RE-EXAMINING THE RESULTS OF THE LONDON CONGESTION CHARGING SCHEME – A CRITICAL REVIEW

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ABSTRACT:

The London Congestion Charging scheme was introduced in 2003 alongside a series of other changes to the transport system, most notably improved bus services. The results of the scheme have been reported and evaluated since then in numerous reports and studies from which a consensus appears branding it a success. Following from that numerous cities are now introducing or considering introducing similar schemes. Research on the effects of the scheme usually attributes (often implicitly) all the changes that took place in central London since 2003 to the congestion charging, while the effects of other factors, as well as the effects of trends over time, are not usually (explicitly) considered. In this context, the paper revisits the results of the London Congestion Charging scheme to examine to what degree observed effects (related to congestion and traffic levels, changes in travel behaviour and air pollution) can be fully or partly attributed to congestion charging. Attention is also given to the amount of revenues the scheme generated. While there is no dispute over the theoretical rational for introducing congestion charging, the London scheme reveals that questions can be raised with regard to its practical effectiveness. While the bundling together of congestion charging with other measures, such as improved public transport, is crucial for various reasons, it is difficult to determine the direct contribution of each measure to the changes that took place after congestion charging was introduced. Overall the paper concludes that it is still not clear what is the long term effect of congestion charging and it suggests that other cities should first try to implement other (non-pricing) measures before introducing congestion charging.

Keywords: Congestion charging, Policy package, Transport policy, London

1. INTRODUCTION

In February 2003, the London Congestion Charge (CC) came into force. Certain types of vehicles crossing the CC zone, which include parts of central London (Figure 1), during charging hours (07:00-18:30) on weekdays were required to pay £5. The program since then have been hailed a success in many respects, not least the Mayor of London's ability to introduce such a controversial scheme, and to successfully implement what have been considered for many years mainly from a theoretical (economic) perspective. The scheme was described as "the most radical transport policy to be introduced in any major European city centre since the centre of Rome was closed off to chariots because of congestion some 2000 years ago" (Banister, 2004, 499). The perceived success of the London scheme generated enormous interest, also beyond the transport/policy debate, to the extent that almost every major city in the developed world is now considering it in some way. This interest is equally apparent in the academic literature.

Alongside, the introduction of CC in London a range of related transport policy interventions were carried out to ensure its success, most notable are the investments in improved bus network and services. Research on the effects of the CC scheme, naturally, focus on the reduction in congestion, and when other effects are considered they are usually attributed, explicitly or not, to the CC. The possible effects of other measures taken (such as improved bus service) get much less attention while they might be equally or more important in contributing to the effects which followed. While contemporary transport policy and planning promotes the use of policy packages, rather than the use of a single or disparate individual policy measures (Feitelson, 2003), their use make it difficult to fully understand which of the measures implemented was contributing most (or not at all) to achieving the policy goals set and to what extent, if at all, the results were due to or dependent on the synergies between the measures included in the package.

Figure 1: The London Congestion Charging zone in 2003 (darker area)

Source: Wikimedia

The London CC scheme aimed to achieve multiple objectives set in the Mayor of London 2001 Transport Strategy, the first of which was to reduce traffic congestion (Banister, 2003). Overall, the main two objectives for CC were to reduce levels of car use within the zone and to raise revenues for investment in public transport and other transport projects. The London CC scheme was a well crafted policy package, certainly from the implementation perspective, but its results requires further analysis before a verdict is made and implications for other cities are derived. In this context, the paper returns to examine the results from the London scheme trying to link observed effects (like increase in bus patronage) to the introduction of the charge and/or to other policy measures. The analysis raises questions about the use of CC as a tool to address the main problems related to urban transport, including congestion, and it calls for more caution in adopting CC as a panacea, especially in other cities.

To establish the existence, or not, of a link (and even better causality) between CC or other measures and the observed effects some form of statistical analysis is required. Yet, for the purposes of this research such data were not available and therefore links and causality, or their absence, are only implied. The approach adopted is to examine to what extent different observed impacts appear to be continuation of a trend which begun before CC was introduced, the result of other interventions in the London transport system, or the result of the charge. This approach means that the analysis can only succeed to the point of associating different impacts to different causes, but this proves sufficient to (re)open the debate on the effectiveness of congestion charging as a transport policy tool. The analysis relies on data published annually since 2003 by Transport for London (TfL) in the impacts monitoring reports and in other studies (some of which did employ statistical analysis).

In July 2006, the CC was raised from £5 to £8 and in February 2007 the CC zone was extended westward (with a buffer road/zone between the original and extended CC zones). In 2008, following the election of a new Mayor of London further changes were announced, including the abolishment of the western extension. These changes further complicate the attempts to unravel what is the real impact of CC alone, or of other measures. For this reason, the paper focuses almost entirely on the first years post CC, up to and including 2006, and does not consider at all the extended area of the CC.

Before the analysis of the main effects which can be associated with CC is described in Section 3 looking separately on traffic and congestion effects, travel behaviour changes, the environmental impact, and the revenues generated, section 2 provides a short literature review. The results are discussed in Section 4, after which the implications for other cities are examined in Section 5. Final conclusions are presented in Section 6.

2. A BRIEF OVERVIEW OF PAST RESEARCH

Congestion charging as a way to internalize the external costs of congestion has been considered for some time, also for London, but in a theoretical manner. The earliest reference to London is probably made in what is known as the Smeed report (MoT, 1964).

Although London was not first (to attempt) to introduce some form of pricing for the use of urban roads, a scheme in Durham, UK and in Singapore precede it, it generated most of the interest in the subject, mainly due to its scale, the political risk taken (by the Mayor), and the media coverage. Banister (2003) suggests it is “the most radical transport policy to have been proposed in the last 20 years and it represents a watershed in policy action” (Banister, 2003: 259).

Since CC was introduced in London in 2003, a large number of studies described different aspects of it. Early papers that examined the impact the charge had were very much based on results from the first two years (and more the first year) of operation, for example Santos and Shaffer (2004) and Santos and Fraser (2006). Also a special section of *Planning Theory & Practice* (2004 - Volume 5, Issue 4) which discussed different elements of the scheme one year on, generally described it as a success. Perhaps this general conclusion that the scheme is a success, and it certainly appeared to be a year after it was introduced, shifted the interests to a more in-depth investigation of specific issues related to CC from discussing its overall merits. Almost all papers on the London scheme, since it was introduced, have generally been supporting of it and did not challenge the premises about its effectiveness. One exception was the work by Prud’homme and Bocarejo (2005) who conducted a CBA comparing the costs of the scheme to the congestion reduction benefits and concluded that the net benefit of the scheme appear to be negative. Their findings were contested in a comment by Mackie (2005) and Raux (2005).

