# 1. Introduction

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This introduction has two purposes: to present the book's central theme, that is, the implications of London's Congestion Charging Scheme and the Stockholm Trial for the United States, and to summarize the key points of the contributing chapters.

The idea of pricing for the use of roads has been around for a long time, stretching back at least to the turnpike roads of the eighteenth century (much more common in the United Kingdom and other parts of Western Europe than in the United States), and more recently, the privilege under the Interstate Highway System for each State to designate one highway as a toll road (implemented more in Northeastern States, such as New York and New Jersey) and the plethora of toll bridges throughout the country. But all these examples were either to raise revenue or to recover construction costs not to decongest roads.

The idea of pricing as an instrument to tackle road congestion is based on literature in economic theory from the early 1960s in which economists such as Walters (1961), Vickrey (1963) and Johnson (1964) developed the standard road congestion analysis to demonstrate that the market equilibrium derived from unpriced roads results in excessive congestion. The key idea was obvious: drivers pay only for their own congestions not those of others. Setting the price of driving equal to the social marginal cost, however, would reduce traffic to its optimal level. There may still be some level of congestion, but it will be 'optimal'. The possibility that this could be translated into transportation policy, however, lagged for a long time primarily on the grounds of political feasibility: no politician subject to regular elections would risk the wrath of the voter-driver by implementing such a proposal.

The first breach in this view was made in a less democratic society (Singapore) where a successful downtown congestion pricing scheme has been in place since 1975. A later example, on a ring road in Trondheim, Norway, from 1986, was for revenue raising not congestion control, with a very moderate toll that was supposed to be abolished once the construction costs had been recovered.

This introduction deals with a much more recent and highly publicized scheme, the London Congestion Charging Scheme begun in 2003 (Leape, 2006; Richardson and Bae, 2006), and to a much lesser extent with the so-called Stockholm Trial of 2006. These are discussed in great detail in some of the later chapters; here we focus on an overview. However, the main purpose of this preliminary evaluation is to raise the question of whether the European experiences enhance the prospects of a wider application of congestion pricing in the United States. In that context, we should also take into account the beginnings of such applications, either implemented or in the planning stage, in several States, 23 according to the Government Accountability Office (GAO, 2006).

## 1 THE LONDON CONGESTION CHARGING SCHEME (LCCS)

Introduced in February 2003, the LCCS was the brainchild of the first elected mayor of London, Ken Livingstone (formerly known as 'Red Ken' during the Thatcher era when he was Leader of the Greater London Council). The scheme is an area licensing scheme in which charges are imposed when vehicles cross a boundary into or out of the zone. The zone is part of Central London, specifically the Borough of Westminster (see Figure 8.1 in Santos, Chapter 8 of this book) although an approximate doubling of its size to include the Borough of Kensington and Chelsea took place in February 2007 (Figure 8.2, also in Santos, Chapter 8). The initial zone was small, covering only 8.4 square miles, or about 1.3 per cent of the total area of Greater London; the extended zone is almost double the original.

The charge applies between 7:00 am and 6:30 pm, Monday to Friday (excluding public holidays such as the quite frequent Bank Holiday Mondays). The fee was initially £5 per day but was raised to £8 (almost $16) in July 2005. There are about 165,000 violations per month with a rising scale of penalties up to £150 after a month. Currently, more than a third of permit purchases are made through retail outlets (typically newsagents and tobacconists). Exemptions include buses, taxis, police cars, emergency service vehicles, disabled drivers and certain alternative fuel vehicles. Residents of Westminster and the adjacent borough (Kensington and Chelsea) receive a 90 percent discount after paying an annual registration fee of £10. The scheme is enforced via automatic number plate recognition (ANPR), based upon camera sites located at each entry and exit point and also within the zone, reinforced with a manual check.

The western extension has two free corridors (one of them North-to-South along the original zone boundary), and the hours have been shortened, with the charge ceasing at 6:00 pm rather than 6:30 pm (in both the extension and the original zone). However, it does not have the same impact as the original zone because two-thirds of the traffic entering the zone is not subject to charging. Nevertheless, trip reductions are more than 10 percent with a similar increase in trip speeds. On the other hand, traffic has increased by about 2 percent in the original zone with free travel into Kensington and Chelsea.

Livingstone had three major objectives in introducing the charge: raising revenue; promoting public transit; and, of course, reducing congestion (although this was the only goal claimed by Transport for London: TfL). Attaining the first objective fell far short of expectations. The original goal was a *net* revenue of £130 million, but only £50 million were raised in the first year (despite 110,000 participants per day). The two explanations for the shortfall were much higher administrative and operating costs than anticipated (mainly because of technological glitches) and a sharper reduction in vehicles entering the zone than predicted. The raising of the charge has a problematic impact on revenues because of the price elasticity effect, although the extension of the boundary should have a positive impact on revenues. Nevertheless, the target *net* revenue of up to £100 million remains problematic.

Meeting the second objective (promoting public transit) was very successful. TfL added hundreds of buses, and of the 60,000 reductions in the number of drivers entering the zone, about one-half shifted to taking the bus (a much smaller number shifted to the Underground (that is, the subway) where capacity was not increased). Part of the reason was a dramatic decline in bus traffic delays by 60 percent.

