DISCUSSION PAPER - 13TH ACEA SAG MEETING ➨ MAY 2008

Urban Access Charging

An Efficient Means of Urban Transport Management?

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Content

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Foreword

The ACEA Scientific Advisory Group

The members of the European Automobile Manufacturers' Association (ACEA) established a Scientific Advisory Group (SAG) in 1998 to examine important transport policy topics and overcome the shortfall of scientific understanding of some transport policy issues. The thirteenth meeting of the SAG, held on 4 March 2008 in Brussels, dealt with "Urban Access Charging – An Efficient Means of Urban Transport Management?". The participants in the workshop included:

Prof. Dr. Alexander Eisenkopf	*Zeppelin University Friedrichshafen*
Prof. Mario Carrara	*Politecnico di Torino*
Michael Niedenthal	*VDA*
Götz Finke	*BMW*
Manfred Buck	*Daimler*
Maurizio Pastine	*FIAT*
Martin Eckner	*FORD*
Jean Wibaut	*GM*
Francesco Massa	*IVECO*
Annerose Zacherl	*MAN*
Christian Rousseau	*Renault*
Ziad Dagher	*Renault*
Sabine Spell	*Volkswagen*
Andreas Svenungsson	*Volvo*
Imane Khalifa	*CCFA*
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1 Introduction

Urban mobility and urban charging: Freedom to move?

The vast majority of Europeans live in urban areas. On average Europeans make 1 000 journeys each year, with half of these being less than 5 km. In Europe — as in much of the rest of the world — the car is 'king', with almost 75% of all trips made within urban areas using privately owned vehicles.

Many initiatives to improve urban mobility have been launched over the past few years. Indeed, hundreds of cities across the EU27 are currently undertaking measures which aim to improve mobility and quality of life, to reduce air pollution, noise, traffic congestion and accidents.

To improve urban mobility and to make our towns and cities free-flowing, smart, efficient and accessible, solutions must be found. How can we solve traffic congestion? To what extent does such congestion impact on our economy, as well as our social, health and environmental welfare? With space increasingly at a premium and environmental constraints at the forefront of modern urban development, how should current traffic volume best be managed?

Are urban charging schemes really the answer? How viable are such schemes and do the economic costs associated with the investment and management actually outweigh the economic gains they generate? How justifiable in economic terms are such systems in the long-run? Indeed, what factors constitute an efficient, effective and widely accepted urban charging scheme?

With these questions as a backdrop, this paper aims to investigate the impact of urban charging as a device for urban transport management. Examples of urban charging schemes from Europe and beyond are outlined and evaluated against economic theory, in order to assess the contribution of such schemes to improving overall urban mobility. This paper also assesses the role of the European Commission in the debate, discussing its recent Green Paper 'Towards a new culture for urban mobility', which aimed to foster debate among stakeholders on the key issues regarding mobility in European towns and cities.

2 The Economics of Road Pricing and Urban Access Charging

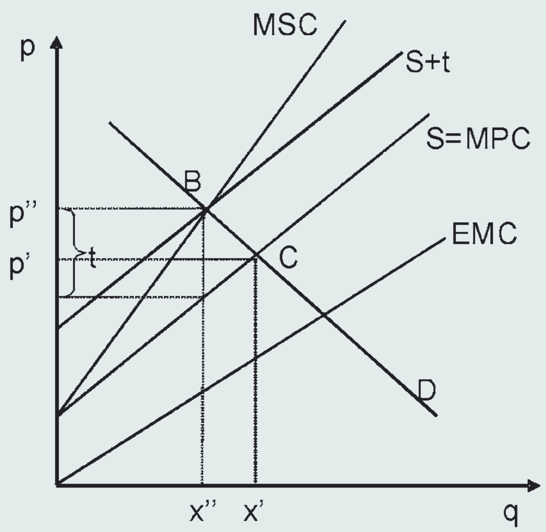
In economic theory and transport policy, the public management of transportation infrastructure has increasingly become the subject of critical debate. This is largely due to the fact that public funding for transport infrastructure has been scarce for several years now, with the provision of public infrastructure supposedly suffering from inefficiencies. While private investment in rail infrastructure is still in its infancy, the pace of privatisation in the road sector has been stepped up in recent years. Regardless of the role the private sector actually plays in infrastructure provision, however, the idea of user financing has dominated the discussion on transportation infrastructure financing during the past decade. Among other measures, proponents of user financing suggest imposing infrastructure charges (Wissenschaftlicher Beirat 2000).

Infrastructure charges, particularly road charges, are a necessary prerequisite both for user financing and for private investment in infrastructure provision. While user financing of roads offers a number of important advantages compared to the mechanism of funding from public budgets, it is necessary to establish a viable system of infrastructure tolls to make use of these opportunities. In accordance with principles of transport economics, user charges should fulfil three basic tasks (Eisenkopf 2002):

- First, infrastructure pricing is a means for allocating infrastructure cost in proportion to volume of usage and the damage caused by individual users. In order to ascertain the level of this allocation, the true resource costs of an economic activity need to be determined. Given a fixed stock of infrastructure, a toll system has to charge for the marginal costs of infrastructure use. These costs should typically be very low as compared with the total costs relating to the provision of infrastructure, particularly in the case of private cars. Another question to be dealt with is the extent to which marginal social costs need to be charged for. Supplementary congestion and/or environmental charging may be introduced to deal with scarcity of capacities (congestion) and with negative environmental externalities relating to transport.
- Secondly, infrastructure charges help apply the benefits principle that is common to other goods or services markets. On the one hand, this means the implementation of the 'pay-as-you-use' rule described above; on the other hand, pricing should also provide incentives for infrastructure development. The expansion of infrastructure should follow user demand.
- The third task is closely aligned with the second one and addresses the problem of funding. Infrastructure charges are an efficient instrument to substitute user financing of infrastructure for public financing, while generating sufficient revenues for providing infrastructure[1]. As marginal cost pricing regularly causes a deficit in the case of transportation infrastructure[2], alternative pricing schemes become necessary. Average cost pricing should be fairly easy to establish and negates the deficit problem. It is therefore often chosen by public institutions preparing a road pricing regime, such as the German heavy-goods vehicle road toll. Pricing theory also offers alternative solutions that are superior to average cost pricing from a welfare point of view, such as two part tariffs or price discrimination[3].

