Congestion Pricing in the city of London

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Abstract

In an effort to reduce the adverse impacts of the cars and promote green transport in Central City of London, governments have implemented Congestion Charging scheme in order to diminish the number of vehicles in congested areas. The monitoring program and the analysis done in this paper, which evaluates the transport, economic, social and environmental impacts of the Congestion Charging, has led to the conclusion that the benefits of its implementation overweighs the negative impacts. The traffic delays were reduced 30%, there was also significant increase in the average speeds (37%), the occupancy rate of cars (5%), the bus usage (20%) and the bike share (79%). Overall there was a substantial reduction of 38.8 %, 50.1%, 19.9 % and 22% in the emissions of CO, CO_2, PM_{10} and SO_2 respectively. This paper begins with an overview of the problem that was considered important with the primary objectives. It discusses in detail the methodology adopted and the impact of the Congestion Pricing on reducing traffic delays, on average speeds of cars, on improvement of public transport and bike use. It also presents the impacts of Congestion Charging on the environment. Finally, it examines the potential role of Congestion Pricing as a demand management tool to reduce the congestion in the center of London city.

Contents

1. Introduction

1.1 Problem Statement

The scientific inventions to make our lives smooth and comfortable, along with the increase of globalization society have shown a tremendous expansion of the car use. Number of cars per household is expanding day by day and has now started causing problems that require adequate attention and solution. The problem mentioned in this study is the increasing congestion and environmental pollution in the city centers, focusing on the center of London city.

1.2 Research Objective

Increase in congestion has negative effect on travel times, delays, energy consumption, and environment in terms of pollutant emission among others. All these lead to the necessity of congestion's reduction. The main objective of the study is to identify the solution to encounter the congestion problem and ways to control the environmental pollution in an economical way.

1.3 Research Questions

To achieve the research objective, it is very important to find the solution of the following areas of concern:

a) Reducing the level of congestion
b) Reducing the emissions i.e. lowering the environmental pollution
c) To achieve our objective in an economical way.

Detailed analysis of the above research questions will allow us to justify the effectiveness of the system in an economic, social and environmental way.

1.4 Hypothesis

The conservation of the existing landscape and infrastructure in the city centers has to be taken into account due to the fact that most of them have great history attached and there is the need to preserve and protect them. Taking into account the aesthetics as well as answers to the research questions, it is found that congestion pricing is an effective method to counter the issues. This method has been implemented in the city of London and so the study's main purpose is to analyze the effectiveness of the method 'Congestion Pricing' in the center of London as an appropriate solution to our problem statement.

2. Literature review

2.1 Reduce Traffic Congestion

Traffic Congestion has become a major problem in many metropolitan cities as it causes delays, time wastage, fuel wastage, increased air pollution etc. As a result the governments around the world are investing in finding ways to reduce congestion on roads. There are several measures that can be done in order to decrease the congestion problem in urban areas. For, example providing exclusive lanes for public transport increases their speed, reliability and attractiveness. Unfortunately, exclusive lanes are often controversial since they 'take' space that could otherwise be used by private vehicles. Moreover using Regulations and Traffic Engineering to Control Traffic such as Parking Restrictions, Turn Restrictions and Loading Restrictions can be used to reduce congestion impacts on public transport. It's important to note that traffic regulations (e.g. removing parking) can be controversial and should be developed and implemented with public input. City planning and urban design practices can also have a huge impact on levels of future traffic congestion, though they are of limited relevance for short-term change. Congestion pricing is another alternative that not only helps in the reduction of congestion in urban areas but also helps in reducing emissions. Moreover it also causes revenue generation which in turn can be invested in improving the transportation infrastructure.