The overachievement of the third objective was perhaps the most surprising. Total traffic entering the zone declined by 18 percent (the drop in charged vehicles was somewhat greater, but was offset by an increase in exempt vehicles), cars declined by 33 percent, and traffic circulating within the zone dropped by 15 percent. These reductions were also associated with a 21.5 percent increase in trip speeds. In addition to the shift to buses and the underground, about one-quarter of the vehicles moved around the zone, with some negative effects such as more congestion (resulting from a 4 percent per annum increase in vehicle miles traveled (VMT) in the inner ring roads, somewhat mitigated by improvements in transportation management) and more air pollution although there was significantly less pollution within the zone (see Ho and Maddison, Chapter 10, and Banister, Chapter 9). With respect to air pollution, there is a proposal being discussed to impose differential tolls based on emission rates (this would represent an important step in internalizing two kinds of transportation externalities, both congestion and pollution). Other consequences of the traffic reduction included: (i) shifts to the less important modes (carpools, motorcycles, bicycles and walking); (ii) diversion of traffic to uncharged hours; and (iii) trip reductions. These last effects explain a reduction of about 12,000 cars entering the zone (or a fifth of the total).

A key question is how the LCCS stands up in a cost–benefit analysis. An early internal analysis by TfL was based not on optimality, which requires marginal analysis, but on a comparison of total costs and benefits. The study estimated annual benefits of £180 million and annual costs of £130 million. The major item on the benefits side of the ledger was time savings while the major cost item was the operating costs of the scheme. Santos and Fraser (2006) undertook a more sophisticated cost–benefit analysis that consistently showed benefit–cost ratios below unity.

Santos (Chapter 8) has undertaken a detailed analysis of the price elasticities and marginal costs associated with the LCCS. Her estimates of the point elasticity for cars is quite high because the ubiquity of public transit facilitated shifts from cars to transit. The elasticity for taxis is very high (note that in this case taxis are exempt and taxi use increased substantially) because the charge encouraged a strong substitution between cars and taxis. The elasticities for both vans and trucks are low because there are few substitution modes, and routes (and to a lesser extent times) are difficult to change. The congestion charge elasticities are very low because the increase in the charge in 2005 had a negligible deterrent effect. Also, truck traffic increased when the charge went up, primarily because of a truck fleet discount scheme.

Santos also estimates the marginal congestion costs by mode and compares them with the actual congestion charge per mile driven. Her results show that an efficient scheme would charge individual modes a different rather than a uniform charge. This would be relatively easy to do from an administrative point of view but difficult politically because the truck lobby would strongly resist raising the charge for the grossly undercharged trucks. The data suggest that cars are overcharged, while trucks and (to a lesser extent) vans are severely undercharged. The increase in the charge to £8 aggravated the overcharging of cars, and brought the charge for vans closer to their marginal congestion cost while trucks remain significantly undercharged.

Interestingly, while the LCCS has received enthusiastic support abroad, largely because of its reductions in automobile use, European observers have, in general, been more critical. Santos and Fraser (2006) have criticized the scheme as being inefficient, arguing that the charge does not approximate the marginal social costs of congestion. Similarly, Prud'homme and Bocarejo (2005) claimed that the scheme is an economic loss in cost–benefit terms, offset somewhat by its political success. Also, research at Imperial College London suggested that congestion charging has had a significant effect on sales in some central London retail establishments because of the shift in shopping habits to suburban outlets (*Local Transport Today*, 2004).

## 2 THE STOCKHOLM TRIAL

Even more recent than the LCCS is the trial with congestion pricing in Stockholm that began with an expansion of public transport from August 2005 and continued with a congestion pricing experiment between January and July 2006 authorized by the Congestion Charges Act of 2004. In the General Election on 17 September 2006, the result of the vote was a modest 5 to 4 majority to make the experiment permanent (Eliasson et al., Chapter 15).

The main component of the public transit initiative was the purchase of new buses, the opening of new bus lines, and the establishment of new park-and-ride facilities with 13,800 parking spaces (these met an unfulfilled demand, regardless of the congestion charge). The toll scheme was a cordon operating between 6:30 am and 6:30 pm on weekdays. The most interesting feature of the Stockholm Trial is its variable time-of-day tolls. There is no toll on the major bypass road (Essingeleden) or on drivers from Lidingö Island in the East provided that they cross the cordon within 30 minutes (Stockholm is the only land connection for the island).

What were the main results of the six-month trial? The most important is a 22 percent decline in all auto passages (about 100,000), somewhat steeper in the afternoon/evening than in the morning peak, on all control points (there was also a 10 percent decline in truck passages). An expected consequence was faster travel times. Less expected was the very modest, almost negligible, increase in public transit use (see Chapter 15 and Hugosson and Eliasson, 2006 for detailed results).

Other results include: a decline in exhaust emissions in the inner city (by 14 percent in the city but much less (3 percent) in Stockholm County); a decline in accidents within the toll zone (by up to 10 percent); a detectable but insignificant decline in noise levels; no increase in carpooling; and a negligible impact on the regional economy. The technology worked well, as measured by the very few appeals against the charges, with almost none being accepted. As for cost–benefit analysis, the start-up costs were very high and clearly were not recouped in a six-month trial. However, Eliasson et al. argue that a permanent toll will generate a net present value of SEK 760 million, with a quite rapid 4-year payback period, largely based on travel time savings. On the other hand, the bus investments are definitely 'unprofitable' in terms of cost–benefit evaluation. Another point is that the short-term adaptation to a previously announced six-month trial may be very different from the long-term response. Certainly, public opinion changed over the trial period, shifting from a 55 percent to a 41 percent disapproval of the toll.

