ROAD PRICING IN URBAN AREAS: FROM CASE STUDIES ASSESSMENT TO POLICY INDICATIONS

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ABSTRACT:

This paper presents an assessment of the two congestion charging schemes of London (2003) and Stockholm (2006) and the urban road pricing scheme of Oslo (1990). We implement a simulation model based on the standard (static) short run congestion model in order to estimate travel time savings, which form the greatest part of benefits of a congestion pricing scheme. The second main methodological point is the inclusion of public funds scarcity. Our assessments show negative and sometimes positive balance between benefits and costs, depending on the assumptions. The issue of technologies of road tolling and their costs is obviously a crucial one. Some policy implications are discussed.

Keywords: cost-benefit analysis, congestion charging, travel time savings, London, Stockholm, Oslo.

INTRODUCTION

The apparent success of both the London Congestion Charging Scheme which started in 2003 (Leape, 2006; Santos and Fraser, 2006) and the Stockholm trial in 2006 (Eliasson, 2008), followed by a durable implementation in 2007, fosters the interest of other cities in the world toward urban road pricing.

Economists have long advocated congestion charging on the grounds of its economic efficiency. However, the debate about the economic efficiency of these schemes has been subject to some controversy (Prud'homme and Bocarejo, 2005; Mackie, 2005; Raux, 2005; Prud'homme and Kopp, 2010), which casts some doubt on the intrinsic efficiency of congestion charging as predicted by the theory: in particular transaction costs may undermine the benefits of the scheme.

The effective implementation of road pricing especially in urban areas raises not only the economic efficiency but also other issues such as equity or political and social acceptability (Schade and Schlag, 2003; Raux and Souche, 2004). Yet economic efficiency remains a pre-condition in the justification of such schemes. In order to help the decision-maker, cost-benefit analyses are performed in order to determine whether this kind of policy, when implemented in a specific area, increases the welfare or not.

This paper presents an assessment of the two congestion charging schemes of London and Stockholm and the urban road pricing scheme of Oslo.

The London and Stockholm congestion charging schemes are well known and are described in detail elsewhere (see for instance Leape, 2006, for London; and Eliasson, 2008, for Stockholm). Oslo road pricing scheme is older (1991) and is described with other urban road pricing schemes in Norway by Ramjerdi et al (2004) and Ieromonachou et al (2006).

The remainder of the paper is structured as follows. We first present the main aspects of the methodology used in this assessment. Then we present our assessment of successively the London and Stockholm congestion charging schemes and the Oslo road pricing scheme. Finally we discuss overall these results and draw some conclusions.

METHODOLOGY

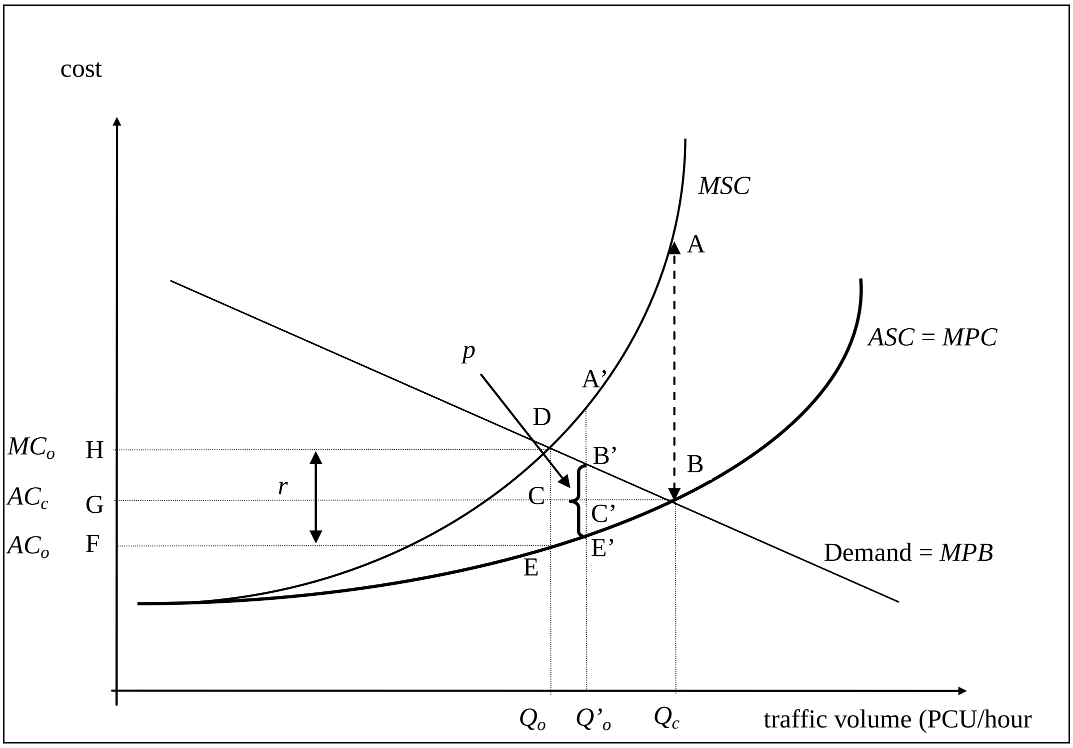
Since travel time savings form the greatest part of benefits of a congestion pricing scheme we implement a simulation model based on the standard (static) short run congestion model. The second main methodological point is the inclusion of public funds scarcity which goes beyond conventional CBA.