Much of the discussion since focused more on the process of implementing CC, with attention especially devoted to aspect of public acceptability. For example, Banister (2003) discusses how ‘critical pragmatism’ led to the successful implementation of the London scheme and Ison and Rye (2005) compared the successful implementation of CC in London with two failures, in Hong-Kong and Cambridge. Naturally, the apparent consensus which developed around the London case prompted research on the implication for other cities. Perhaps most notable in this respect is a book devoted to ‘Implications for the United States’ of congestion pricing in Europe (Richardson and Bae, 2008)[1].

One of the concerns with CC in general, and its public acceptability as a result of this, is its equity effects, and many papers on the London experience examined this aspect. Santos and Rojey (2004) looked more generally on the subject, when it was too soon to assess the actual results. Later, Santos and Bhakar (2006) calculated the economic benefits of the scheme for drivers who continue to drive and those who switched to bus after CC was introduced, claiming that also those who did switch to bus as a result of CC might be better off with it despite having to shift modes.

In 2007, in a special issue of Transportation Research Part A that was devoted to “success and failure of travel demand management: is congestion charging the way forward?” (Saleh,

[1] Out of five sections one is devoted to London and another one more generally to experience in the UK including London.

2007) none of the papers directly dealt with the London scheme[2]. Implying the London case has already been sufficiently covered. At this point, it seems attention shifted to two other cities: Edinburgh, where in 2005 more than 70% of voters in a referendum on CC rejected it[3] and Stockholm where in a 2006 referendum 79% of the voters supported CC. In Stockholm, unlike in Edinburgh and later Manchester, a seven month full-scale trial of CC preceded the referendum. The results of Stockholm trial have since covered extensively, in another special issue of Transportation Research Part A (Eliasson, Hultkrantz, and Smidfelt Rosqvist, 2009) and in a book (Gullberg and Isaksson, 2009). For the research on (political) accessibility of CC the case of the three cities provided a unique empirical experiment (see for example, Gaunt et al., 2007). In the context of this paper it is important to note that the large success attributed to the Stockholm trial is based on results obtained less than a year after it was introduced.

Before the focus of empirical research on road pricing is moving again, this time to the Netherlands where a national road pricing scheme is set to be introduced, it is worthwhile to return and examine the results of the London CC scheme. With a slightly longer time period investigated (essentially three years, although some of the analysis looks beyond 2005) and a more critical review of the evidence less decisive conclusion about the success of the London scheme emerges.

3. THE RESULTS OF THE LONDON CONGESTION CHARGING SCHEME

In this section the possible impacts of CC on traffic and congestion, travel behaviour and the environment are examined together with examination of the revenues it generated. Unless specifically stated otherwise, all the figures quoted are from Transport for London (TfL) reports (TfL, 2003-2008). The focus here is on presenting the results while discussing them in Section 4.

Two aspects on which CC had potentially an effect are not examined, the effect on the local economy and safety. There was concern that congestion charging will negatively impact central London economy, but the analysis by Quddus et al. (2007) suggests that while CC had a significant impact on sales at one large department store (7% down at John Lewis Oxford Street) the charge did not affect overall retail sales in central London. This study however only considered data for the department store up to January 2004 and for central London up to December 2004. An analysis of total casualties in London by Noland et al. (2008) suggests no statistically significant effect, but some significant effects within the charging zone (e.g. drop in motorist casualties). The data used was from January 1991 to November 2004.

[2] An edited book based on the same symposium also did not have any chapter devoted to the London case (Saleh and Sammer, 2009). It should be noted, however, that a paper on the London scheme was included in the symposium program.
[3] Later, in December 2008, it was Manchester's turn to reject a CC scheme. 79% of the voters voted against (The Guardian, 2008).

3.1 General traffic and congestion levels

The majority of people entering central London do not use the car. In 2001, on a typical weekday morning (between 07:00 and 10:00) the share of the car in travellers' choice of mode to get to central London was only 12%. Many more travellers arrived to central London using public transport (83%, of which only 7% used bus services, the remainder used the national rail and London Underground services – TfL, 2003).

Already before CC was introduced, a long-term trend of slowly declining traffic in central London was apparent. At the central London cordon[4], the long-term trend was an average growth of 1% per annum until the end of the 1980s and thereafter traffic has fallen at an average rate of 1.9% per annum (TfL, 2005). More specifically, between 2000 and 2002, traffic levels within the CC zone fell by 7% for all traffic and by 9% for vehicles subject to the charge. This is in contrast to the trend within Greater London, where traffic increased as a whole by 7% between 1989 and 2001.

Following the introduction of CC, dramatic changes to traffic patterns took place (Table 1). Most of these changes occurred within the first year of operation, and appear as a one-off shock, after which no further large changes can be observed. As expected, some effect of substitution took place in the first year of operation as the number of potentially-chargeable vehicle-km (vkm) fell down (25%) and the number of non-chargeable vkm went up (18%, e.g. Taxies). Total vkm driven within the CC zone during charging hours decreased (12%). Potentially chargeable vkm continued to decline in 2004 but only by 5% compared to 2003, then they appear to level off. In 2006, all types of traffic which recorded decline in vkm between 2002 and 2003 were now showing an increase in 2006 compared to 2005 (although relatively small) and the opposite change in trend took place for traffic which recorded an increase in vkm between 2002 and 2003. Overall, after two years of decline in total vkm, in 2005 traffic levels were slightly up and again up the year after. The effect of CC on traffic levels was immediate and was generally maintained four years after.

Congestion can be defined in several ways but all relates to the speed of travel. Table 2 reveals a continues increase in congestion, as traffic speeds decline, for the CC zone from 1986 to 1997, but this seem to stabilize for the next two consecutive observations in 2000 and 2002. It appears that in the years up to the introduction of the charge, congestion was building up in the charging zone also when traffic was declining. This indicates the role of other factors then traffic levels in determining the level of congestion. The most important of these factors is probably the capacity of the road network (overall capacity as well as the actual capacity available, which is influenced by road works).