2.2 Congestion Charge, a background

Given relentless growth in population and real income, expanding demand for automobile travel around the world continues to outpace road construction, causing worsening urban congestion. Despite higher fuel prices, the trend of rising urban congestion is set to continue. Meanwhile, because of environmental constraints, neighborhood opposition, and high land acquisition costs, new road construction is increasingly difficult. The governments around the world have tried several measures to reduce the congestion on the roads. Expanding transit and subsidizing fares has limited impacts on automobile congestion. Fuel taxes are also a blunt instrument as they do not differentiate between urban and rural driving, or between peak and off-peak travel. It is therefore not surprising that the governments around the world are looking for more effective congestion policies. In theory, congestion pricing (sometimes called value pricing) is the ideal policy in this regard because it exploits all behavioral responses for reducing congestion, such as reduced overall travel, increased carpooling, shifting trips to off-peak periods, to transit, and to less congested routes.

(*Pricing Urban Congestion, Ian W.H. Parry, November 2008 RFF DP 08-35).*

2.3 What is Congestion Charging?

Road use charging means charging a price for the use of scarce road space. It is a method of charging for the use of the road at the point and time of use to reflect the economic policy objective that vehicles should cover the full costs of their use. Congestion charges are designed to be levied in cities; vehicles are charged as they cross a cordon on the outskirts of the city – or through a series of zones within a city. The aim of using congestion charging is to charge a price sufficiently high to promote modal shift and achieve transport policy objectives such as reducing congestion and encouraging a shift to public transport. The aim may be to charge the economic price for the road space in order to promote the most efficient use of the facility and parallel facilities. Congestion fees may also help with the growing funding gap for financing upgrades of the aging transportation infrastructure.

(Congestion Charging, Susan Harvey, June 2000).

2.4 Types of Congestion Charging

Congestion charging can be done by using:

Cordon–based system: In this system a charge is levied either per day or on vehicles every time they cross cordons or charging points. The use of electronic road pricing is advisable as cordon–based charging requires electronic checking of vehicles as they cross cordons or screen lines.

Area based system: This system takes the form of area or supplementary licenses. These allow permit holders to use the road network in the charged area for the period covered by the license. One advantage of an area license is that both vehicles driving into the charged area and those making trips wholly within it will be charged.

Continuous charging system: This system requires an on–vehicle device, which makes a variable charge according to the speed at which the vehicle is travelling within the city.

(Congestion Charging, Susan Harvey, June 2000).

3. Methodology

Research Questions	Sources	Analysis method
Is London's Congestion pricing effective on traffic congestion? To what extend has influenced the mode choice?	To determine the effectiveness of Congestion Pricing, data were taken from *'Traffic for London'* concerning: ● numbers and percentages of the current traffic condition in London. ● graphs numbers and percentages of the current traffic condition in London compared to those before 2003. ● travel volumes estimated daily average number of journeys stages by mode.	Describe and compare the current situation with the situation before the implementation of Congestion Pricing in terms of traffic congestion decrease and transport mode choice.
Has air quality been increased due to congestion pricing?	To identify the impact of the congestion charging on pollution levels within the congestion charging zone data was collected from two sources. First one was collected from the available online data from the website of Environmental Research Group, King's College London. The website provided the emission data from 2002 to 2012 for two monitoring stations (Westminster- Horseferry and Camden-Shaftesbury) within the congestion charging zone of London. The second source was from the research paper "The impact of congestion charging on vehicle emissions in London" *(Beevers & Carslaw, 2004)*	Daily mean data of different parameters (CO, NO_2, NO_x, SO_2 & PM_{10}) was extracted from 2002 to 2013 for two measuring stations i.e. Westminster- Horseferry and Camden-Shaftesbury station. The data was then averaged for each year and tabulated. For each station the analysis was done by computing the percentage difference between the situation before the implementation of congestion charging and the situation in 2012. At the end the average mean was taken for both stations.
Is the congestion charge reasonable?	To identify whether congestion charge is reasonable or not, data was collected from the following sources: ● *'Impacts Monitoring – Fifth Annual Report: June 2007'* concerning the impacts of congestion charging ● '*Peter Mackie (2005), The London Congestion Charge'* and *'Remy Prud'homme and Juan Pablo Bocarejo (2005), The London Congestion Charge'*. These are two economical appraisals concerning two different points of view on congestion charging	From the data collected, two different points of view on congestion charging were presented and compered to each other. First, an analysis was done by presenting the claims against the congestion charging. Next, an analysis was done by presenting the claims for the congestion charging. In this way a comparison between the two different points of view took place.