Bearing these tasks in mind as we focus our attention on the road sector, it is necessary to be able to distinguish between inter-urban/long-haul transportation infrastructures (motorways and highways), and urban roads. While road charging for motorways and highways largely satisfies the aim of generating sufficient funds for infrastructure provision, urban charging is frequently applied for other reasons. Infrastructure charges in cities aim at internalising the externalities caused by transport activities (congestion, noise, air pollution etc.), and at regulating the demand for urban transport (Kossak 2004, Glaister/Graham 2006). Figure 1, below, illustrates the economics of such user charges for externalities. It is a simple market diagram with a demand curve D (negative slope) and a supply curve S (positive slope), with the latter representing marginal private costs (MPC). Without any internalisation, people will choose the quantity x' and pay price p' according to their private cost of road usage and their private willingness to pay for transport activities (reference point C)[4].

FIGURE 1: ROAD PRICING AND THE PIGOUVIAN TAX



The problem we encounter here is that road users impose some external costs on other road users (mainly through their contribution to congestion) and on other people in the city (through the generation of noise, air pollution or other negative externalities). In Figure 1, these marginal external costs are represented in a rather simplistic manner by the curve EMC (external marginal cost)[5]. Putting private and external marginal costs together with the social marginal cost, it becomes clear that the optimum solution will be different from (x', p'). Basing decisions only on the private cost of transportation obviously means choosing a higher quantity of transport than that which is optimal for society. Regarding the marginal social cost of transport, quantity x'' is the optimal activity level and price p'' is the optimal price. Assuming that there are no further distortions on related markets, this solution would be superior from a social welfare viewpoint. In this case, infrastructure users would not only bear their private costs, but also the external costs associated with their activities[6].

Without additional measures, however, people do not base their decisions on the full social cost of their activities. Therefore, the idea of internalisation, which refers to the theory of famed British economist Arthur Cecil Pigou (1877-1959), claims a charge for marginal external costs[7]. State intervention is required to raise a first-best Pigouvian tax that helps to reach the optimal solution B (via the new supply curve S+t) in a world of perfect information. The problem is that to reach the welfare optimum B, the tax must be as high as the marginal external cost in the optimum situation itself. It is impossible to quantify the marginal external cost for this desired outcome, particularly under real conditions with fluctuating demand and relatively unknown (external) cost curves (Kruse 1996). In addition, decisions about the charging level (or the boundaries of a charging zone) are not always guided by efficiency principles, but rather by political considerations (Santos/Fraser 2006).

Irrespective of the difficulties in determining the optimal level of the Pigouvian tax and the welfare consequences related to this[8], transport policy nowadays relies on infrastructure charging in order to internalise marginal external costs – in addition to regulations and standards, such as for vehicle emissions. Charging for the externalities of road transport with heavy-goods vehicles became a major subject of EU transport policy in 2008. In the European Commission's September 2007 Green Paper on Urban Mobility, traffic charging is explicitly mentioned as one of the measures that can improve urban mobility. The Green Paper refers to the examples of London and Stockholm, where road pricing regimes have been introduced recently, as in the case of Stockholm, or some years ago, as in the case of London (European Commission 2007).

Therefore, the main goal of this paper is to evaluate the efficiency of urban charging as an instrument of transport management and to assess the ideas of the European Commission against this backdrop. As argued above, urban charging is principally desirable from a theoretical point of view to deal with congestion and its environmental effects: the idea of internalisation through a Pigouvian tax remains attractive to economists, unless its implementation lacks the accuracy requested by the theoretical model. Therefore, it is necessary to analyse the practical experiences with congestion charges, in order to find an answer to this question, or to at least identify the pros and cons of urban charging in practice. This calls for an intensive evaluation of the London and Stockholm examples. Nevertheless, other examples of urban road pricing around the world prior to London and Stockholm should also be considered. Therefore, the remainder of this paper is organised as follows: Chapter 3 will present the characteristics of some of the prime examples of urban charging worldwide. The critical assessment of these examples will be condensed in Chapter 4, before an analysis of the policy objectives of the European Union in Chapter 5. Finally, Chapter 6 will summarise the main lessons learned from the overall analysis.

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1 *Consistently, the introduction of road infrastructure should be accompanied by a reduction of mineral oil taxes or similar duties to give the necessary compensation to users.*

2 *Marginal cost pricing may be cost-covering in the economic model under restrictive circumstances, e.g. absence of economies of scale, choosing optimal marginal congestion charges, and optimal investment; see Mohring (1965), Mohring/Harwitz (1962), Hau (1998). This solution does not seem viable under real life conditions, however; for a critical assessment see Eisenkopf (2002).*

3 *For a critical overview see Eisenkopf (2002).*

4 *Private costs of road usage should include the cost of road damage in this model.*

5 *The graphics presented in Figure 1 do not fully represent the characteristics of congestion, because marginal congestion costs are not rising in a linear fashion, but very steeply; see Hau (1992) for more details on modelling congestion.*

6 *It should be added that externalities also remain in this optimum situation, but at an optimum level. The persistence of externalities results from the economic consideration that it takes resources to prevent externalities. Hence, the optimum level of externalities is reached when the marginal external cost of damage equilibrates the marginal cost of avoidance.*

7 *Pigou (1920); the application of marginal social cost pricing to congestion on roads was firstly carried out by Vickrey (1955) and Walters (1961).*

8 *See Kopp/Prud'homme (2007) for an analysis that shows the pitfalls of the Pigouvian tax concept in this case.*

3 International Experiences with Urban Charging – a Critical Assessment

London Congestion Charge

The capacity of London's inner city road network had not been substantially extended since the medieval ages, due to lack of space. Congestion was overwhelming and regularly led to severe traffic jams. Indeed, in the 1990s the average speed of a trip across London was below early 20th century levels (Leape 2006). The London Congestion Charge was introduced in 2003 to counter this severe lack of road capacity, which had led to unusually high levels of congestion in the City of London. The City of London boasts an excellent area-wide public transport system, which served as an alternative for people hit hardest by this congestion charge (Ison/Rye 2005).