Prud'homme and Kopp (2006) have taken a more critical approach. While we could argue about the different numbers from alternative sources, Prud'homme and Kopp bring out some broader issues, although they do produce data that indicate that the toll was too high (leading to an 'excessive' reduction in auto traffic) and estimated that costs were three times the benefits, largely because of the expensive public transit component. On the other hand, they acknowledge that the scheme might generate net social benefits by about 2020, as operating costs stabilize or fall and the value of time increases.

Their concerns are largely political. Stockholm residents gain, while national taxpayers lose because a high proportion of the start-up costs were financed out of the national budget. The vote for the toll is difficult to interpret because it was fudged in the ballot with a vote for public transit service improvement. In addition, because different political parties adopted strongly divergent views about the toll, party loyalty might have overridden serious thought about the merits or demerits of the toll. Furthermore, the high start-up costs involved in setting up the trial were perceived as a 'sunk' cost skewing the vote in favor of approval.

They also spell out three conditions for success: (i) severity of congestion (very low in Stockholm compared with London, implying that perhaps the time savings benefits in London might be up to 10 times higher); (ii) low implementation costs (Stockholm's were more than half those of London, despite the difference in benefits); and (iii) cheap public transportation (but it is quite expensive in Stockholm). So, their conclusion is that the Stockholm toll is not cost effective.

## 3 RECENT DEVELOPMENTS

There have been recent developments that point to an expansion of road congestion pricing experiments in Europe. These have been partially but not wholly driven by the recent new air pollution regulations passed by the European Parliament in December 2007. These are estimated to produce health benefits of more than 40 billion euros by 2015 and achieve a 40 percent reduction in premature deaths over the period 2000–2020. Among other developments, this has helped to promote a new charge program in Milan ('Eco-Pass') started in January 2008, and the acceleration of new road pricing plans in several East European countries (e.g. Poland and Hungary). It has also resulted in a plan to increase the London charge for high-polluting vehicles (such as SUVs) to £25 sterling. Perhaps the most ambitious program in the European Union is the Valletta CVA (Controlled Vehicle Access) in Malta which began in May 2007 before the passage of the new European Union regulations. A plan was developed for Dublin in September 2007 to be initiated soon on the A50 highway with a variable toll of 2–3 euros. However, there have been developments outside the European Union too. Especially prominent is the Oslo Toll Ring automated system initiated in February 2008 (in fact, six Norwegian cities have schemes in operation, and the original goes back to Trondheim in 1986 when a toll was imposed to finance road construction).

## 4 IMPLICATIONS FOR THE UNITED STATES

There are several types of congestion pricing schemes: area licensing (such as London); a cordon (such as Stockholm); segment (corridor) tolling; joint HOT/HOV (high occupancy toll/high occupancy vehicle) lanes; and system-wide tolling. The choice among these depends upon many factors such as the spatial structure of the metropolitan area and/or its inner core and the objectives of the tolling policy. If the prime candidates for congestion pricing in the United States are the very large cities, area licensing or cordon schemes are ruled out in most cases because of spatial structure and the dynamics of metropolitan growth; in most cities there are too many access routes, and a downtown area is not the most attractive area for tolling and could easily accelerate the decentralization that city governments are so desperately trying to slow down. Two possible exceptions are New York City and San Francisco because of their topography. New York's toll bridges and tunnels (with very few free access routes into Manhattan) make Manhattan almost a cordon. However, a sensible pricing strategy for Manhattan probably requires tolls that are differentiated by route and time of day, and this demands at least a mini-system-wide (that is, cordon and internal area) scheme. Nevertheless, both San Francisco and New York City have discussed schemes very similar to that of London.

There was a major development in New York City in December 2006. The Manhattan Institute published a study (Schaller, 2006) that explored the possibility for a cordon pricing scheme in the two Manhattan central business districts (CBDs) (Midtown and Downtown), south of 60th St. The Manhattan Institute held a conference soon after. The immediate reactions were not positive. They included the costs to some low-income workers, especially those living in the peripheral parts of the outer boroughs, the difficulties of parking near subway stations, and subway capacity problems. Even more telling was the response regarding political acceptability. It was argued that no politician in New York would include road pricing as part of a campaign platform as Ken Livingstone did in London or submit the measure to a voter referendum as in Stockholm. Mayor Michael Bloomberg's initial reaction was that people would regard it as a commuter tax and the State legislature would veto the idea. However, in April 2007, he changed his mind and came out in favor of a $8 entry toll south of 86th St. and for drivers within Manhattan itself a $4 charge. It would require State approval, and some legislators objected on equity grounds. It would not be quite as revolutionary as it appears because the toll would be defrayed by bridge tolls, and most entry points into Manhattan are toll bridges. Also, many car owners living in Manhattan keep their cars in other boroughs for weekend and vacation use, and area tolls might reinforce that trend. However, given New York City's comprehensive transit system and permitting some relaxation of taxi medallion restrictions, road congestion pricing there is both technically feasible and economically viable. However, in July 2007 the State legislature refused to take up the proposal and an important Federal deadline for a possible $500 million grant was missed. This meant that the implementation of a congestion pricing scheme for New York City became a dead issue, at least in the short run.