The static short run congestion model

Figure 1 shows the basic model of static short run congestion with traffic volume on X-axis and cost on Y-axis (see for instance Button, 2004). *ASC* is the average social cost curve, which is obtained by reversing the speed-flow curve (Walters, 1961; Morrison, 1986). An additional user of the road is considering only the time and vehicle operation costs he has to bear: with many users this time cost equates to the average time cost of all current users. Thus the *ASC* confounds with the marginal private cost (*MPC*) of the road user. The marginal social cost (*MSC*) curve represents the extra cost that the additional user places on the existing traffic flow. The difference between the *ASC* and the *MSC* curves at any level of traffic flow equates with the marginal congestion cost, i.e. the externality of congestion.

The demand curve is figured straight for the sake of simplicity and represents the marginal willingness to pay of road users for taking the road. At the equilibrium *B* between demand and *MPC* (or *ASC*), without any implementation of congestion charging, the volume traffic is Q_c. This situation represents a social loss since drivers enjoy a private benefit of $Q_c B$ but incur a social cost of $Q_c A$. Thus Q_c is an excess traffic from a social point of view which should be reduced to the optimal traffic volume Q_0 at which level private benefit of the additional user equals the social cost he/she incurs. *ADB* is the "deadweight loss" coming from congestion.

Congestion charging aims at internalising the externality of congestion, by making drivers to pay a charge, which is optimal at level *r* yielding optimal traffic volume Q_0. However in practical implementations studied in this paper, the actual charge *p* that is implemented may be different from the optimal one: it yields the actual level of traffic Q'_0 after scheme implementation and *A'B'BA* is the actual time savings gained from the implementation of charge *p*. *B'C'B* is the loss of evicted users.



(source: adapted from Button, 2004)

Figure 1: The static short run congestion model

The core of congestion charging benefit lies in the time savings *A'B'BA*. In order to estimate these time savings and to perform some sensitivity analyses we have implemented this model on a data sheet.

For this implementation we need to estimate the function of speed according to traffic level, the average charge (*p*) and the value of time for car trips.

For the speed function we use a common specification (as in Prudhomme and Bocarejo, 2005)

$$v(q) = v_0 - bq \qquad (1)$$

where v_0 is the free-flow speed, q the traffic and b a parameter to estimate. This function describes the technical capacity of the road network. It is calibrated from aggregate traffic and average speed before and after scheme implementation.

Average charge per vehicle-kilometre p is computed from annual revenues and traffic volume (in vehicle-kilometres).

Average social cost *ASC* is assumed to vary only with the trip duration, thus with the traffic speed. Marginal social cost *MSC* is obtained by derivation of average cost. Thus the cost functions can easily be calibrated. The demand function can also be calibrated from the knowledge of speed function (see above) and both average costs and traffic level before and after scheme implementation (following the methodology described in Prudhomme and Bocarejo, 2005): thus the slope of the demand function (assumed to be a straight line) varies according to value of time, speed and traffic volume before and after scheme implementation, and average charge.