According to official documents, the main objectives for the introduction of the London Congestion Charge were the following (Transport for London 2007):

- to reduce traffic volume and traffic jams;
- to increase the average speed in the City;
- to increase public transport usage; and
- to gain an additional source of finance for investment in public transport.

The geographical scope of the original congestion charging zone was a 21 km² area within the boundaries of the Inner Ring Road, which remained toll free. The charging area is relatively small and represents only 1.3% of the surface area of Greater London (Santos/Fraser 2006). A substantial enlargement (a western extension) of the charging area took place in February 2007 (see Figures 2 and 3, below).

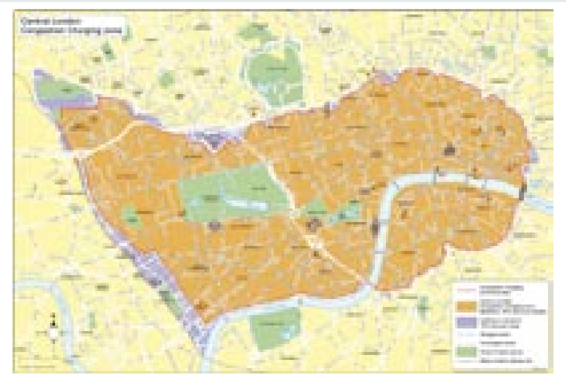
Fees and regulations of the London Congestion Charge are as follows: A vehicle entering or parking in the charging zone has to pay £8 per day (since July 2005, up from £5) from 7 a.m. to 6.30 p.m. on weekdays (Monday to Friday). There are no other charges with respect to the time of day or the actual extent of congestion. In addition, people can drive for as long as they want within the charging area after paying the charge. It is also possible to leave the charging zone and to re-enter without paying again. Furthermore, drivers can buy weekly, monthly and yearly licences at a discounted price. There is also a 90% discount for area residents. Some vehicles and persons are totally exempt from paying the charge, e.g. buses and coaches (over 9 passengers), motorcycles, police, fire brigade and all other emergency vehicles or disabled persons (blue badge holders). The various payment methods are cash, cheque and credit/debit card at petrol stations, retailers or post offices. Alternatively, drivers can pay by

FIGURE 2: LONDON CONGESTION CHARGE: INITIAL CHARGING ZONE (SOURCE: TRANSPORT FOR LONDON)

credit/debit card through a call-centre, online, or by using self-service machines or SMS technology on their mobile phones (Leape 2006).

Strict enforcement is crucial for the effectiveness of the London Congestion Charge. Video cameras register all vehicles entering the fee area. Data are then passed through an Automatic Number Plate Recognition (ANPR) software, which reads and records each number plate with an accuracy rate of 90%. With a 10% margin of error, additional manual checks are therefore necessary. If a driver enters the congestion zone, but only pays after 10 p.m. that day, a surcharge of £2 is levied. In case of non-payment, the standard fine is £100 (rising from £80 before July 2004), which is lowered to £50 if settled within two weeks, as for parking tickets. On the other hand, the penalty rises to £150 if it is not settled within 28 days (Leape 2006). Repeat offenders face the risk of their vehicle being seized or decommissioned. In order to attenuate the harsh consequences of the enforcement regime, a Pay Next Day rule was introduced in June 2006. If a vehicle user pays the Congestion Charge until midnight on the following day, there will be no prosecution, but the user has to pay the higher amount of £10 (Transport for London 2007).

FIGURE 3: LONDON CONGESTION CHARGE: WESTERN EXTENSION (SOURCE: TRANSPORT FOR LONDON)



An analysis of the traffic and fiscal effects of the London Congestion Charge allows for an assessment of its efficiency[9]. Transport for London's annual monitoring reports provide the relevant figures to compare the situation before and after the London Congestion Charge was implemented. According to the 2007 report, the number of daily car journeys to the (former) charging zone declined by 21% compared to 2002 levels. Prior to the increase of charges in 2004 and 2005, the cutback was around 18%. Within the zone, vehicle kilometres declined by 19% on 2002 levels, but movements of buses (+25%) and taxis (+12%) were remarkably higher. Bicycle traffic rose by some 43% (Transport for London 2007)[10]. Around 50% of former car users switched to public transport; the others either used bicycles, motorcycles, car sharing (either formal schemes or informal arrangements), or simply cut down on the distance or duration of their journeys. After the introduction of the charge, the average speed in central London increased to 16.7 km/h (from 14.3 km/h in 2002), while the congestion risk declined sharply. Congestion dropped by about 30% between the start of the charge in February 2003 and mid-2005, measured in terms of minutes of delay experienced compared to a reference situation free of congestion (Leape 2006). In 2006, Transport for London warned of a slightly higher congestion risk than in previous years. The increased congestion risk mainly referred to an intentional reduction of road space for individual traffic and necessary additional construction activities in the City (Transport for London 2007).

Overall, Transport for London reports a significant improvement in traffic conditions in the City after the introduction of the London Congestion Charge. A primary assessment of the enlargement of the charging zone to Kensington and Chelsea also showed positive results. Traffic volume was reduced by 10-15%, and the congestion risk in this area went down by 20-25% (Transport for London 2007)[11]. Concerning environmental effects, traffic emissions have been reduced by about 20% since 2002, whereas the reduction of the accident rate was in line with the long-running downward trend. It is difficult to accurately assess the environmental effects of the charging zone. Transport for London, however, asserts that year-on-year, the enhanced emission performance of the UK vehicle fleet contributes most to the improvements mentioned above.