However, in August 2007 the story took yet another turn. The US Department of Transportation selected New York City as one of five beneficiaries (the others were San Francisco, Miami, Minneapolis and Seattle) of the new Urban Partners program, despite New York City's failure to make the application deadline. The grant was for $354.5 million, although there were other components in addition to congestion pricing. There were still hurdles to be overcome: opposition from some politicians in the Outer Boroughs and approval needed from several bodies (the new 17-member New York City Traffic Congestion Mitigation Committee, the State Legislature and the City Council) by March 2008. Nevertheless, it appeared to be an impressive victory for Mayor Bloomberg.

However, the victory was temporary. Although New York City Council voted in favor of congestion pricing by a 30–20 vote on 31 March 2008, the State Assembley (under pressure from Democrats in the New York City Outer Boroughs and suburbs) refused to take the proposal to the floor for a vote on 7 April 2008. As a result, for the foreseeable future, the plan is dead and New York City lost Federal funds for the project.

The easiest approach is probably an expansion of HOT/HOV lanes given the existence of many HOV (or carpool) lanes in many metropolitan areas. Opening up these lanes to paying solo drivers, that is, converting them to HOT lanes, represents a very simple approach to expanding the scope of congestion pricing (Lee and Gordon, Chapter 17). A variant of the HOT/HOV concept is the existence of adjacent free lanes and HOT/HOV lanes as in the example of SR91 in Southern California (Richardson et al., Chapter 18), a 10-mile stretch in Orange County between Los Angeles County and Riverside County, formerly in private ownership and now back in the hands of the Orange County Transit District (OCTD).

Corridor projects are often stimulated as much by construction financing needs as by congestion pricing goals. For example, Washington State has been plagued by transportation revenue shortfalls in recent years, aggravated by stalemate in the legislature (somewhat relieved by a 9 cents per gallon increase in the state gasoline tax) and voters' mandated constraints on vehicle registration taxes. The result is recommendations for tolls not only on new roads but even on some existing roads to finance the construction of new roads and bridges (WSDOT, 2006; Bae et al., Chapter 16).

A comprehensive congestion pricing scheme would be system-wide in the sense of applying to the whole metropolitan region, even if in practice it was restricted to freeways and arterial roads. A few years ago this would have required massive investments in road sensors and other pricing infrastructure. Recent technological changes have made this approach easier but not necessarily cheap. On-board global position system (GPS) equipment can measure charges for any road and change the price at any time, thus dealing with the two bugbears – differentiation by route and by time of day (see Chapter 16). The main infrastructure investment would be the remote monitoring stations, equipment and personnel. There is obviously a cost associated with installing the equipment on the vehicle, not an overwhelming obstacle given the strides in (and falling costs of) onboard navigation technology, and with economies of scale the cost on new cars might be quite modest. The trickier problem is the transition: what do you do about the car fleet already on the road? Perhaps a fixed annual fee might be a workable if third-best solution.

Within the United States, there has been slow and somewhat unsteady progress towards road congestion pricing in San Francisco, Seattle, New York City, Minneapolis, Miami, Houston, Boston and Portland, among others. Table 1.1 summarizes the projects (operational and planned) as of 2000. A more recent GAO study expands the list to 23 states, 16 operational and seven in the planning stage (GAO, 2006), and new proposals are made almost month by month.

An interesting question, not necessarily with a clear-cut answer, is whether the European experience in general and London's in particular sheds any light on the scope for expanding congestion pricing in the United States.

First, London illustrates the importance of political leadership and political will. The LCCS was the personal priority of London's first elected

*Table 1.1 Projects as of 2000*

| State | Location | Facility | Status |
|---|---|---|---|
| Arizona | Phoenix | All freeways | Study |
| California | Alameda Co. | 1-680, I-880 | Study |
| | Contra Costa | SR 4W | Study |
| | Los Angeles | Various | Post-study |
| | Orange Co. | SR 91 Express Lanes | Operational |
| | Orange Co. | SR 57 | Study |
| | Riverside Co. | SR 91 extension | Study |
| | San Diego Co. | I-15 | Operational |
| | Santa Cruz Co. | SR 1 | Authorized |
| | Sonoma Co. | US 101 | Post-study |
| Colorado | Denver | I-25 | Study |
| Florida | Miami | I-95, SR 836 | Study |
| | Orlando | I-4 | Study |
| Maryland | Baltimore suburbs | Various | Study |
| Minnesota | Minneapolis | All freeways | Study |
| Oregon | Portland | Various | Study |
| Pennsylvania | Philadelphia | US 1 | Study |
| Texas | Austin | I-35 | Study |
| | Dallas | I-635 | MIS |
| | Houston | I-10 | Operational |
| | Houston | I-10 extension | MIS |

*Source:* Poole, Robert W. and C. Kenneth Orski (2000), 'HOT lanes: a better way to attack urban highway congestion', *Regulation*, **23** (1).

mayor, Ken Livingstone, and without his enthusiasm for the scheme, it would never have been implemented (Rye and Ison, Chapter 14). There were other UK plans that failed because of a lack of political support, for example, Edinburgh and Cambridge. In Stockholm, the Green Party was a major champion in the national legislature. In the United States, the projects that have got under way have usually been based on technical rather than political criteria. They have succeeded because of their limited scale. Although there is support from think-tanks and interest groups (for example, the Reason Foundation), there has been no individual (or broad) political support for a major scheme, with the exception of a mechanism for highway financing, often on inter-urban roads. In a nation of motorists, this has been a very difficult cause to sell, and most politicians are risk averse.