Various sensitivity tests are performed, as shown below, to variations of traffic volume and average speed measured before and after. It should be noted that for each change of input parameter the model recalibrates the speed-flow relationship (slope *b* in equation (1)) and thus the average and marginal social costs, to obtain finally the new figure for monetised travel time savings *A'B'BA*. Regarding variations of the "official" value of time this only changes the monetised result, not the total travel time savings.

The issue of public funds

Modern CBA adds now to the analysis of real effects of investments the financial consequences from the point of view of public funds. The marginal cost of public funds (MCPF) is defined as "the direct tax burden plus the marginal welfare cost produced in acquiring the tax revenue" (Browning, 1976). One example of this welfare cost is when VAT reduces consumption or when taxes on work income distort the work supply decisions of workers.

MCPF seems to be ignored in the UK appraisal current practice (at least in TfL, 2007), but it is taken into account in Sweden (it is set at 1.3, that is to say each incremental unit of money collected by tax costs 1.3 unit to the society, or 0.3 unit in welfare cost).

In Sweden, appraisal adds the opportunity cost of capital (the rate of return for public funds is set at 23%). Confusion occurs sometimes in the literature between these two kinds of costs. The MCPF refers to the distortion effect of the tax levy while the opportunity cost refers to the value in the best alternative use of these funds.

Toll revenues are considered as having no distorting effect on consumption and hence yield a gain in welfare (rate of 0.3 for a MCPF of 1.3) when compared to conventional taxation revenues. Additional revenues from public transport increased use also yield a gain in welfare with respect to alternative financing (e.g. subsidies) by taxation. On the opposite an increase of public expenses (here the investment and the operation of congestion charging and new buses) or a decrease of current fiscal revenues (such as VAT or fuel excise) are weighed down with the MCPF. Opportunity costs are also applied to public expenses.

THE LONDON CASE ASSESSMENT

Implementation of the model in the London case

Data for calibrating the speed function are available in TfL (2007): these include before and after aggregate traffic volumes (respectively 1,531 and 1,276 thousands of veh-km), average speeds (resp. 14.10 and 16.40 km/h) and average charge per veh-km 0.85 €. The calibration of equation (1) gives a slope *b* of 0.009. The value of time is given by TfL (2007): the average figure is 42 pence per minute per person in the Central Area that is to say 37€ per person per hour (with a currency equivalence of €1.45 for £1).

From this computation we obtain monetised time savings of €133 million per year in the Charged Area which can be compared to TfL estimates of €135 million in the same area. This gives at least a partial validation of our model implementation.

Results

The issue of marginal time savings

In the London case the overall time savings of car users are estimated by TfL (2007) to be about €280 million per year. As indicated by TfL these savings may be broken down according to areas where travel occurs. TfL distinguishes the "Charged area", the "Inner area" and the "Outer area".

Table 1: Breakdown of time gains per area in London

	unit	Charged area	Inner area	Outer area	Total
Post-charge veh km	1000 per day	1,276	14,722	32,708	48,706
Time saved per veh km	minutes	0.59	0.06	0.01	
Value of time vehicle	€ per hour	44	32	25	
Time gains	million € per year	135	117	37	290

(Source: Tfl; 2007 and authors calculation. Charge is applied from Monday to Friday, excluding bank holidays, i.e. approximately 255 days per year)

As shown in Table 1 the saving per kilometre amounts to 0.06 minute in the Inner Area and 0.01 minute in the Outer Area. Weighted by the corresponding traffic volumes (respectively 14,722 and 32,708 thousands vehicle-kilometre), these savings yield 14,245 hours saved per day in the Inner area (more than the 11,953 hours saved in the Charged area) and 5,812 hours saved per day in the Outer area. Combined with the values of travel time in these areas, this gives added monetised time savings of respectively €117 million and €37 million per year: overall this doubles the time savings computed on the sole Charged area (€135 million).

When it comes to the perspective of user behaviour, the savings of 0.06 minute per kilometre in the Inner area and 0.01 minute per kilometre in the Outer area look very low when compared to the significant level of saving in the Charged Area, i.e. 0.59 minute per kilometre. For instance, for a 10 kilometres trip these savings of 0.06 minute and 0.01 minute per vehicle-kilometre represent respectively 36 seconds and 6 seconds: this should be compared to the total duration of the trip which is about 30 minutes according to TfL.

