in this approach to reducing congestion. In contrast to the pricing projects in U.S. that have focused on single facilities and generated moderate revenues, areawide pricing programs overseas are more than self-supporting and generate large revenues far in excess of costs. Overall, areawide pricing shows considerable promise in a time where transportation agencies are struggling to find new and robust approaches for financing transportation programs. Moreover, it has been shown that, with proper attention to acceptability issues specific to project areas, pricing can be a fair and equitable part of a road user charge program.

- *Much Remains to be Learned*

Much has been learned about the promise and potential of areawide pricing over the last several years, yet much more remains to be learned. Long-run impacts on land use, auto ownership, business and productivity need to be monitored more carefully over time. Continued progress in implementing acceptable, effective and ultimately informative

pricing programs has required careful planning, coalition building, public education and participation, and sufficient time and resources for the development of well designed and locally acceptable project plans. Several models for effective and workable ways to proceed are shown in this report.

Areawide pricing holds the promise of reducing congestion, enhancing mobility and economic productivity, reducing environmental and energy costs, and providing new sources of funding for transportation investments. Yet, despite this potential, the concept of congestion pricing remains controversial in many potential applications. It involves a new approach to dealing with congestion problems and charging for road use. However, the overseas programs demonstrate favorable outcomes are possible with careful and inclusive planning and outreach.

The overseas experience provides a valuable guide to planners in exploring the feasibility of future pricing applications and identifying projects for implementation. A particularly important consideration in the U.S. cities considering areawide is the use of revenues generated by pricing to address and mitigate plausible equity impacts. At the same time, operating pricing programs abroad have demonstrated broad definition and attention to fairness versus simple income equity, a wise focus given the extensive findings summarized here on the link between fairness and acceptability.

Overseas experience suggests the need for focusing more on the potential environmental and energy benefits of pricing. Overseas analysts have made limited but important preliminary findings about air quality impacts, and more work can be expected. While the air quality and energy conservation benefits of small-scale U.S. pricing projects implemented to date may have modest effects on overall regional environmental quality, areawide projects beginning to receive attention in the U.S. will do well to pay attention to results and methods from overseas, as areawide systems may have more significant environmental and health benefits worthy of tracking.

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