[4] The Central London Cordon consists of a cordon around the Central Statistical Area, which has traditionally been used as the definition of 'central' London for various survey purposes. This cordon is not co-incident with the charging zone, and encloses an area significantly larger than the charging zone.

Table 1: Traffic within the CC zone during charging hours (millions vehicle-km driven, annualised weekdays)

	2002*	2003	2004	2005	2006
Cars and minicabs	0.77	0.51	0.47	0.47	0.49
Vans	0.29	0.27	0.26	0.25	0.26
Other	0.07	0.07	0.07	0.07	0.07
Potentially chargeable	**1.13**	**0.85**	**0.80**	**0.79**	**0.82**
Licensed taxis	0.26	0.31	0.29	0.3	0.29
Buses and coaches	0.05	0.07	0.07	0.07	0.07
Pedal cycles	0.07	0.09	0.09	0.10	0.10
Other	0.13	0.13	0.13	0.14	0.13
Non-chargeable	**0.51**	**0.60**	**0.58**	**0.61**	**0.59**
All vehicles	**1.64**	**1.45**	**1.38**	**1.40**	**1.41**

* Before CC was introduced.
Source: TfL, 2007.

Table 2: Average all day network speeds (km/h) June/July period

	1986	1990	1994	1997	2000	2002*
Within the charging zone	**17.2**	**15.6**	**16.3**	**14.9**	**14.1**	**14.2**
Inner ring road	16.5	16.1	17.6	16.5	15.1	16.0
Main roads in inner London	20.8	23.1	22.5	20.9	20.1	21.3

* May/June period
Note: there is no data in the TfL reports for the average speed after 2002, just reference to excess delay.
Source: TfL, 2003.

In London, congestion is measured as the average excess delay (minute/km), which is the delay to traffic compared to the free flow speed. That is, the difference between the *average* 'all-day' network speeds and the average speed during the early hours of the morning, when traffic flow is at its lightest, and traffic is most able to
move around the network at its 'free-flow' speed (TfL, 2003). In 2002, the average excess delay on roads inside the CC zone was 2.3 min/km – the base congestion level before CC was introduced. This has fallen to 1.6 min/km in 2003, the often quoted 30% reduction in congestion. The level of congestion remained the same in the following year but started to increase thereafter. In 2005, 2006 and 2007 this has been increased to 1.8, 2.1 and 2.3 min/km respectively. Thus, congestion has returned to its pre-charging level in 2007. For 2008 (January to April only), the congestion level remained unchanged at 2.3 min/km (TfL, 2008). TfL notes a relative high road disruption in 2008, but this has also been noted for the base year, just before CC was introduced[5].

Comparing changes in congestion and traffic levels over the years do not seem to indicate a strong correlation between the two[6]. In 2003, congestion was down 30% and traffic by 12%, compared to 2002 levels. In the year after, congestion level did not change while traffic continued to decline, by another 5%. In 2005, traffic was up by about 1% compared to

[5] TfL states that "it is therefore important to be aware that 2002 was characterized by an unusual amount of disruption to the road network in central London" (TfL, 2003: 15).
[6] The time series is too short to conduct a meaningful statistical test.

previous year and congestion level increased by 13%, and in 2006 traffic was relatively stable (increased by less than 1%) while congestion was up by 17% compared to 2005. While the main aim of CC is to reduce the amount of (chargeable) traffic, in order to reduce congestion, this is not necessarily, it appears, the main factor determining the level of congestion. Trying to find out what are these other factors is extremely important.

3.2. Changes in travel behaviour in central London

Up to the introduction of CC, the share of travellers using private transport (mainly car) to enter central London in the morning peak (7:00-10:00) was almost constant between 1988 and 2001. With respect to public transport, there is a clear downward trend in its use from 1988 to about 1994 and a relatively sharp increase from 1996 to 2001, just before CC was introduced (TfL, 2003, Figure 6.2).

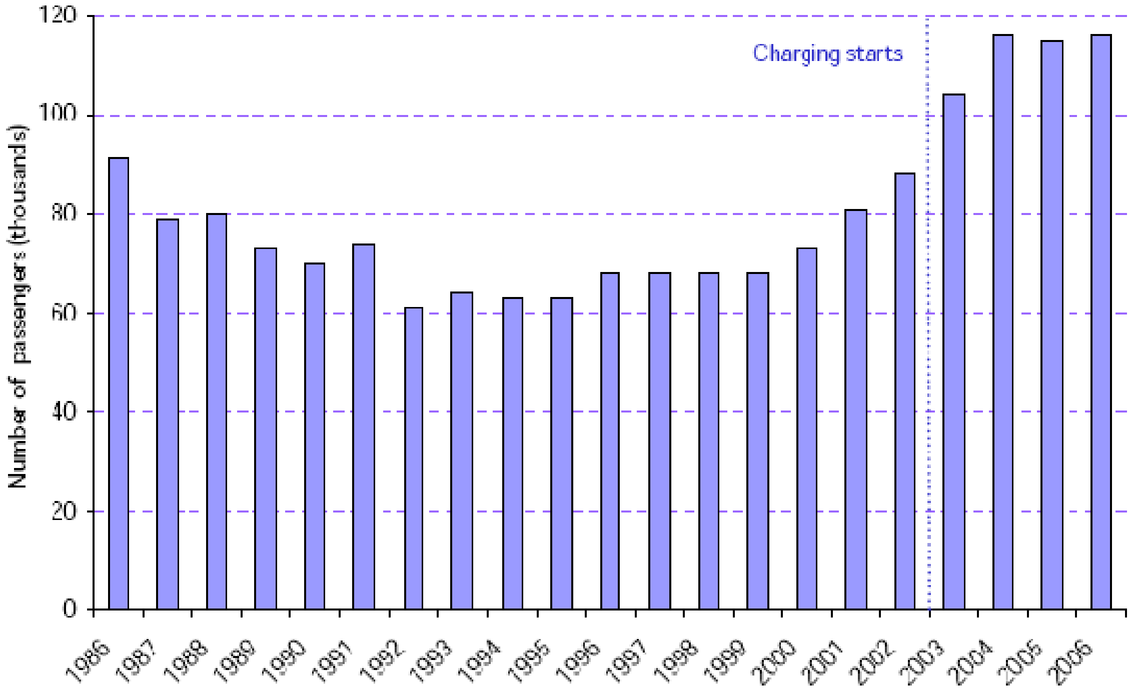
Bus use into central London has been increasing dramatically since 1999, after about 8 years of steady use and, before that, a decline in use between 1986 and 1992. Thus, prior to the introduction of CC bus use in central London has been increasing and it continued to increase for another two years after CC was introduced when it seems to stabilize (Figure 2).