This is why in our own estimates we consider two possible values, one restricted to the Charged area, the other extended to the Inner and Outer area as TfL does.

Loss due to eviction of car users

Users who reduce their car travel incur a loss of surplus since they took advantage in travelling by car before CC implementation (bus users gains are measured elsewhere). TfL estimates this surplus loss by combining the decrease in VKT (34% with the charge of 5£ plus an additional decrease of 6% with the charge of 8£) and the time savings these evicted users would have benefited if they had been staying on the road. This surplus loss amount to 20 M£ (29 M€) for both business and other users in the case of 5£ charging and 31 M£ (45 M€) in the 8£ charging.

We can estimate this loss in another way. It is represented by the area B'BC' in Figure 1. Considering only the Charged Area, the average charge level (0.85 €/v-km) minus time savings these users would have benefited (0.59 min/v-km) times the average value of time (44 €/v-h), applied to 255,000 v-km suppressed in the Charged Area, extended to 255 days and halved give 14 M€ per year. This amounts as half the estimate of TfL which includes vehicle-kilometres suppressed in the Inner and Outer Areas (20 M£ or 29 M€).

Bus passengers time savings

Average bus speeds in Central London are 10.86 km/h before CC opening and 11.71 km/h after. We reasonably assume that speed gains are negligible outside the charging area. We have to estimate passenger-kilometres by bus in the charging area. Only total passenger-kilometres on London area is available, that is 5,734 millions of p-km (TfL, 2005c). We assume that the share of p-km in the central zone is the same as the share of p-km by car in this zone (3%). Moreover the increase of trips by bus in this zone amounts to 11% and we consider that it is the same increase for p-km (assuming same average distance travelled). This gives an estimate of 154 million p-km by bus in the central zone after CC implementation and 139 million before.

The estimate of bus passenger VOT is based VOT data per car vehicle and per trip purpose provided with car occupancy in (TfL, 2007). According to HEATCO report (2004), bus passenger VOT amounts to 80% of car user VOT for business purpose and 71.5% for other purposes. We assume that, as for car users, bus users are split equally into business and commuting purposes. Thus we obtain a VOT of 28 € per hour for bus users in the central zone.

We can then compute time savings surplus for existing users which is 26 million euros and the surplus for new users which is (applying the rule of half) 1.4 million euros. This amounts to 27 million euros, slightly over half of TfL estimate (35 M£ or 51 M€). The difference may be explained by inclusion of time savings outside the charging area as is the case for car (the first estimate of TfL in 2003 gave 29 M€).

Depreciation of investments

Regarding duration of depreciation of charging infrastructure TfL considers 10 years as Prud'homme et Bocarejo (2005), which gives 28 M€. Regarding the 250 additional buses we take a duration of 15 years which gives an annuity of 7 M€.

Synthesis: a cautious assessment

We consider in turn transport users, transport operators, externalities and public accounts. Moreover, given the low level of time savings per vehicle-kilometre outside the Charged area we present two overall assessments: one pessimistic restricts these time savings to the charged area, the other optimistic includes the total of time savings on the three zones (Charged, Inner et Outer areas) like TfL does.

Referring to TfL (2007a) we consider the following items:

For transport users:

- Charges paid by car users (215 M€ with the 5£ charge and 236 M€ with the 8£ charge) and charge revenues do not appear as they compensate and represent a transfer from car users to the community. However they are taken into account considering the marginal cost of public funds (see below);
- Two estimates of time savings are given, the one restricted to the Charged area (133 M€), the other including time savings of vehicle driving in the Inner and Outer areas (290 M€);
- Despite controversy in measurement of reliability improvements we keep TfL estimate at 27 M£ that is 39 M€;
- We exclude savings in car operation costs because they are very low (0.1 penny per km savings before after, excluding fuel) and also fuel savings (change of 7.8 km per litre to 7.9 km per litre);
- We keep compliance costs for car drivers, as given by TfL, that is 22 M£ or 32 M€;
- We also keep loss due to eviction of car drivers, that is to say 14 M€ if restricted to the Charged Area, or 29 M€ if including the Inner and Outer Areas;
- Regarding bus users, we include time savings due of bus speed improvement (27 M€ according to our estimate) and also improvement in reliability (8 M£ according to TfL, that is 12 M€);

For transport operators:

- We take into account the investment cost in additional buses with a depreciation over 15 years, that is 7 M€, and corresponding operating costs (18 M£ or 28 M€), thus a total of 33 M€.
- Additional revenues following increase in bus users are also included (19 M£ or 28 M€).
- We include loss of parking revenues due to decrease in car use that is 36 M€.