Overall, trends in measured air pollution remained static because of other important factors determining air quality in London. There are various polluters, with only around 2% of total vehicle kilometres in London affected by congestion charging (Transport for London 2007).

In addition to the environmental impact, it is necessary to assess the fiscal effects of the London Congestion Charge. Before the system was implemented, Transport for London estimated that 150 000 vehicles would pay fees every day, leading to a revenue of £130 million per year. The estimate by ROCOL, the working group that prepared a review of charging options for London in 2000, was even higher at £230-270 million in net annual revenue (ROCOL 2000). Transport for London only reached the revenue level it had expected for the first time in 2006. Net income from the Congestion Charge was £123 million in the fiscal year 2006/07, a remarkable surge compared to the first year of operation (just £68 million). Revenues increased mainly due to the higher charge after 2005, as well as stricter enforcement – around £65 million of the £123 million total in the fiscal year 2006/7 were generated by fines (Transport for London 2007).

Overall, the London Congestion Charge does not fulfil the criteria of congestion pricing as per the economic pricing model discussed above. For reasons of economic efficiency, an urban congestion charge has to vary with the capacity utilisation of infrastructure and/or time of day. The London Congestion Charge, however, represents a kind of Area Licensing Scheme that is not yet able to charge for single trips, and that can therefore not be adjusted according to changes in traffic patterns.

On the other hand, a very simple flat rate toll, charged when entering the marked off area, can be managed with less operating expenses and is self-explanatory for everyone. The theoretically efficient model may therefore be the less efficient solution in real life conditions in London. In any case, the London Congestion Charge has been effective with respect to the goal of traffic reduction in the inner city. Another reason for the success of the flat rate toll might be that congestion was a general and permanent phenomenon in London, without the typical patterns of on- and off-peak changes of intraday capacity utilisation (Leape 2006). Nevertheless, fiscal revenues were distinctly below ex ante predictions for a long time after the introduction of the congestion charge. This leads to the question as to whether toll 'elasticities' have been underestimated by the proponents of the charging system. From an economic point of view, it seems rather obvious that a sharp decline in traffic activity after the introduction of the charge would lead to relatively lower revenues from the system – a relatively simple microeconomic example[12].

However, other questions remain concerning the 'soft' and 'hard' factors that favour the adoption of such an inner city road pricing scheme. One critical point with respect to urban charging is gaining the acceptance by the people affected. Regarding the question of public acceptance, the London Congestion Charge was frequently cited as a reasonably successful project. One reason for public support in favour of road pricing could be the extraordinary amount of everyday congestion. Other reasons might be the success of a policy champion, namely Mayor Ken Livingstone, who was popular enough to hold off even powerful opposition on the issue, the simplicity of the charging scheme, and its clear communication (Ison/Rye 2006, Gaunt/Rye/Allen 2007). Another argument has not been sufficiently stressed in related literature until now. It concerns the 90% rebate for residents which, while lessening the intended positive traffic and fiscal effects, nonetheless provided an important incentive for acceptance. Notwithstanding these explanations, the alleged public acceptance has to be questioned when looking at the structure of revenues. The fact that 53% of revenues stem from fines (£65 million) casts some doubts as to the level of acceptance by the people commuting into central London.

Moreover, the broader economic impacts of the London Congestion Charge, such as on the competitiveness of local firms or property prices, have not yet been analysed sufficiently. There is a lack of representative studies dealing with these aspects of urban charging in London, with only a small number of studies assessing the impact of the London Congestion Charge on local businesses. Even though negative impacts of urban charging on a single store within the charging zone could be proved, overall retail sales across Central London did not suffer unduly (Quddus/Carmel/Bell 2005 and 2007). According to one such representative survey, a majority of firms said that the impact of congestion charging on London's economy was neutral (32%). Around 25% of the respondents reported positive effects, while a further 25% reported negative effects (Clark 2004). A lack of sound empirical studies on the economic impacts of charging on various branches and districts remains, however.

Additionally, the system cost of the London Congestion Charging needs to be taken into consideration. The running costs of the scheme turned out to be twice as high than expected and equate to more than two thirds of the scheme's benefits (Leape 2006). Cost benefit analysis of the London Congestion Charging is heavily affected by running costs and the scheme is subject to controversial debate for this reason, along with others (Mackie 2005, Prud'homme/Bocarejo 2005).

Stockholm Congestion Tax

Urban charging in Stockholm (the so called Trängselskatt) was introduced in August 2007 to lessen congestion during rush hours and to reduce environmental damage from motorised vehicles. Since it is such a new scheme, there is therefore currently a severe lack of hard evidence about the effects of the new toll system on traffic volume, or its economic viability. However, a temporary trial from January to July 2006, prior to the obligatory introduction of road pricing, led to some remarkable results. Congestion charging in Stockholm is organised as a form of 'cordon pricing'. Everyone entering or leaving the city centre from 6.30 a.m. until 6.29 p.m. by vehicle (the charging zone includes an area of 35 km^2) has to pay a charge depending on the time of day. Charges vary from SEK10 to SEK20 per trip, with a maximum daily charge of SEK60 per vehicle (Kloas/Voigt 2007). Similar to the rules in London, there are exemptions for buses, taxis, motorcycles, emergency vehicles or disabled persons, but there is no discount for residents, which is possibly one of the reasons for the low acceptance rate at the beginning of the trial.

Charging is carried out automatically, supported by microwave technology. Each vehicle is required to be fitted with a transponder, provided free of charge by the government. Such a technologically sophisticated solution for the charging problem is expensive. It is therefore unsurprising that the Swedish Government had to bear costs of around SEK3.8 billion for the initial investment in the charging system before the trial. Annual depreciation of the investment has reached around SEK200 million in the current stage of operation, with any future revenues exceeding the costs of operation and depreciation to be invested (or re-invested) in public transport (Kloas/Voigt 2007).