Second, the success of London (if measured by reductions in automobile use) owes much to the availability and expansion of public transit (especially buses) that explain the huge shift of 33,000–42,000 from cars to transit. This would not happen in the United States. The modal share of cars in the United States of 89.5 percent compares with 64.4 percent in the UK. Even in New York City cars account for 37 percent of commutes compared with a pre-LCCS share in London of 9.9 percent (Lee, Chapter 11). It would be difficult to expand transit on the London scale because of its low financial priority. Even if it were possible, the modal shift would not occur on a similar proportionate scale (55 percent), perhaps because of a predisposition against riding on public transport but primarily because of its inability to compete with door-to-door travel times.

Third, the spatial structure of US metropolitan areas would dictate a different congestion pricing scheme from London and elicit different responses. As suggested above, tolled corridors might work. A downtown cordon or area licensing scheme would be inappropriate in most cases because of the small role of downtown in metropolitan region population and employment (an efficient downtown cordon scheme for a US city might present a difficult design problem; see May et al., Chapter 7). A freeway-only scheme might decongest the freeways because many US metropolitan areas have surface highway redundancy but all of them have some congested arterials that might benefit from congestion pricing. As a generalization, most US metropolitan areas are very dispersed and decentralized, usually with several suburban choke points, so dealing with the complications of a system-wide congestion scheme seems the most appropriate approach.

Fourth, in an important sense Stockholm offers more guidance than London. This is because of its time-of-day pricing which even in the limited Stockholm Trial showed different responses at different times of the day. In the United States, there are substantial efficiency opportunities for time-of-day pricing because of the time distribution of daily trips with long morning and afternoon peaks with a lesser mid-day hump, and especially because of the large number of peak non-work trips (especially in the afternoon) that might be tolled off into non-peak hours (Gordon and Richardson, 1989). Today's technology allows us to implement time-of-day pricing relatively easily. For example, the SR91 FasTrak system (Richardson et al., Chapter 18) allows infinite time-of-day adjustments (to the individual cent if required), but this has never been adopted by sticking to the time block approach with minimum 50-cent differentials on the ground that more sophisticated adjustments would be too complicated and confusing to drivers.

Fifth, the pressure for congestion pricing is a function of the severity of congestion. As pointed out above, London is much more congested than Stockholm. It is almost more congested than the average large American cities, with travel speeds approximately half of those in the United States (Giuliano and Narayan, 2003). Although commuting times have increased in US metropolitan areas since 1995, as shown in both the 2000 Census and the 2001 National Household Transportation Survey, their long-term stability means that there is much milder congestion than experienced in London. There have been dire predictions, but they have not happened yet. This may help to explain why transportation revenue generation has been a more powerful stimulant to tolls than congestion reduction.

Sixth, institutional constraints are more severe in the United States than in Europe. Municipal governments in the United States have a high degree of independence and any system-wide scheme would involve charging on roads that cross many jurisdictions. Obtaining agreement among all the parties is complex; one idea is to obtain political consensus by some kind of revenue-sharing mechanism in favor of cities rather than regional transit agencies or other uses (King et al., Chapter 19). In other cases, the political quagmires can be minimized by reliance on a single organization such as a regional transit agency. This is one of the reasons why the Edinburgh proposal failed.

Seventh, equity issues have not been foremost in Western Europe on the congestion pricing issue, despite widespread concern about 'social inclusion' in many other areas. Yet in the United States, they have been critical. Texas, for instance, is thinking about a credit-based tolling scheme that would return toll revenues in advance, even to non-motorists. There has also been much discussion about 'Lexus lanes', based on the idea that low-income drivers cannot afford to pay tolls. The best solution to this problem is to have adjacent free and toll lanes that offer a choice. However, the equity arguments do not provide an overwhelming objection (Richardson and Bae, 1998; Bae and Mayeres, 2005), in part because of a variety of revenue-redistribution mechanisms, in part because even moderate-income households place a value on travel time.

Finally, there are financial constraints. In both London and Stockholm, most of the funding came from the central government. In the United States, the Federal government has funded a few small-scale pilot projects, but is unlikely to fund congestion pricing schemes across an array of metropolitan areas. Private corporations may be able to finance both the capital and operating costs of a congestion scheme via bond issues repaid out of toll revenue, but the willingness to rely on the private sector varies from state to state. An expensive component in both London and Stockholm was investment in public transit. It would be difficult to implement this in the US context. Federal financing and sales tax revenues have been frequent sources, but the flow of funds is often sporadic. If GPS technology is adopted, another issue is: who would pay for the onboard equipment? The answer is probably the motorist via additional equipment cost at the time of purchase. The current cost is about $300; if the automobile manufacturers were to install the equipment in all new vehicles, economies of scale would reduce costs significantly, probably by more than half. What to do about the existing car fleet is a vexing problem. Many of these issues are difficult to resolve but are manageable.