For externalities other than congestion:

- We keep a benefit accruing to decrease of atmospheric pollution (CO_2, NOx and PM10) of 5 M€.
- Regarding accidents, according to TfL between 254 and 307 accidents would have been avoided (model computation). However only 148 accidents have been actually avoided in the charging zone in 2003 compared to 2002. So we take half of TfL estimate, that is 7 M£ or 10 M€.

Regarding public accounts:

- The costs of charging scheme include operating costs (109 M£ or 158 M€) and investment costs depreciated over 10 years (28 M€).
- Loss of fiscal revenues include loss of fuel duty (between 25 and 27 M£, that is between 36 and 39 M€) and loss of VAT revenues (between 13 and 14 M£ , that is between 19 and 20 M€).
- Regarding costs of public funds, as indicated previously, we keep a MCPF ratio of 1.3. On the other hand the opportunity cost may vary between 5% (see Prud'homme and Bocarejo, 2005) while in Sweden the official value is 23% (applied in Stockholm assessment). We take a central value of 15%.

These figures are summed up in Table 2.

Table 2: Summary of cost-benefit analysis for London

Summary (€ million per year)	TFL assessment (5£ charge)	TFL assessment (8£ charge)	Our assessment (5£ charge) Charged area	Our assessment (5£ charge) Charged + Inner + Outer area	Our assessment (8£ charge) Charged + Inner + Outer area
Benefits					
Car users travel time savings	284	331	133	290	331
Car users reliability benefits	39	46	39	39	46
Bus passengers time savings and reliability	62	62	39	39	39
Bus additional revenues	28	28	28	28	28
Society (accidents and environment)	25	25	15	15	15
Total benefits	438	492	254	411	459
Costs					
Charging costs (amortization +operation)	-194	-194	-186	-186	-186
Additional buses	-26	-26	-33	-33	-33
Deterred trips (car users)	-29	-45	-14	-29	-45
Car users compliance costs	-32	-28	-32	-32	-28
Loss of parking revenues	-36	-36	-36	-36	-36
Loss of fiscal revenues (fuel duty and VAT)	-55	-59	-55	-55	-59
MCPF additional bus revenues	8	8	8	8	8
MCPF charging revenues	65	71	65	65	71
MCPF loss of fiscal revenues	-17	-18	-17	-17	-18
Opportunity costs + MCPF bus subsidies	-15	-15	-15	-15	-15
Opportunity costs + MCPF infrastructure and operating costs of charging	-84	-84	-84	-84	-84
Total costs	-415	-426	-399	-414	-425
Balance	23	66	-145	-3	34

Sources: (Tfl, 2007) and authors' calculation (currency equivalence is set at €1.45 for £1, in 2005).

Discussion

Overall, considering the fifth and next to last column in Table 2 (our assessment with 5£ charge) which aggregates the effects of charging beyond the central zone, benefits and costs are approximately balanced (slightly negative with 3M€ which can be considered zero given the errors). To obtain this result marginal time savings of car users outside the charged area and reliability gains for car and bus users must be included. Otherwise one gets the negative balance in column four (-145 M€) where only the time savings of road users within the charged area are included. As indicated by the last column, the balance is definitely positive in the case of 8£ charging, incurring additional time savings and reliability gains.

The socio-economic balance of London congestion charging scheme is definitely hampered by the cost of charging technology, based on camera license plate recognition. A promising technology would be based on GPS vehicle tracking with the perspective of kilometer-based charging, but currently the implementation costs remain high. Another technology, less costly more widely used in several European countries on tolled motorways or in Norway in all cordon pricing schemes, is based on DSRC with roadside beacons and vehicle on-board tags. However, this would imply a generalization of vehicle equipment with fully compatible devices or an ad hoc toll collection mechanism for non equipped vehicles.