There is not much information on the level of service supplied during the period presented in Figure 2. Information is only available for 2002 to 2004 and for a selection of cites within the charging zone (Table 3). The number of buses observed has increased by more than 30% from autumn 2002 (before CC) to autumn 2003 (after CC) and this increase is also reflected in Table 1. In 2004, only a moderate increase in the number of buses took place compared to 2003. The increase in bus patronage for those years seems to match the increase in services, suggesting an elasticity close to 1. TfL notes that the number of buses crossing the charging zone boundary during charging hours on a typical weekday (in the autumn) was 8,280 in 2002 and 10,500 in 2003. Large part of the increase in bus services took place already before the start of the CC. Scheduled mileage increased by 10% (630,000 km) per 4-week period on routes operating within or on the inner ring road between January 2002 and January 2003.

The introduction of congestion charging was expected to improve the reliability of bus service by reducing congestion and thus improving bus journey times in and around the charging zone. Furthermore, to improve bus services and service reliability more specifically, several measures were implemented in addition to increasing the level of service including: the introduction of the 'Oyster' smart-card, investment in robust schedules, enhanced route supervision and the introduction of Quality Incentive Contracts. After the CC was introduced another change to bus services was the introduction of out-of-bus ticket sales (and banning of ticket sales by drivers) aimed at reducing the amount of time buses spend at stops.

In the first full year after the introduction of CC, excess waiting time - the additional waiting time at bus stops experienced by passengers which is caused by service irregularity or missing buses - fell by 24% across Greater London. For passengers in and around the charging zone the improvement was greater, a reduction in excess waiting time of over 30% compared to the previous year. Data from March to December 2004 show bus passengers in and around the charging zone have benefited from a further reduction in excess waiting time of 18% compared with the equivalent period in 2003. Yet, similar improvements over the rest of the network were also observed (TfL, 2005). The 18% reduction in excess waiting time within the zone took place over a period when congestion was unchanged. It is therefore difficult to associate a large effect of CC on bus service reliability. Average bus speed within the CC zone was 11km/h in 2002 increasing to 11.6 in January 2003 (just before CC). Since then, speeds declined to levels lower than the 2002 situation[7] (TfL, 2007).

Figure 2: Bus passengers, inbound, Central Area Peak Count, 7:00-10:00, Autumn counts



Source: TfL, 2007.

Table 3: Bus passengers and buses observed at a selection of cites on the charging zone boundary (inbound traffic)

	Passengers	Buses
Autumn 2002	102,300	4,450
Autumn 2003	146,600	5,900
Autumn 2004	149,200	6,100

Source: TfL, 2005.

White (2009) estimates the major elements contributing to growth in bus ridership in London between 1999/2000 and 2005/2006 period[8]. He found that the effect of CC is up to 5% of this growth, similar to the contribution of completing the transformation of the London bus fleet to a low-floor fleet. 3% of the increase is attributed to population growth. The majority of the

[7] See Figure 4.2 in TfL, 2007.
[8] The data are for financial years.

increase (54%) is estimated to relate to the combined effect of lower real fares and higher levels of service.

In principle, the introduction of a charge for entering central London by car should have resulted in a shift to other (public transport) alternatives. In the year after the introduction of CC reductions in Underground use was recorded, but this was largely due to factors unrelated to CC, such as the prolonged closure of the Central Line, the transfer of passengers from Underground to buses (after bus services have been improved) and a general decline in tourism. Thus, any small increase in passengers due to congestion charging was more than outweighed by these wider reductions (TfL, 2005). In the 2007 report, TfL notes that "the trend in passenger numbers exiting stations inside the charging zone is similar to those for passengers at stations on the charging zone boundary and the remainder of fare zone 1 [central London]" (TfL, 2007: 62). It can be concluded that CC has no discernable impact on Underground use to get into and around the charging zone. CC did result in a shift from car to Underground (see below) but it was too small to influence overall levels of Underground use.

Similar overview of the information available on cycling levels does not indicate a clear impact of CC on bicycle use within the zone (see Givoni, 2009).

In 2003, TfL observed an overall reduction of between 65,000 and 70,000 car movements crossing into the congestion charging zone during charging hours compared to previous year. Table 4 summarizes how these movements were replaced. Most car users who stopped using the car after CC was introduced switched to another mode of transport (60-70%). Of these former car drivers, it is estimated that 40% have transferred to bus, up to around 50% to Underground or rail, while 10-20% transferred to walk, cycle, motorcycle, taxi or minicab. For public transport (bus, Underground and rail) this translates to 35,000 to 40,000 car driver movements, the equivalent of between 40,000 and 45,000 passengers.

Table 4: Estimated net changes in car driver movements coming into the charging zone in 2003 compared to 2002

	Daily change in car movements	
Total net reduction in car movements	65,000 – 70,0000	100%
Terminating car movements – transfers to bus, Underground, Rail	35,000 – 40,000	54% - 57%
Through car movements – diverting around the zone	15,000 – 20,000	23% - 29%
Terminating car movements – transfers to cycle, walk, motorcycle, taxi, car share	5,000 – 10,000	8% - 14%
Terminating car movements – traveling outside charging hour	Under 5,000	0%-8%
Travel to other destinations, reduced frequency	Under 5,000	0%-8%

Source: TfL, 2005.

Based on the increase in bus passengers crossing (inbound) the charging zone boundary on a typical weekday during charging hours (193,00 in 2002 and 264,000 in 2003) and the estimates in Table 4 it can be estimated that about 30,000 additional bus passengers were previously using the car. Whether they were pushed (by CC) or pulled (by better service) to the bus it cannot be concluded.

3.3 The Environment

It is reasonable to expect that CC will result in some environmental benefits, particularly air pollution, if successful in reducing traffic and congestion levels. Reduction in congestion can lead to lower air pollution as a result of the increase in average speed (see Barth and Boriboonsomsin, 2008). Still, environmental issues were not seen as being important considerations in the decision to introduce the London scheme (Banister, 2008). At present, the evidence of reduction in air pollution from CC seems to be mixed.