The prospects for road congestion pricing in the United States remain problematic. However, the recent European experience suggests that political feasibility is no longer a major obstacle. Also, the most important lesson from Europe is that pricing does reduce automobile congestion by significant amounts.

## 5 CHAPTER SUMMARIES

The book is organized as follows. Bell and Wichiensin (Chapter 2) develop an inter-modal equilibrium model that links an urban road network subject to a congestion charge to a parallel urban transit market, with a view to finding the optimum congestion charge consistent with the commercial decisions of transit operators. A congestion charge is set to maximize social surplus. Travel behavior is assumed to conform to elastic-demand user equilibrium traffic assignment. The transit market is assumed to be either a profit-maximizing monopoly or a profit-maximizing duopoly competing non-cooperatively. The operator(s) set the fares to maximize profits and the supply of transit services is determined by the associated demand. The problem has been formulated as a bi-level program with the determination of the congestion charge on the upper level and the setting of transit fares on the lower level. In the case of non-cooperating operators, the Bertrand–Nash equilibrium fares are sought. The results of the model are analysed for an example reflecting the Edinburgh transit market. This reveals the importance of competition in the market for distributing the social surplus between providers and travelers.

The Independent Transport Commission (ITC), a land-use and transport think-tank linked to the University of Southampton, has for several years been studying the application of national schemes of variable road pricing to Great Britain. Bendixson (Chapter 3) discusses the implications of two scenarios developed for the ITC by Glaister and Graham (Chapter 4). In the first scenario, surplus revenue is redistributed in the form of reduced fuel duty to drivers on uncongested roads. In the second, an additional £16 billion is collected and transferred to the Exchequer and devoted to enhanced public services. The scenarios raise the key issue of how road pricing revenue is spent and who decides how it should be spent. Various possibilities are discussed. In one, the roads would be assigned to a set of regional public utilities supervised by a regulator. In others the level of road charges would be determined by an elected national roads board or by public referendum.

Glaister and Graham (Chapter 4) continue this discussion. For transport systems the issues of pricing, service quality, funding and investment in urban areas are inextricably interdependent. They argue that no policy can be set for any of these aspects of transport in isolation from any other. Transport planners and urban policy makers can choose to tolerate congestion, or build new capacity or introduce road user charging. These issues are explored and analysed in the context of London: Europe's most obviously resurgent city and the one with the most recent experience of road pricing in the form of the congestion charge. However, despite the evidence that in the centre, where it applies, the congestion charge has had broadly the effects that economic theory would predict, there is still a growing problem for the rest of London and the UK caused largely by the combined effects of rising real incomes and the improving fuel efficiency of cars which reduces the impact of fuel taxes. This suggests a growing pressure for a national system of road pricing. To date 'prices', in the form of fuel duty (over £0.50 out of each £0.80 for a litre of fuel), have been set on the basis of historical precedent or political expediency. The chapter sets out a regionally based model to analyse the implications of setting alternative levels of congestion charging and environmental taxes covering the whole country. This includes modeling the implications for other transport modes and the net changes accruing to drivers and the Exchequer. The sooner that user charging can be introduced the better. However, the difficulties are real and somewhat intractable. The most significant problem is not the technical feasibility of such a system but finding a sound method for administering the funds that the system would generate.

Hargreaves and Echenique (Chapter 5) test a congestion charging scheme for Cambridge using a MEPLAN land-use transport model combined with a SATURN traffic model. The scheme would include a daily toll for drivers crossing a cordon around the edge of the city and a lower charge for residents driving entirely within the cordon. The congestion charge would dramatically reduce the number of cars entering the city and improve traffic conditions. However, the charge would result in higher property prices as higher-income groups would displace lower socio-economic groups by outbidding them to move into the city in order to avoid paying the cordon charge. This would increase the cost of living and employers' production costs, and some employers would move out of the city, especially those in the retail and service sectors. The revenue raised and environmental benefits might be insufficient to compensate for the negative impacts on the local economy and the social equity. Cambridge Futures then tested this congestion charging scheme in combination with transportation investments. These would include expanding the public transit system and creating an orbital road outside the cordon linking the park-and-ride sites together and making it easier for through-traffic to bypass the city. This combination of road user charging with transportation improvements has a synergistic effect, making areas outside the city more accessible, and reducing average rents by facilitating more residential dispersal.

Unlike the technical approach of Hargreaves and Echenique, Richards (Chapter 6) adopts a more political interpretation. He points out that congestion charging has been on the policy agenda in the UK since the early 1960s, but it was not until the Blair government, elected in 1997, identified it as a way of 'breaking the logjam' of congested roads and introduced enabling legislation that it became a real prospect. With the policy firmly grasped by Livingstone, expelled from the Labour Party but elected the first mayor of London, the Blair government's interest cooled, except for a national Lorry Road User Charging (LRUC) system. This was intended to replace a part of existing fuel duties with a distance-based charge, and level the playing field with operators from other EU countries (where fuel duties are lower) competing in the UK domestic market.