Our own assessment is a cautious yes to the question of improvement of overall welfare in the case of London congestion charging scheme. This improvement is obvious in the case of 8£ charging, when compared to 5£ charging, a level of charge which looks high when compared to average daily charges in Stockholm or Oslo. However this diagnosis is tempered by issues at stake, which are the measurement of car speed improvements, the valuing of marginal time savings and reliability gains in travel time duration (for a discussion of these issues, see Raux et al, 2012).

THE STOCKHOLM CASE ASSESSMENT

Implementation of the model in the Stockholm case

In the Stockholm case we have implemented the same model but with a modification in order to take into account the impact separately on traffic on radial access routes to the charging area on the one hand, and on traffic within this area (which is not charged contrary to London) on the other hand. Thus the average cost *ASC* is broken down into two components, and the speed, demand and supply functions are calibrated separately for radial access to and traffic within the charged area.

Our data are taken from Prud'homme and Kopp (2010) who based their analysis on data from the Stockholm city for traffic entering and leaving the city center, and from a 2004 Transport Survey for traffic having both their origin and destination within the city center. The authors assume that traffic within the city center remains constant since it doesn't pay the toll. The figures for traffic entering and leaving the city center before and after scheme implementation are respectively 410 and 328 thousands of veh-km, and for central traffic 103 thousands of veh-km (this last adds to entering traffic to form the overall traffic within the cordon).

Average speeds on radial routes before and after scheme implementation are respectively 49.87 and 51.05 km/h; the figures for speeds within the center are resp. 23.72 and 26.19 km/h. The former are computed from thousands of measurements on traffic densities at various points in both directions, the latter by the means of floating car speed data (see Prud'homme and Kopp, 2010). The calibration of equation (1) gives a slope *b* of 0.04 for central traffic and 0.02 for radial traffic. These figures are two to four times higher than in the London case (0.009). This is to be related to central Stockholm speeds about two times higher than the London ones, which indicate a fairly low level of congestion in Stockholm when compared with London.

The average charge per veh-km is 9.7 SEK (1.02 €). The average value of time in Stockholm is 122 SEK per hour and vehicle, thus with an average load factor of 1.25, a personal value of time of 97.6 SEK per hour (10.3 €).

From these figures we obtain monetised time savings of €18 million per year: this is one third of the estimate of Transek which amounts to €55 million.

In the estimation made by TRANSEK (2006), the calculation of traffic flows and travel times is based on a mix of statistical method (in the charged area) and model calculations elsewhere (Stockholm's Stad, 2006). Indeed the statistical method needs a great input of data. Traffic flows are measured on a large number of roads in 15 minutes time intervals while for other roads a "matrix calibration" technique is used. For travel times, cameras, floating car surveys, speed detectors and model calculations are used. According to Eliasson (2009) this explains the difference in estimations of time savings, since Prud'homme and Kopp basically use point speed measurements from traffic counts detectors (and the speed is dependent on the location of the detector, e.g. if it is near a junction where traffic is queuing or not) in order to estimate the aggregate speed and aggregate traffic before and after scheme implementation.

Results

Bus passengers time savings

According to Jansson (2008), 16 new main bus lines have been added with 197 additional buses. There does not seem to be any improvement in bus speed according to Stockholmsforsöket (2006a, p.49-50), perhaps because the increase in bus use (+3%) implies longer times of getting into/off the vehicle. However, car speed has increased by 10% on streets and 25% on main roads (Jansson, 2008). We think reasonable to consider a 6% increase in bus speed.

Regarding the number of bus passengers in the charged area, it went from 700.000 journeys before the trial to 727.000 journeys after implementation, that is 3% (Stockholmsforsöket, p.2). According to Stockholm Stad (2006) over the Stockholm county public transport trips have increased by 6%. However Eliasson et al (2009) assign only 4.5% to the charging scheme. We finally keep a cautious estimate of this increase, that is 3%.

Regarding the value of time of bus users in the charged area we assume that it is identical to the remainder of the agglomeration. We apply the same method as in the London case, starting from the value of time of car users (122 SEK/h).Knowing that business purpose represents 20% of trips (Transek, 2006), we obtain a value of 89,3 SEK/h (or 8,9 €/h) for bus users.