In terms of traffic, results of the trial have been encouraging. The goal of the Stockholm congestion charging was to reduce traffic by 10-15%. In fact, transport activities dropped by around 20-25% during the trial period. Environmental pollution decreased by 14%. On the other hand, public transport use rose by just 4%. The SEK400 million in revenues from the congestion tax remained remarkably below planned levels, mainly because of the successful cutback of traffic.

In comparison with the solution in London, the Stockholm Congestion Charge is based much more on economical considerations, since each trip is charged and the charge differs between peak and off-peak periods. This is the sort of model called for by economists, with the results of the trial confirming that the desired drop in traffic can indeed be attained through congestion charging. However, similar to the experience in London, the revenue from the congestion tax did not meet expectations, with the charging scheme having fairly high costs. There is also no reliable information currently available concerning the economic impact of charging on retail and business activities in the city. Public acceptance has risen during the trial period[13], but there are ongoing debates about the privacy of traffic data from the system (Kloas/Voigt 2007).

Other Examples

For more than 30 years, road pricing and congestion charging schemes have rapidly gained popularity worldwide, particularly, but not exclusively, in inner city areas. In many cases, however, road user charging was only controversially debated, but never actually implemented[14]. In the following section additional examples of urban road pricing will be examined. Road pricing for motorways and trunk roads, however, including the motorway tolls in France, Spain, Portugal, Italy or the HGV tolls in Germany, Switzerland or Austria, for example, are not the subject of this paper.

The longest running and most frequently cited example of congestion charging is the case of Singapore. In Singapore, a vignette based Area Licensing Scheme was introduced in 1975, together with restrictive rules for private car ownership and use (Menon 2006). In 1998, the system was upgraded to an electronic road pricing system. Charging now takes place between 7.30 a.m. and 7.00 p.m. in the central business district and between 7.30 a.m. and 9.30 p.m. on motorways and outer ring roads. Charging works automatically by deduction from a CashCard that can be bought and topped-up at retail outlets, petrol stations and self-service machines (OECD 2006).

The first Area Licensing Scheme of 1975 resulted in a traffic reduction of more than 40% during the charging period – accompanied by restrictions for car ownership and use. To achieve these figures, repeated adjustments had to be made, and it was necessary to extend the charging period several times. At the outset, many drivers rescheduled their journeys from peak times to time slots just within non-peak hours (in price theory this is called the ‘shoulder peak’ case). Charging tariffs were also adjusted because the goal of the Singapore charging model was to obtain specific vehicle speeds, which optimise traffic flow. The actual vehicle speeds are monitored quarterly, leading to an adjustment of the charging tariffs if necessary (May 2004, Santos 2005). The Singapore model therefore offers a kind of economic rationality: congestion charges vary according to the capacity utilisation of roads and provide a stable operating load of urban infrastructure.

In Norway, urban charging has been practised since the 1980s and 90s. Charging via cordon pricing is applied in cities like Bergen (1986), Oslo (1990), Trondheim (1991), Kristiansand (1992) and later on in Stavanger (2001). The common ground of the Norwegian examples is that the purpose of their introduction was not primarily traffic demand management, but rather financing of infrastructure investments[15]. Urban charging was introduced in Bergen, for example, to provide funds for the development of a road system that had been chronically overloaded. Private vehicle movements were down by only 6-7% after the introduction of road pricing, with around 70% of the revenues used for road construction projects. It is only since 2002 that more than half of the money has been used for public transport. Nominal charging tariffs have doubled since the outset of the scheme in 1986, when the driver of a private vehicle had to pay NOK5 for entering the city. With the switch to an electronic road pricing system in 2004, the toll is now NOK11 for a private car and NOK30 for a heavy-goods vehicle (Kloas/Voigt 2007).

The idea of urban charging in Oslo and Trondheim is very similar. Revenues from the Oslo road pricing system were used to finance a road tunnel in the city (the Oslo tunnel) and additional measures to improve roads and public transport. With the Oslo Package 2 (2001-2011), 100% of toll revenues are used for public transport improvements. Individual car traffic declined by 5% after the introduction of the toll, but the situation is difficult to assess because of the simultaneous opening of the Oslo tunnel. A modal shift to public means of transport in Oslo cannot be confirmed either. In Trondheim, the revenues from the electronic cordon pricing were primarily used for bypasses to strengthen the road system and, to a lesser extent, for the improvement of public transport. Taken together, the impacts on road traffic were relatively minor. However, it was noticeable that road users tried to shift their trips from peak times to the toll-free off-peak times. Controversial debates about the future development of the charging system, particularly the question as to whether it should be used for demand management, led to a political agreement to shut down the system at the end of 2005 (Kloas/Voigt 2007).

Another urban charging scheme that is frequently cited in the relevant literature is the Melbourne 'CityLink'. This privately financed toll road, 22 km in length, links three of Melbourne's arterial freeways. It was opened in 1999, with an average daily number of users during the working week standing at 650 000, bringing in revenues of at least AUD187 million. In contrast to the other urban charging systems discussed above, the Melbourne example is not an area wide road pricing system covering the whole city. Only the CityLink that had to be integrated into the existing toll-free road network is subject to charging. Because of the difficult traffic conditions in the city of Melbourne and the lack of public funds, acceptance by the public was striking and significant; even the local motorists club supported the project.

Charging in Melbourne relies on purely automatic vehicle identification technology. There is no alternative of direct-payment at toll booths. Each vehicle is equipped with a pre-paid 'e-tag' placed on the windscreen that is read by scanners on overhead gantries. People have to top-up their accounts when the balance falls below a certain level, with the fine for offenders being a flat fee of AUD100. Road charges are differentiated by the length of the trip on the charged section and the average fee is slightly higher than a ticket for public transport. Evaluation of the project shows that congestion was significantly reduced in north and west Melbourne. It has also been reported that levels of environmental pollution dropped, and that traffic safety increased (Kloas/Voigt 2007, OECD 2006).