With Livingstone's LCCS widely accepted as a success, and with a new transport secretary (Alistair Darling) the government renewed its interest, and commissioned a Steering Group to undertake a feasibility study for a national system of road pricing for all vehicles. Although the Steering Group's report was published in 2004, with a General Election ahead, little public progress was made until the government had been re-elected in May 2005. Although the citizens of Edinburgh had emphatically rejected a proposed congestion charging scheme in February 2005, and the government canceled the LRUC scheme in July 2005, Darling made it clear that he saw road user charging as an important policy option for reducing traffic congestion and increasing national efficiency. In November 2005, he announced that the government would be funding demand management studies in seven areas. However, he made it clear that he was not willing to introduce charges on the inter-urban highway network under the government's direct control, except where capacity is also increased.

The primary purpose of the chapter is to review the development of changes in policy since 1997 to identify the key policy drivers that might jumpstart extensions of road charging to cities outside London in the next decade or two. A major one might be using charges as a means of reducing the need for new highway investments.

May et al. (Chapter 7) address a much more technical problem, how to design optimal cordons, under the assumption that other UK cities may adopt congestion charging schemes in the future. A cordon will reduce congestion within the area but aggravate it outside because of an increase in bypass traffic. The net welfare impact will depend substantially on the specifics of cordon design. More complex schemes could generate higher benefits than the single cordon approach adopted in the LCCS.

The chapter discusses two major design options. The first is based on genetic algorithms (an artificial intelligence searching technique; see Chapter 7 for more details). This is tested on the Edinburgh road network. The second, short-cut approach combines a simpler model (selective link analysis) with judgment to improve cordon design without requiring an optimal solution. Tests suggest that this method can achieve more than 90 percent of the benefits of an optimal solution.

Santos (Chapter 8) describes and assesses the first three years of the LCCS and its impacts. In a very detailed analysis she computes elasticities for different types of vehicle to analyse whether the charges are efficient, and also estimated marginal congestion charge elasticities (that is, what happened to traffic when the charge increased). She also examines the costs and benefits of the zone and its extension to Kensington and Chelsea. Although the original LCCS had positive impacts overall, the proposed extension will result in economic and social losses.

The two chapters by Banister (Chapter 9) and Ho and Maddison (Chapter 10) focus on a relatively ignored problem, the environmental issues associated with congestion charging. One of the main benefits from the LCCS has been improvements in air quality and reductions in noise and accidents in the central area. These chapters outline the evidence from the existing scheme on the environment, and then discuss the environmental issues raised in the consultation on the western extension. The bottom line is that air quality improved within the charging zone (Banister) but deteriorated outside (Ho and Maddison), reflecting trip diversion. These environmental issues are then placed in the wider context of plans for a London-wide low emissions zone and other technological initiatives being taken in the transport sector to improve air quality. The conclusions argue for the inclusion of environmental costs and benefits in the evaluation of congestion charging, and for the possibility of making the charges directly related to the emissions from vehicles rather than the same charge being applied to all vehicles.

Lee (Chapter 11) considers the transfer of the LCCS to US cities. Her primary objectives are: (i) to identify and apply a framework of analysis for policy transfer; (ii) to argue that a successful transfer should involve incorporating key aspects of the overall planning process to overcome implementation barriers in the UK–US context; and (iii) to examine the key travel characteristics likely to affect the outcome of congestion charging in the US.

Nash et al. (Chapter 12) examine a very different problem, the European Commission's policy on pricing for inter-urban freight traffic. The analysis focuses on competition with rail and on how to avoid discriminatory pricing policies between one country and another. The principle of marginal social cost pricing is supported, although its application to both road and rail is subject to political constraints. The directive on inter-urban road goods vehicle charging links tolls to equating *average* revenue and *average* infrastructure cost, but with variations in differentials in environmental, accident and congestion costs. The chapter examines experiences in Germany, Austria and Switzerland (although Switzerland is outside the EU).

Prud'homme and Kopp (Chapter 13) shift attention from London to Paris. Bertrand Delanoe, a leftist mayor elected at about the same time as Livingstone, also wanted to reduce traffic, partly to reduce air pollution, partly to reduce congestion, mostly because he (and, above all, his Green allies) hated cars. For ideological reasons, he did not want to introduce a congestion charge.

What he did, at least in the 2000–04 period, was to make the life of car and truck drivers more difficult. This was achieved primarily by reducing the amount of road space available to cars and trucks (by enlarging and isolating bus lanes, by creating bicycle lanes and by widening pavements), but also by stopping underground parking construction, by increasing street parking prices for non-Parisian residents, and by semi-closing some areas to traffic.

Interestingly enough for the analyst, the supply of public transport did not increase in the period considered, in part because RATP, the public transport company, is not under the direct control of the municipality (although a new tramway was introduced in 2006). This makes it possible to associate changes in motor vehicle traffic, which were of the same magnitude as in London, to changes in car-usage costs, particularly in additional time spent because of increased congestion or, more precisely, reduced speeds.

Available data show that bus speeds and bus patronage did not increase at all in the period considered. There was no modal shift at all from car to bus. Metro patronage did increase, but not faster (in fact, more slowly) than in the preceding period, so that it is unclear that there was a modal shift from car to metro. Public transport users gained nothing.