NOx emissions contribute to both local air pollution and climate change and are therefore a good indicator for potential environmental benefits from CC. Figure 3 shows running annual mean NOx concentrations over time at different locations and none of the graphs indicate any substantial reductions after charging started. Roadside levels within the charging zone (third line from the top) indicate a clear downward trend from the summer of 2001 which continued for a while after CC was introduced. It is important to note the relatively large, and expected, difference between roadside levels (top three lines) and ambient levels (bottom three lines), the latter group is probably a better indicator for the potential environmental benefits from CC.

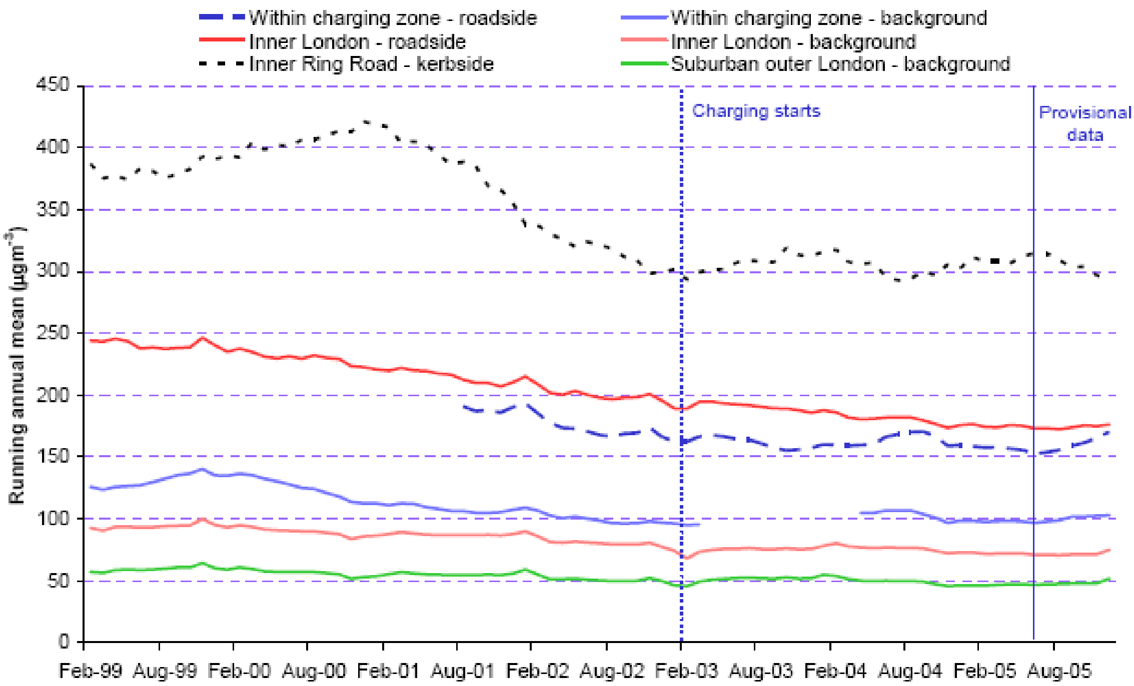


Figure 3: Running annual mean NOX concentrations (Source: TfL, 2006, p. 121).

Studies which looked in detail on air pollutants concentrations data and estimated the environmental effect of CC show mixed results. Beevers and Carslaw (2005) used traffic monitoring data and emissions model to estimate the reduction in emissions from CC. They estimated a reduction of over 10% in NOx and PM_{10} emissions between 2002 and 2003 in the charging zone. In their analysis they did not include emissions from increasing bus traffic although they note that the introduction of particle traps on the bus fleet potentially mitigated the associated emissions. They note that their calculations “retain a high level of uncertainty” (p. 4).

Calculating reductions in emissions from traffic is not sufficient to conclude that CC result in lower air pollution benefits. Benefits will occur if the ambient concentrations of pollutants would change, which is harder to estimate. Ho and Maddison (2008) used a multiple regression analysis on time-series panel data recording of PM_{10} levels before and after CC was introduced. Amongst the many variables that were estimated, a dummy variable for the days after CC was introduced and interaction variables between this and other variables was used. They showed that CC saved about 10.5% of PM_{10} emissions inside the zone compared to the expected level of emissions if pre-charging trend was extrapolated. In other words, they showed that following the introduction of CC a distinct structural break in PM_{10} trends inside and outside the zone could be identified. Inside the zone, the slope of emissions with respect to time changed sign (became negative), while outside the zone the positive slope of the line denoting PM_{10} ambient concentrations over time increased.

Yet, a more recent study by Atkinson et al. (2009) which also looked at ambient concentration levels of different pollutants could not show CC had a significant effect. “Our study suggests that the introduction of the CCS [Congestion Charging Scheme] in 2003 was associated with small temporal changes in air pollution concentrations in central London relative to outer areas. However, the causal attribution of these changes to the CCS per se is not appropriate since the scheme was introduced concurrently with other traffic emissions interventions which might have had a more concentrated effect in central London” (p. 5500).

With respect to London as a whole, Prud’homme and Bocarejo (2005) note that the environmental benefits from CC are likely to be small because vkm driven within the CC zone represent a small fraction (about 1%) of total vkm driven in greater London.

3.4 Revenues from the London congestion charging scheme

In public schemes like the London CC, the extent to which a scheme generate any financial revenue is usually less relevant, what is more important is whether it is beneficial to society (total social costs are lower than total social benefits). This is different in the London CC case since one of the main objectives of the scheme is to raise money for investment in the transport system (hypothecation).

The TfL reports provide detailed information on the financial performance of the scheme including the operating costs, the revenues generated and how the profits were used. No official information is given by TfL on the initial cost required to introduce the scheme, but some estimates are given in the literature. Santos (2008) quotes an estimate provided by TfL of £200 million (at 2002 prices), and notes that most of it was provided by the central government, while Metz (2008) suggests implementation costs of £162m for the original scheme. The scale of the investment that was required in the London scheme is important to have in mind when considering the operating costs and revenues.