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9 A very strict way of evaluating the efficiency of the London Congestion Charge would be a cost-benefit analysis. It is not the purpose of this paper to conduct cost-benefit analyses due to the severe methodical problems related therewith; see Prud'homme/Bocarejo (2005) and Mackie (2005) for the debate about cost-benefit analyses for the London Congestion Charge. A particular problem regarding the economic assessment of the London Congestion Charge points to the data source. Any data necessary for independent economic calculations come from Transport for London, as the official data provider. From a politico-economic perspective there are various incentives for Transport for London to present the London Congestion Charge as a success story.

10 From 2002 to 2003, the total number of private cars, vans and trucks entering central London dropped by 27%. There was a 33% drop in inbound private car traffic, which represented about 65 000 - 75 000 trips (Leape 2006).

11 The cost-benefit ratio of the expansion has been critically assessed by independent transport economists; see Santos/Fraser 2006.

12 The so-called Amoroso-Robinson Relationship between marginal revenue and price elasticity is well known from textbook microeconomics. It argues that under conditions of elastic demand (› 1), higher prices result in declining revenues because the loss of quantity sold cannot be compensated by the rising price.

13 The acceptance of urban charging may rise because of such trials, which allow users to experience the benefits of congestion pricing; see Marner (2007). Trials with remarkable investments, however, create incentives for the government to introduce mandatory urban charging in order to make use of the otherwise 'sunk' facilities.

14 Examples are Kuala Lumpur, Hong Kong, the Netherlands, several proposals in the USA, and Cambridge and Edinburgh in the UK. The main reason for their failure is insufficient acceptance by the public and/or by politicians; see Gaunt/Rye/Allen (2007) and the literature cited therein.

15 One explanation for the frequent occurrence of urban charging in Norway is the fact that the government provides additional infrastructure funding when charging systems are implemented; see Kloas/Voigt (2007).

4 Urban Charging Schemes: a Substantial Contribution to Improve Urban Mobility?

Looking at the examples discussed in Chapter 3, urban charging may look like a panacea for urban mobility. It obviously reduces congestion and traffic problems, mitigates environmental pollution and additionally serves to generate money that can be used to improve public transport. It seems to be an all-in-one device suited to every purpose. But how far is this statement true?

The model for congestion or environmental pricing from Chapter 2 provides us with a benchmark for the evaluation of real-life charging schemes. The basic problems addressed by urban charging are the scarcity of road space and negative environmental effects of the motorised traffic. Considering the scarcity problem, pricing is a means to substitute rationing via loss of time (the 'first come first served' principle) by rationing via a willingness to pay. Road users are 'selected' by their willingness to pay for the use of a scarce commodity, i.e. road space, as it is common to other markets. If users pay the congestion charge, they are signalling that their marginal evaluation of time is higher than that of those who do not pay the charge and therefore withdraw from the roads altogether, or use another mode of transport. Therefore, even in a world of imperfect information, the implementation of road charging improves society's welfare with regard to congestion.

Compared with theoretical reference, however, none of the toll schemes discussed above completely fulfils the requirements of an economically well-founded charging scheme. An optimal congestion fee would require at least the charging of single trips in the congested area and a charging tariff reflecting the actual extent of congestion and vehicle type. This is not the case with the London Congestion Charge, which is a simple uniform charge one has to pay when entering the designated charging zone in the City (Eichinger/Knorr 2004). In other cases, there is at least a daytime differentiation of fees (Trondheim, Stockholm and Melbourne), whereas the Singapore model explicitly focuses on price differentiation and carries out quarterly adjustments to ensure the improvement of traffic flows.

The economic goal of fighting congestion cannot be attained by flat-rate pricing (except if congestion is a permanent phenomenon), but the cost of introducing a charging scheme also needs to be taken into consideration. Establishing a fully flexible pricing system which reflects changing congestion patterns brings with it prohibitively expensive costs. These costs include not only the system costs of a flexible electronic road pricing system, but also considerable transaction costs for the users who always have to inform themselves about the actual traffic conditions and the actual tariff before setting off on a trip. Significant transaction costs may therefore prevent the usage of fully flexible electronic pricing schemes. Nevertheless, urban charging should at least offer a variety of possibilities to users, such as charging single trips and different fees for peak and off-peak periods. A flat charge per day, as with the London Congestion Charge, does not fulfil the necessary conditions for an economically sound congestion charge.

Fixed rates entail another problem concerning the distributional effects of road pricing. Congestion pricing causes distributional effects, since – as compared with the status quo – people with insufficient willingness or ability to pay will be excluded from road use. Even though this exclusion principle is also used in 'normal' markets, road pricing is often addressed as being socially irresponsible and unreasonable for the average motorist. In reply to this distributional argument, the usual exemptions (e.g. for disabled persons) should be noted, and particularly with regard to the use of any eventual revenues. In most cases, revenues form urban charging are spent on measures to improve public transport. Strengthening public transport may be assessed as a means of counterbalancing distributional effects (Mohring 2006). With fixed lump sums, however, redistribution becomes even less effective. In the case of the London Congestion Charge, the problem is eased by the residents' discount, but such a rule is, in turn, not totally reasonable from the perspective of allocation efficiency (Santos 2005).

A residents' discount, as found only in London, also performs another task. Although urban charging can offer economic benefits to society as a whole, these advantages are unequally distributed. Because of the persistence of the status quo, the introduction of urban road pricing will lead to resistance. Examples for urban charging discussed above – and particularly in those attempts that failed – show that opposition against such measures is quite remarkable and that politicians will introduce road pricing only if it does not diminish their chances for re-election (Marner 2007). From a political economy point of view, however, urban charging is much more likely to be implemented than charging on trunk roads, since benefits can also be allocated on a local level – unlike the benefits of a road pricing project on a national level. This argument might be true with Melbourne, for instance, where the improvement of traffic conditions with the new CityLink is perceptible for everyone. For this reason, the acceptance of the project was remarkable. Other projects were controversial, but acceptance rose with the perception of less congestion and improved traffic flows (e.g. Stockholm). In London, the introduction of congestion charging was part of a political campaign that possibly could have failed without the considerable discount offered to residents. In any case, it must be seen that acceptance by the public is one of the key success factors for the introduction of urban charging (Gaunt/Rye/Allen 2007).