Travel time savings of bus users can then be computed as the sum of gains for existing users (3 863 000 €) and gains for new users (halved) of 74 500 € on six months of trial. On 12 months this gives respectively 7.7 M€ and 0.1 M€. These figures are significantly lower than Transek estimate (17 + 3 M€) and nearer Prud'homme & Kopp estimate (11 M€).

Depreciation of investments

Regarding duration of depreciation of charging infrastructure Transek considers a duration of 40 years (which with an investment of 1881 MSEK gives an annuity of 50 MSEK) while Prud'homme and Kopp considers 8 years. Considering devices involved (cameras, electronic captors, computer devices) 40 years look exaggerated. HEATCO (2004) recommends a duration between 10 and 30 years for electronic tolls. Considering the important share of electronic and computer devices in the system we think reasonable to keep a duration of 10 years (like TfL in London). This gives an annuity of 188 MSEK.

Synthesis

Charges paid by car users (763 MSEK or 80 M€) and charge revenues do not appear as they compensate and represent a transfer from car users to the community. However they are taken into account considering the marginal cost of public funds (see below);

Travel time savings are computed thanks to our implementation of the static congestion model (see above). Regarding travel time reliability we keep the value of TRANSEK (79 MSEK or 8 M€.

Regarding bus users we take our estimate of 8 M€ while the loss of comfort is taken as 64 MSEK (or 7 M€) according to Transek.

For additional revenues of public transport in the charged area we apply our estimate of increase of 3% to initial revenues of 4,079 MSEK which gives 122 MSEK (or 12,8 M€)

Environmental gains are taken from Transek as 86 MSEK (or 9 M€).

Regarding accidents, Transek uses modeling to simulate the impact of decrease of traffic and increase of speed on the number of accidents and concludes with a gain of 125 MSEK (or 13 M€). However, police reports do not give evidence of significant variations of accidents during the trial. According to CUPID project (2004) medium range study is needed to compare before/after effects. Thus we do not include any gain in accident.

We keep the operating costs of the charging scheme as in Transek at 220 MSEK (or 23 M€).

Regarding the increase of public ransport supply we keep the Transek estimate of 341 MSEK for additional vehicles and 3 MSEK for garages.

Loss of fiscal revenues is taken as 53 MSek as in Transek.

Finally, regarding the costs of public funds, a MCPF ratio of 0.3 is applied while the opportunity cost is set at 15%.

Table 3 sums up these figures and presents in two variants of our assessment, one including all these aspects and the other excluding the cost of bus extension. This last variant is based on the argumentation by Eliasson (2009) that this extension had been decided and implemented several months before the trial, while no significant effect of this extension on automobile traffic has been evidenced. In surveys, only 4% of bus users declared to be previously car users, that is to say 600 car trips less to be compared to the decrease of 100,000 vehicles crossing the cordon during charging operation. This is why the decrease in traffic can be reasonably attributed exclusively to the charging scheme and not to the bus scheme.

Table 3: Summary of cost-benefit analysis for Stockholm

	Transek 2006		Our assessment		Our assessment (without public transport)	
Summary (per year)	Msek	M€	Msek	M€	Msek	M€
Benefits						
Car users travel time savings	523	55	170	18	170	18
Car users reliability benefits	78	8	78	8	78	8
Bus passengers time savings and reliability	181	19	75	8	73	8
Bus additional revenues	184	19	122	13	122	13
Environment	86	9	86	9	86	9
Accidents	125	13				
Total benefits	1177	124	531	56	529	56
Costs						
Charging costs (depreciation)	-50	-5	-188	-20	-188	-20
Charging costs (operation)	-220	-23	-220	-23	-220	-23
Additional public transport supply (amortization + operation)	-344	-36	-344	-36		
Loss of comfort in public transport	-64	-7	-64	-7	-64	-7
Deterred trips (car users)	-13	-1	-64	-7	-64	-7
Loss of fiscal revenues (fuel duty and VAT)	-53	-6	-53	-6	-53	-6
MCPF additional bus revenues	55	6	37	4	37	4
MCPF charging revenues	229	24	229	24	229	24
MCPF loss of fiscal revenues	-16	-2	-16	-2	-16	-2
Opportunity costs + MCPF public transport improvement	-182	-19	-155	-16		
Opportunity costs + MCPF infrastructure and operating costs of charging	-143	-15	-184	-19	-184	-19
Total costs	-801	-84	-1022	-108	-523	-55
Balance	376	40	-491	-52	6	1

Sources: Transek (2006) and authors' calculation (currency equivalence is set at €0.10512 for 1 SEK).