Table 5 summarises the financial performance of the CC scheme over four years from the second year of operation (more or less). It shows an increase in the revenues over time, while costs (with the exception of 2007/8 financial year, when the CC zone was extended) remaining relatively stable. This results in an increase in the amount of money available for investment into the transport system, the majority of which (over 80%) is spent on improving the bus network and services.

Table 5: Costs and revenues of the London CC

Financial year	2004/5	2005/6	2006/7	2007/8
Charges	117	145	158	195
Enforcement income	72	65	55	73
Total revenues	**190**	**210**	**213**	**268**
Total (operating) costs	**(92)**	**(88)**	**(90)**	**(131)**
Net revenues	**97**	**122**	**123**	**137**
Net revenues invested in the bus network	80%	82%	82%	82%

Source: TfL, 2005-2008.

Considering Figure 2, it can be argued that the money available from CC for investments in the bus network does not make a large impact on the level of bus patronage since the level remains stable after 2004. Data from the DfT for the entire London bus network show that the number of vkm, an indicator for the level of service provided remained almost the same after 2004 and although bus patronage increased more than bus vkm, which might suggests improvements to bus services were in other elements of the service than increased vkm, these increases are similar to the increase since the 2001/2 financial year (DfT, 2007).

In the financial year 2004/5 TfL's gross expenditure was estimated to be £5bn (Greater London Authority, 2004). Of this, the net service expenditures (e.g. on Underground, rail and river services) in the budget for that year were £2651m. This means the net revenues from the CC are about 5% of TfL's budget for spending on transport services. Yet, in this budget the amount dedicated to bus services is only £667m and thus contributions from the CC to bus transport in London appear substantial. Still, it is not possible to determine that from a revenue perspective the contribution of CC to London, and specifically to its transport network, is significant. More important, it is not clear that CC is the best way to raise this amount of money for investment in the transport system especially given the high initial investment that was required.

4. WHAT EFFECTS CAN BE ATTRIBUTED TO CONGESTION CHARGING IN LONDON

The London CC scheme is perceived to be a great success, within the transport planning/policy making arenas and beyond. This makes CC to be considered as one of the most effective tools in dealing with problems associated with urban transport, like congestion, air pollution, lack of funding, etc. But is the evidence from London so convincing? This section discusses this question in light of the analysis described above. It mainly tries to establish the extent to which changes in various parameters (like bus patronage, air pollution, etc) can be linked to the CC, to other measures implemented in conjunction, or none of these. The nature of the analysis means that concrete conclusions cannot be made, but it is sufficient to question the perceived success of the London scheme, which has important implications.

In evaluating the London CC its impact on congestion levels should be examined first. Economists argue that the London CC is not a classic case of CC since the charge does not vary with the level of congestion nor the vehicle type (Santos and Bhakar, 2006)[9]. Nevertheless, the aim of the CC was first to reduce congestion and this is what policy makers and the public expected it to achieve. Since the introduction of CC the level of congestion returned to pre-charging levels, albeit in different settings which include a higher charge and an extended zone (which means many more exemptions from the charge). This in itself is not a sign that CC failed, as congestion levels could have been worse without it. CC is aimed at deterring some drivers (by increasing the generalised cost of travel to central London) and hence reducing the level of traffic “which should in turn reduce the congestion experienced by other road users” (TfL, 2003: 47). Yet, as congestion is reduced some (potential) drivers will find driving to central London more attractive (lower generalised costs of travel to central London) resulting in higher levels of traffic and hence of congestion, a classic rebound effect[10]. While this might offset the benefits of reduced congestion, from an economic perspective, it leads to a more optimal (efficient) allocation of the available road capacity as only those who value it use it. There is another issue to consider. Following economic theory reasoning, if demand for transport is increasing over time then the impact of congestion charging, the increase in generalized cost of travel for chargeable modes (ignoring the above rebound effect) will only delay this increase and therefore after some period we can expect demand to increase and again exceed supply (of road capacity) resulting in similar or higher levels of congestion[11]. However, the pre-charging trend of traffic into central London was a declining one. Finally, the effect of congestion charging on the cost of driving to central London might have been offset by a reduction in parking fees inside the zone (Levinson, 2010).

[9] In economic terms, the London scheme is a second-best pricing measure and not a first-best one.
[10] Traffic generation, or induced demand, is part of this rebound effect where people who were not using car or not travelling at all to central London before the charge now decide to do so.
[11] The increase in the level of the charge in 2006 might allow investigating this, but soon after, the CC zone was extended which will make it more difficult to isolate the effect of increasing the charge.

Two other issues need to be accounted for in this discussion. First, there are anecdotal references in the various TfL reports about the level of road works affecting the actual road capacity available. For example, TfL notes a relative high road disruption in 2008, when congestion levels returned to pre-charging levels, but this has also been noted for the base year, just before CC was introduced[12]. This factor might well be the main explanatory variable for the level of congestion in central London, but there is no data to investigate this. Second, and somewhat reinforcing the first, it is surprising that a more apparent correlation between changes in the level of traffic and the levels of congestion could not be detected.

There is no question that CC had an immediate effect on the levels of traffic and congestion, but two years later traffic levels were starting to increase (after declining for several years) and later also congestion increased. Similar immediate effect was apparent in the Stockholm CC trial (Eliasson, Hultkrantz, Nerhagen and Smidfelt Rosqvist, 2009). The long term effect of CC on traffic levels and congestion is still not clear. In Birmingham, the second largest city in the UK where CC was not implemented, evidence shows that the number of people entering Birmingham city centre by car in the morning peak has fallen by 32% in 2007 compared to 1995 and in the same period, the use of public transport increased and the share of public transport rose from 42% in 1995 to 56.4% in 2007 (LTT, 2008).

Increase in public transport use was one, but not a primary, objective of the London scheme (Banister, 2003) but there is no evidence for a large increase in the use of public transport (other than bus) to get to central London. Specifically, the effect of CC on rail and Underground use was too small to be detected. There was nonetheless, a sharp increase in the use of bus transport and evident ‘success’ in this respect, but there is no evidence to suggest that CC was an important contributor to this increase, not even indirectly by improving the speed and reliability of bus services. Much more important, as White (2009) demonstrated, was the increase in the level of service, the reduction in fares and other improvements to bus services[13].