Gaining acceptance for urban charging is particularly difficult because the service that is due to be charged for was free in the past and capacity will remain scarce. In most cases, urban charging does not involve any expansion of road infrastructure – a mechanism that is known from 'normal' markets. The idea of road pricing is simply to allocate scarce capacity through a price mechanism. Political communication on road pricing is therefore easy when the revenue from the toll is used for new road infrastructure, but it is difficult to connect the dots between charging and improvement of congestion in advance.

Another issue to be discussed is the role of urban charging in comparison to other means of transport management methods, such as traffic control systems or parking management systems. The idea of traffic control systems is to manage the scarce road capacities through technical solutions rather than price mechanisms. Traffic management can be very effective in improving traffic flows (e.g. via flexible traffic signal systems, traffic information or variable traffic signs), and the introduction of congestion charging should only be considered after having made use of modern systems of traffic control. However, in cases of severe urban congestion, traffic control systems are no longer able to solve the problem. This is also true for parking management. A reduction in parking facilities, or higher parking fees, may reduce the attractiveness of a city and therefore diminish congestion phenomena, but urban charging has a much more direct impact on traffic than parking management.

Efficiency problems are also related to the organisation and the technical features of charging schemes. First, the charging itself should be as easy and cheap as possible, because the costs of the charging system should not exceed its economic benefits (Leape 2006). However, flexible charging, which is more desirable from an economic standpoint, requires highly sophisticated charging technologies. Although information technology allowing the identification of vehicles without the interruption of traffic flow is available today (e.g. microwave based technologies), completely automated charging cannot be realised because vehicles require specific tags. Cars not equipped with a tag (e.g. visitors from abroad) must be charged manually, a solution that causes additional system cost and eventually disturbs the flow of traffic. The standardisation of charging systems, particularly for several cities in the same country, is another concern. In this case a proliferation of non-compatible standards and charging regimes should be avoided.

Implementation of urban charging entails another severe problem, namely the question of how to draw-up the borders of the charging zone. On the one hand, the extent of the charging zone is important for achieving the desired traffic effects. From this point of view, a charging zone should be rather significant in size. On the other hand, the redistributive effects of charging and possible negative impacts on the local retail industry or other commercial activities increase the larger the charging area, which also needs to be considered. In any case, there will be discrimination between people inside and outside of the zone, with different consequences depending on the pricing scheme. In the case of an area licensing scheme, residents feel worse because they have to pay for every trip inside or leaving the charging area, whereas people from outside of the charging zone only have to pay when entering or crossing into it. For this reason, the London Congestion charge offers a residents' discount of 90%. In the case of cordon pricing, people inside the cordon are better off because they can reach destinations within the cordon without paying the charge. Irrespective of the charging model, the amount of traffic on bypass roads surrounding the charging area may increase because people try to circumnavigate the charging area where possible.

Until now the discussion focused on the contributions of road charging in relation to the improvement of traffic flows and the prevention of congestion. There is another argument for road pricing, however. Urban charging aims at decreasing negative external effects such as pollution (e.g. from particulate matter in vehicle emissions), noise and accidents. Therefore, we must ask ourselves whether urban charging is an adequate instrument to internalise such external costs of vehicle traffic.

It is impossible to precisely quantify the external marginal cost of environmental damage and to get the prices right. An environmental surcharge on road tolls will therefore always be arbitrary and economically ill-founded. Moreover, there are additional methodological and empirical difficulties. Pollution emissions of cars and heavy-goods vehicles are internalised by emission standards based on EU specifications. Since emission standards have been tightened continuously in the past, it is difficult to justify additional charging. This is also the case for particulate matter emissions. Critics of motorised traffic have to accept that vehicles are responsible for only a small fraction of the overall particulate matter emissions in cities.

A surcharge with regard to CO_2 emissions, as planned in London, is not a suitable solution. Carbon emissions are a global problem. They are not linked to the environmental situation in an individual city, so that differentiating urban charging according to CO_2 emissions is largely hollow. Charging for noise and accidents is also difficult because of methodological problems. With respect to noise, the problem is that the curve of marginal cost shows a negative slope, which does not fit our pricing model (Reinhold 1998). Regarding accidents, it is argued that most of their costs are internalised by insurance coverage, with the main causes of fatal accidents being non-compliance with speed restrictions and driving under the influence of alcohol (Eisenkopf 2006), factors that cannot be influenced effectively by urban charging.

Altogether, it neither seems useful nor efficient to internalise such environmental externalities by an urban road charge, whereas the use of urban charging to reduce congestion seems generally reasonable, despite the pitfalls and difficulties discussed above. With this in mind, the proposals of the European Commission in its recent Green Paper on urban mobility will be assessed in the following chapter, with a view to evaluating the possible further role of urban charging for urban transport management.

16 Nevertheless, as mentioned before, it might have been the right solution for the London case, because congestion had been rather permanent without the typical cyclical intraday fluctuations, as reported for example by Santos (2005).

17 A recent plan by London Mayor Ken Livingstone includes a £25 charge for cars with CO_2 emissions above 225 g/km and free access for cars emitting less than 120 g/km.

5 Urban Charging and the Green Paper on Urban Mobility

With the Green Paper 'Towards a new culture for urban mobility' (COM (2007) 551 final, September 2007), the European Commission aims to launch a broad public debate about European policy on this issue. The position of the Commission itself seems very clear: the European Union has to play an important role in the process of creating a new urban mobility culture, integrating measures such as technological innovation, the development of clean, safe and intelligent transport systems, economic incentives and amendments to existing legislation. The main result of the broad public consultation carried out by the Commission is that stakeholders expect the formulation of a genuine European mobility policy. In the Green Paper, the European Commission assesses the potential role of the EU in this process.