What is sure is that car and truck users are now spending more time traveling within Paris. The time lost because of the policy is estimated to be worth around €700 million. Worse, the policy slowed down the decline in motor vehicle-related pollution. At urban speeds, the elasticity of pollution emissions to speed appears to be high (if not precisely estimated), so that we have slightly fewer cars polluting much more, resulting in more pollution (relative to what would have happened in the absence of the policy) rather than less, the opposite of the policy objective. The only clear winners are bicycle users. However, they accounted for only 0.01 percent of passenger-km in Paris in 2000. They now account for 0.014 percent, a 40 percent increase. But even the most generous estimate of their gain is far from justifying the policy. By comparison, a congestion charge, in spite of all its limitations, is an efficient instrument for reducing traffic.

Rye and Ison (Chapter 14) consider the factors that have been key to the successful implementation of congestion charging in the relatively few schemes that exist in Europe and Asia, developing, in effect, a conceptual framework for implementation. They then look at a few US metropolitan areas, specifically those that applied for funding to the Federal Highway Administration's (FHWA's) Value Pricing Initiative. Conditions in these areas are compared with the conceptual framework to assess the likelihood of successful implementation and to suggest recommendations.

Eliasson et al. (Chapter 15) analyse the recent Stockholm Trial. The trial consisted of two parts: a congestion charging scheme in place between January and July 2006, and extensions in public transport between August 2005 and December 2006. Initially, the trial was meant to consist only of a congestion charging scheme. Later, it was decided that the charging scheme should be complemented by public transit extensions: several new bus lines, additional capacity on commuter trains and subways, and more park-and-ride facilities. Somewhat surprisingly, apart from the park-and-ride facilities of which there had been a severe shortage, the additional public transit opportunities had little impact. The trial produced more than a one-fifth decline in automobiles entering the cordon, a result very close to that achieved in London. Public opinion has come round to support the scheme, so it is being made permanent.

Bae et al. (Chapter 16) report on a federally-sponsored pilot project in the Seattle metropolitan area on road pricing (one of the FHWA's value pricing initiatives). This was one of several such experiments in the United States (for example, in Georgia, Iowa, Minnesota and Oregon), and it takes place against a backcloth of much more attention being paid to road pricing than some years ago. While it is true that the primary driver is the transportation funding problem, road pricing in urban areas would have substantial congestion-reduction effects. The most interesting aspect of the Seattle experiment was its use of GPS technology rather than the more standard transponder plus road sensors. Although the experiment was small scale, it offers opportunities to judge the feasibility of the GPS approach. If it works effectively, it may be more suitable for a system-wide approach (that is, freeways plus arterials) than other alternatives.

Economists agree that most auto-highway systems are mismanaged because congestion is the default rationing mechanism and this is inefficient. Modern toll collection technology and real-time speed-flow data-gathering technology make peak-load pricing feasible and attractive. To date, the effects of pricing on land use are not yet well understood. Lee and Gordon (Chapter 17) analyse the spatial impacts of various freeway pricing scenarios, including the conversion of HOV to HOT lanes. Spatial allocations occur via a congestible highway network of almost 90,000 links, including almost 5,000 freeway links.

Richardson et al. (Chapter 18) apply the Southern California Planning Model (SCPM) to an important prototype application, a 10-mile segment of California SR91. SCPM is an integrated model that estimates trip production densities (and employment and population) for over 3,000 spatial zones of the Greater Los Angeles area at the level of 47 economic sectors. The possible widening of this route via extra tolled or extra general-purpose lanes has been the subject of considerable controversy. A non-compete provision in the franchise awarded to the California Private Transportation Company (CPTC) had stood in the way of public agencies' efforts to provide additional capacity in the corridor. The approach sheds light on this controversy. The main finding is that, whereas congestion tolls are widely presumed to be efficient, the efficiency outcomes are complex when only a small part of the network is tolled. In sensitivity tests, the most plausible results, and the largest user benefits from adding a new tolled lane, are for the mid-range values of our various assumptions. This result is consistent with recent theoretical investigations of second-best pricing. Flows on congested, untolled, parallel routes benefit from the addition of untolled facilities. The discussion is extended to an examination of impacts throughout the Los Angeles network, including changes in destination choice by drivers and freight operators. Most research on road pricing (usually on corridors) has been of a partial equilibrium nature, and does not consider network effects.

In the final chapter, King et al. (Chapter 19) point out that the political feasibility of congestion pricing depends in part on how the toll revenue is used. They argue that congestion pricing on freeways will have the greatest chance of success if the revenue is distributed to cities, and particularly to cities through which the freeways pass. In contrast to a number of previous proposals, they further argue that cities are stronger claimants for the revenue than either individual drivers or regional authorities. Drawing on theory from behavioral economics, the idea is illustrated with data from several metropolitan areas. In Los Angeles, where potential congestion toll revenues are estimated to be almost $5 billion a year, the distribution plan could be both politically effective and highly progressive.

Overall, the book aims to contribute to the debate about road congestion pricing in the United States, primarily by drawing upon recent European experience. The theoretical rationale for pricing was made by several transportation and urban economists more than four decades ago, but now there are real-world case studies to buttress the argument.

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