The increase in bus use in central London is important and it demonstrates that improving services will increase ridership. The role of CC, it can be argued, made these possible by providing the funds. CC undoubtedly provides large part of the budget for bus transport in London, but this contribution is a small part of the ‘transport’ budget in London. If bus services were a priority a different allocation of funds within TfL budget would have likely to be more cost effective. Prud’homme and Bocarejo (2005) argument is also valid here, “spending the charges proceeds on transport expenditures might create utility, but spending it on health or education would also be useful, and presumably equally useful” (p. 285). Ear-marking the CC proceeds to public transport might increased its public acceptability (as it provides for better alternatives to the one that is penalized) but it is not necessarily cost effective. From a local perspective, however, it is important to note that most of the cost of

[12] See footnote 5.
[13] White (2009) found the effect of CC on increased bus use is equal to that of transforming the London bus fleet to a low-floor fleet. In an email correspondence, the author claims that extending his analysis to cover more years show the effect of the CC on bus patronage is even smaller.

introducing the CC in London came from the national government, a net increase in funding for London which without CC would have not been available for Londoners.

To date, there is also no clear evidence that there were (direct or indirect) environmental benefits from CC. To begin with, this was not a defined objective for CC although if CC was effective in reducing congestion and traffic levels reduction in air pollution would have been expected.

The need for a range of policy measures rather than a single measure to meet one or more policy objectives, a 'policy package', is widely recognised (May and Roberts, 1995; Banister et al., 2000; Feitelson, 2003). The London CC by any definition was a policy package. It is generally agreed that the process of policy packaging should start with a core measure, the measure seen as the most important/effective in addressing the problem at hand (congestion). It can be questioned if congestion was such a problem, given the dominant position of rail transport in the trips to central London, the declining road traffic levels pre-CC and Prud'homme and Bocarejo (2005) estimate that congestion costs were about 0.1% of the GDP produced in the charged zone. Assuming congestion in central London was a major problem it is questionable if CC was effective in dealing with it. The analysis above suggests it probably was not while it suggests that the ancillary measures taken along side CC, notably the improved bus services, were successful, not in their contribution to congestion but to increased bus use.

From a transport planning perspective this results in a paradox. While there is consensus for the need for a package of policies to address a certain policy objective, certainly multiple objectives, it might be later difficult to determine which elements of the package worked and which did not. This makes it almost impossible to learn from past experiences on the effectiveness of different policy measures. Could the London CC package achieved similar results at lower costs if the package excluded CC? While the bundling together of policies/measures is important, and can determine the outcome, it makes it hard to determine which of the measures is really necessary.

Before dismissing CC as an effective policy measure two factors need to be considered. First, as Santos and Fraser (2006) indicate, the deviation of the London CC scheme from the first-best pricing measure was very much influenced by political considerations which influenced the level of the charge, the times at which the charge was imposed, and the area of the charging zone. These political considerations is what Banister (2003) termed 'critical pragmatism'. Second, London was first to implement CC on such scale and therefore inevitably faced high implementation costs. Public and media scepticism also meant that it was crucial to secure successful start which probably further raised the costs. Future schemes can be expected to be cheaper to implement.

5. LESSONS FOR OTHER CITIES

The large positive impact of CC on congestion and traffic levels in central London in the first year of operation immediately shifted the focus of the debate to 'the implications for other cities', as the London scheme became "a global prototype" (Siemiatycki, 2004, p. 511), and the rush to 'replicate' the success elsewhere begun[14]. Since CC was introduced in London it was, and still is, considered in numerous cities around the world, wherever congestion is perceived to be a problem and before the full effect of CC is understood.

This is evident in both the literature and in transport policy making where the untested assumption is that London CC was an absolute success. The discussion therefore revolves around the extent to which physical, political, and other conditions are similar and/or will allow replicating London's experience.

Coverage of the Manchester vote on congestion charging in The Guardian (2008) included statements such as: "The issues have still not gone away. We still have issues of congestion, of poor air quality and poor public transport" and "Manchester has missed the opportunity to develop a clean, fast and efficient transport network". There is no evidence to suggest that a CC scheme in Manchester would have had such affects or resulted in the above. An exception being the funds that Manchester would have got from the national government to invest in local transport which were conditioned on the implementation of CC. The promotion of CC in cities by the UK government through the Transport Innovation Fund and the condition to provide funds if CC is included in the transport policy package is undoubtedly also a result of the perceived success of the London scheme.

For other cities considering CC it seems the question is not if to do it but a question of how. For example, the perceived benefits of CC were the motivation for investigating its suitability for four cities in South America, especially "the apparent success of the London Congestion Charging scheme" (Mahendra, 2008, p. 106).

Santos (2005) asserts that "the main lesson [from London and Singapore experiences] for other towns and cities around the world considering the possibility of introducing congestion charging is that any such scheme ought to be accompanied by complementary measures that will provide motorists with a valid alternative to the car." (p. 511). It might be, as bus patronage in London shows, that providing motorists with a valid alternative is sufficient. The main lesson for other cities from the analysis presented in this paper is that before implementing CC other measures should be implemented first, as these might suffice, and in any case are required for CC to succeed as noted by Santos (2005). Furthermore, the analysis shows that cities which do not have the resources to introduce CC have many other tools at their disposal which can achieve many transport policy goals (perhaps not congestion reduction).

[14] It seems this effect on the debate continued in the years after. "There is little doubt that London's 'success' has contributed in large part to the fact that more cities, not just in the UK but also in the rest of the world, are now considering congestion charging ever more than before" (Lee, 2008, p. 212).

It is somewhat puzzling that so many other cities are considering introducing congestion charging of some form, given that it is likely to be unpopular with voters, especially in places where the majority drive and own a car. However, if the policy is perceived to reduce congestion, raise funds to invest in public transport, which as a result sees increased use, and is environmentally 'sustainable', it should not necessarily be a political cost[15]. The perceived success of the London scheme meant CC became 'best practice' in transport policy. This often means it is rapidly transferred to other places on the basis that it is 'best practice' without due considerations of its suitability and the results of where it was first tried. Macmillen (2009) remarks, in a more general context of transport policy and research, that "the central tenets of 'best practice' appear to be tacitly accepted as self-evident" (p. 2).