Discussion

Considering the overall assessment including the bus extension, our balance is negative (approximately 50 M€ per year). On the contrary, excluding the bus extension as argued above, the balance is slightly positive.

The difference with the very positive balance given by Transek depends essentially on the estimates of car user time savings and also of depreciation of investments in charging infrastructure.

Even so the main objectives assigned to the scheme have been achieved. Road traffic has decreased above the 15% aimed at, average traffic speed has increased in the centre (from 22.9 km/h to 26.2 km/h) and in the suburbs (from 49.5 km/h to 51.1 km/h). Emissions of atmospheric pollutants have decreased and people show their satisfaction (Hiselius et al, 2007).

As in London, the significant investment in charging infrastructure and its operating costs weigh down the balance of benefits and costs of the scheme.

THE OSLO CASE ASSESSMENT

We have added the example of Oslo, which is not a “congestion” charging but a simpler “road user” charging scheme which started in 1991. In Oslo there was no objective of reducing traffic or the pollution from automobile, but rather to levy new funds in order to finance a package of new infrastructure investments. The charging system is simpler than in London or Stockholm, with basically embarked on-board units and a dialogue with road-side beacons at a few gantries. Thus the costs of charging (operation plus depreciation) amount roughly to 10%-12% of toll revenues.

Congestion charge revenues amount to 77 M€. Table 4 below sums up the balance for the Oslo scheme. There is no benefit in decongestion and apart from charging infrastructure costs, other costs (or benefits) stems from the public accounts (with a MCPF of 1.3 and an opportunity rate of 15%).

Table 4: Summary of cost-benefits analysis for Oslo

	€ million per year
Congestion charge costs (operation + depreciation)	-9
MCPF Congestion charge revenues	23
MCPF Congestion charge costs	-3
Opportunity costs Congestion charge expenses	-1
Balance	10

Sources: Norwegian Public Roads Administration (2006) and authors’ calculation.

The balance is positive since with a trivial charging technology on a cordon pricing scheme, the charging revenues exceed by far the charging costs, which combined with the marginal cost of public funds yields the benefit from the point of view of public accounts.

CONCLUSION

Regarding the models used to estimate user surplus, especially considering time savings, the robustness of the standard static short run congestion model should be underlined. Applied with average inputs (i.e. speed, value of time, etc.) it has been shown to reproduce correctly the values of surplus obtained by TfL with more sophisticated models.

Among the most sensitive issues regarding CBA we find the issue of marginal time savings, the depreciation of investments and the cost of public funds. These last costs play a significant role in the final balance and it is to develop in the future due to the increasing scarcity of public funds.

Subject to caution regarding these issues, our assessments show negative and sometimes positive balance between benefits and costs, depending on the assumptions. The balance is clearly positive in the case of London when considering the increase in daily charge to 8£ in 2005.

Despite this mixed view, one should consider that the main objectives have been achieved: traffic has decreased significantly (in the charging areas), atmospheric pollutant emissions have also decreased nearly in proportion in Stockholm, and the schemes are accepted by a majority. However, this achievement may have been at the price of a possible economic inefficiency.

The assessment is very different in the case of the Oslo road charging scheme. The balance is definitely positive because, in the absence of decongestion the gains in marginal costs of public funds stemming from charging revenues draw up the balance and the costs of the charging scheme are considerably low.

This example puts in the forefront the issue of technologies of road tolling and their costs. This three schemes show that the charging technology is closely linked to the specific aims of the scheme and its configuration, considering whether the geography, the pricing structure or the hours of operation.

Are congestion charging schemes a “luxury” reserved for big cities, and only on limited areas with a sophisticated technology? The counterexamples of Oslo and especially of midsized Norwegian cities show that schemes with a low level of charge on wider areas and more rustic although totally electronic technology can be more successful.

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