The paper identifies five challenges which need to be addressed as part of an integrated approach to urban mobility. The first challenge concerns traffic flows in cities. As congestion has negative economic, social, health and environmental impacts, several measures should be adopted to optimise the use of private cars and freight transport, and to promote a modal shift towards sustainable modes of transport. The second challenge concerns air pollutant emissions, CO_2 emissions and noise. From a Commission view point, clean and energy efficient vehicle technologies should be promoted through economic mechanisms, such as incentives for the purchase and operation of vehicles, or by regulatory mechanisms, such as restrictions for heavy polluters and privileged access for low-emitting vehicles in sensitive areas.

European transport policy should also promote new technologies as key element of Intelligent Transport Systems (ITS), to achieve the efficient management of urban mobility. According to the Commission, key topics to be addressed in this policy field are 'smart charging' as an effective method of managing demand, along with the availability of user-friendly, adequate and interoperable multi-modal trip information. The fourth challenge deals with the problem of accessibility, particularly for persons with reduced mobility, disabled and elderly people, or families with young children. A series of measures could improve access, for instance by making urban transport more affordable for people with lower income, by creating an appropriate EU legal framework, by prompting innovative and cheap transport solutions such as rapid transit buses, and by making better use of land, through the integration of urban planning, economic and social affairs and transport. Finally, the Commission's strategy aims at safe and secure urban transport that includes safer behaviour, safer and more secure infrastructures and safer vehicles.

Before assessing individual assertions of the Green Paper, it is necessary to determine whether or not the European Union should be taking an active role in rethinking and reforming urban mobility in Europe. On the one hand, the Commission argues that there is a need for cooperation and coordination at European level to solve the (largely similar) problems of urban mobility in European cities. The idea behind this is that the impacts of local problems are also felt at national or European level, meaning that the European institutions should therefore play a facilitating role in helping to bring about the necessary changes in urban mobility, within the framework of subsidiarity and with the support of various stakeholders.

On the other hand, even the basic assumptions of the Green Paper have been challenged. Controversial issues included the Commission's assertion that EUR100 billion or 1% of the EU's GDP are wasted each year as a result of congestion in towns and cities , and that the bottlenecks in the logistics chain or the problem of climate change are related to weaknesses of urban transport policy. The competence of the EU for a rethinking of urban mobility is not as clear as the Commission states, and there are serious concerns about the extension of their competences in the field of urban mobility. It could be surmised that the Commission will extend the scope of its activities in order to verify the alleged 'European added value', which may lead to an overregulation of urban transport policy and additional bureaucracy that impedes effective action at the local level.

In the Green Paper, urban charging is only one of a large number of measures discussed and does not belong to the core concepts. The Commission states positive effects of urban charges on traffic flows and cites London and Stockholm as best practice examples. However, charging is only one single element of the strategy to improve traffic flows and improving traffic flows, in turn, is just one of five policy fields addressed. Additionally, urban charging is mentioned with respect to the environmental problems of urban traffic. The message of the Green Paper is that, while urban charges and local traffic restrictions sometimes have positive impacts, there is a risk of creating a fragmented patchwork of urban areas with new border lines drawn up across Europe. From the Green Paper itself, it is not quite clear whether this statement applies to traffic restrictions or to urban charging, but it seems reasonable to set a minimum European regulatory framework for both in order to prevent exorbitance. On the other hand, some people fear that a future introduction of local traffic restrictions or charging schemes by the Commission could place major constraints on bigger cities.

The Green Paper also addresses urban charging in the context of financing tools for urban transport. Parking charges and road pricing are mentioned as possible contributions to urban transport financing, particularly "by earmarking the revenues raised for the financing of urban transport measures". The Green Paper refers to the London Congestion charge as a positive example to learn from. Bearing in mind that most of the Commissions' proposals in the Green Paper would be very costly to implement, urban charging may become more important for urban policy than it is currently formulated. As shown in the examples above, the aim of creating sufficient revenues runs counter to the goal of traffic reduction. When urban pricing is introduced as a means to effectively reduce congestion in the cities, politicians should not simultaneously expect maximum revenues from charging. For the same reason, improvements to public transport in cities should rather rely on the principle of user financing.

18 See Kopp/Prud'homme (2007) for a critical assessment.

6 Conclusions

The goal of this paper was to assess urban charging as a means of urban transport management. Considering the examples discussed and looking at their evaluation against the backdrop of economic theory, urban charging does not increase the efficiency of urban transport in each case. However, efficient use of road pricing is possible under the following specific circumstances:

- Urban charging is a meaningful strategy for reasons of optimal allocation, when there is a severe lack of road space and when capacities cannot be expanded. In this case, however, public acceptance may not be very high since pricing is often just another way of dealing with shortages and problems of redistribution occur.
- The use of urban charging as a means of funding infrastructure investments to enhance road capacity is a second possibility, though this may frequently contradict the political will to promote a modal shift towards public transport. Additionally, tariffs have to be set at a rather low level in order not to discourage potential users.
- Finally, urban charging can serve to smooth peak levels of traffic demand that cause temporarily heavy congestion. Smoothing, however, requires flexible charging schemes which may be expensive and are not easily understood by the general public.

Summing up the results of this paper, urban charging should not be seen as a general device for improving the efficiency of urban transport. It is not a 'silver bullet' for improving urban mobility. Even in cases where charging is meaningful in principle, a number of problems remain. The main argument against urban charging from an economic point of view is the costs relating to the charging scheme itself. If the costs of charging are high, as in London and Stockholm, the net benefits of congestion pricing will be far lower than widely anticipated. Another problem is that economic efficiency of the charging system requires flexible charging and sophisticated pricing rules, which in turn reduce levels of public acceptance. A further important determinant of public acceptance is the earmarking of revenues to improve road capacity or public transportation. An exemption for residents in highly congested cities in order to curry favour will considerably affect the gains in efficiency from urban charging. When cities face lower levels of congestion, do not provide valid alternatives to private car use, or when drawing a boundary is difficult due to certain geographical reasons, then urban charging might not function as well as intended. The experiences from London, Stockholm, and elsewhere cannot therefore be generalised without reservations.

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