In addition to the rational in following best practice, there might be issues of image and prestige involved. Siemiatycki (2004) suggests that the successful implementation of CC provided the scheme, and London, with a sense of legitimacy and prestige that other cities can borrow by adopting the policy. He adds that when cities are in constant competition for an advantage in attracting globally footloose capital investment these issues can be important. CC did focus attention on London and gained its mayor world recognition, which he might have not earned without it. Somewhat similarly, the Paris bike hire scheme - the Vélib', has shifted attention (of the media, with respect to transport) to the city and resulted in world-wide (mostly positive) coverage. Not surprisingly, numerous cities are now considering or implementing similar bike-hire scheme, before full evidence from the Paris scheme are known. The most notable example is probably London.[16]

6. CONCLUDING REMARKS

There is no question, certainly from an economic perspective, about the theoretical merits to introduce congestion charging in an effort to 'internalize the externality' of congestion. What the above discussion and analysis suggests is that there is still a gap between theory and practice. This raises an important question, what would be the situation if all the changes made to the transport system in central London took place but without the introduction of congestion charging? While this paper does not answer this question in full it provides evidence that there might have been better ways to improve the transport situation in London, especially given the fact that different travel indicators were already changing in the desired direction in the years prior to the introduction of CC. Furthermore, given that the majority of people wanting to get to and travel within central London do not use the car, but rely mainly on public transport, for them improving the service is more important than reducing congestion, and better public transport might be achieved in other (maybe more

[15] Goodwin (2004) notes that most commentators believed that CC gained, not lost, the Mayor of London votes, yet it can also be argued that later his plans to extend it further cost him the re-election.
[16] Both London with its CC and Paris with the Vélib' scheme are highlighted examples of best practice in transport on the 'C40' website. The C40 is a group of the world's largest cities committed to tackling climate change and working in partnership with the Clinton Climate Initiative [http://www.c40cities.org/bestpractices/transport/ (accessed 10 March 2010)].

cost effective) ways than introducing CC. It can be expected, however, that as more cities adopt CC and as experience is building up the costs of implementing and running a CC scheme will go down, reducing the gap between the theoretical and practical merits of CC.

This has important implications for the many other cities who are now considering the introduction of CC. It is important to establish first whether, from economic, social and environmental perspectives, reducing congestion is so important, and this naturally depends on the existing levels of road congestion and the extent to which the accessibility of a city depends on the private car. In addition, and if CC is seen mainly as an instrument to raise money, it is important to question if the level of traffic is likely to generate enough revenues to make CC cost effective.

More generally, and probably more important, in the context of (urban) transport policy is the following question. Given the apparent failure of transport planners over the last 50 years or so to 'fight' congestion (mainly through building more roads and due to traffic generation effect) is reducing congestion (in cities) still a valid policy goal or we learn to live with it? The experience from London indicates that this might be a better way forward.

Whether or not congestion can be reduced, another question is whether CC is the best way to raise money for investments in transport and can public transport use be increased without penalising car drivers? The ear-marking of the CC proceeds to public transport is an important element in making it acceptable, but it does not seem to be justified in financial terms. At the same time, other cities investing in improving the public transport, and without CC, can be encouraged from the London experience which showed how improvements to the bus network can be effective in increasing bus patronage, probably also by attracting car drivers, even if (or especially when) congestion is not targeted.

It is the recognition that we 'cannot build our way out of congestion' that paved the way for demand management to take centre stage in transport planning. What is often referred to as the *new realism* (Goodwin et al, 1991 in Owens, 1995). Banister (2003) noted that congestion in London is a key political and public concern because "it is accepted that there seems to be no alternative strategy to addressing congestion apart from demand management ... [and because] public transport alternatives (to demand management) would not be effective on their own." (p. 250). Also Saleh (2007) suggests that one of the reasons for the popularity of pricing measures is that implementation of non pricing measures and policies have failed to achieve evident impacts on traffic congestion reduction and other related urban problems. The extent to which such a generalisation about 'non-pricing measures and policies', can be made is questionable. Even if this is the case the derived conclusion that "pricing measures are more effective in achieving their objectives than non pricing measures and they generate a stream of revenues which could help in the implementation of pricing and other travel demand management measures" (Saleh, 2007, p. 611) is not necessarily true, as shown for London.

There might be another approach that ought to be, at least, considered. That is to manage the supply of transport infrastructure. If the supply of (road) capacity could never meet demand, or at least there is agreement that we should not 'predict and provide' and that some level of congestion is likely to always exist, there is room to consider limiting the amount of (road) transport infrastructure that is supplied. Under this strategy, we can expect road congestion levels in cities to remain constant (albeit at high levels[17]), alternatives to private road transport (including less travelling) more attractive, and a range of environmental benefits (lower air pollution, noise, etc). The question is what about the 'economy'? At the current level of supply of (road) transport infrastructure in most European and north American cities, for example, it is generally accepted that investing in more infrastructure is not likely to generate substantial economic development gains (Banister and Berechman, 2000). Likewise, reducing the capacity can be thought to not result in economic stagnation or decline. This proposition of course requires further analysis, which is done elsewhere. In this strategy of supply management pricing policy tools are central, not to reduce congestion, but to ensure an effective use (from an economic perspective) of available (road) capacity. Goodwin (2004) alluded to this option in reference to lessons learned from the London scheme (albeit only a year after). He noted that "traffic reduction by planning or engineering methods ... has in fact been a stronger strand for longer and has shown more successes than road pricing" (p. 503).

In an influential book in the debate on climate change the author postulates that "it is city governments that have pioneered congestion charging as a means both of preventing traffic gridlock and bringing about emissions reduction..." (Giddens, 2009, pp. 128). In the absence of clear evidence for such effects in London, the need for better informed and balanced review of CC in general and the London scheme in particular is apparent. With respect to the long term effect of congestion charging on urban transport and its (side) effects, and despite the emerging consensus within the academic and policy debates, the jury is still out. William Vickrey notes at the start of his paper on marginal cost pricing the following, which probably suggest the way forward:

> As a preface to a discussion of the role of marginal cost pricing, it is perhaps well to state explicitly that in common with any other theoretical principle, the principle of marginal cost pricing is not in practice to be followed absolutely and at all events ... On the other hand, I propose to maintain that marginal cost must play a major and even dominant role in the elaboration of any scheme of rates or prices that seriously pretends to have as a major motive the efficient utilization of available resources and facilities. (Vickrey, 1955, p. 605)

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[17] At a certain (high) level of congestion the general cost of driving will be too high for this choice of mode to be made. This is certainly the case now and before CC for many travelling to London, hence the low share of car journeys to central London.

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