An important carrier of data is the *'Transport for London'*. TfL is a local government responsible for most aspects of the transport system in Greater London in England. Its role is to implement the transport strategy and to manage transport services across London. All numeral data, concerning traffic congestion, are up to 2011.

Now concerning the pollution measurements data from roadside (sample inlets between 1 m and 5 m from the kerbside of a road) and urban background (sample inlets sites at least 10 m from any major local sources and broadly representative of city-wide background concentrations) monitoring stations were selected for analysis. Due to the non-availability of the complete temporal data for roadside background, the data source was selected with urban background.

Finally, another important carrier of data is the '*Impacts Monitoring – Fifth Annual Report: June 2007'*, especially for the information concern the congestion charging. It is a report from TfL which draws on the most recent data for 2006, reflecting four years of operation of the congestion pricing, alongside previously published findings.

4. Main Analysis

4.1 Traffic congestion impacts and shift modes

The implementation of the Congestion Pricing in the city of London has offered to the city numerous benefits. Traffic has been reduced and that made central London a much more pleasant place to live, work, visit and to walk. Congestion has been substantially reduced, bringing efficiency benefits to remaining, 'higher value' trips. Although recent trends in congestion have tended to reduce these decongestion benefits relative to the pre-charging base, 'Transport for London' analysis indicates that against a 'without charging' scenario, decongestion benefits are still at a comparable level to those in the early days of congestion charging. Congestion charging has contributed to the increased use of public transport for travel to, from and within central London. All these contribute to the wider use of public transport for travel in London in order to enhance efficiency and sustainability.

Transport for London and various academic organizations established a five-year monitoring program to evaluate the transport, economic, social and environmental impacts of congestion charging (Todd Litman, 2011).

Just over a million people enter central London during a typical weekday morning peak (7-10am). Over 85% of these trips are by public transport. Prior to the congestion pricing program about 12% of peak-period trips were by private automobile. During the programs first few months automobile traffic declined about 20% (reduction of about 20,000 veh/p/d), resulting in a 10% automobile mode share.

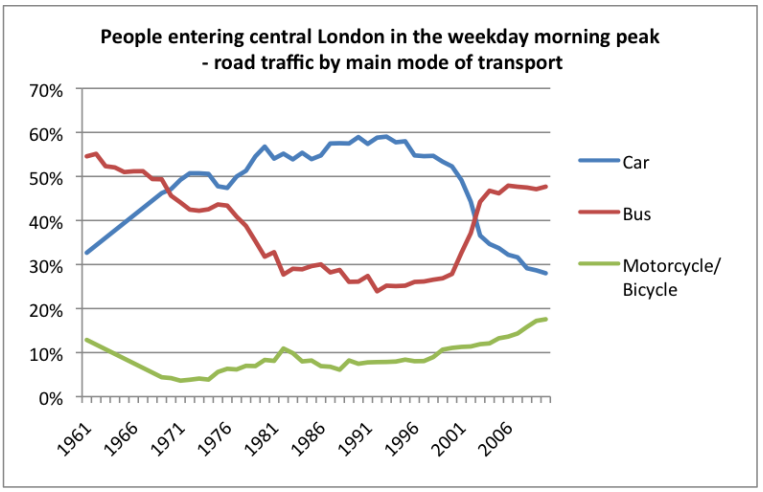
Most people who change their travel patterns due to the charge transfer to public transport, particularly bus. Some motorists who would otherwise drive through Central London during peak periods shift their route, travel time or destination. Others shift mode to taxis, motorcycles, pedal cycles, or to walking.

This has significantly increased traffic speeds within the zone. Average traffic speed during charging days (including time stopped at intersections) increased 37%, from 8 miles-per-hour (13 km/hr) prior to the charge up to 11 miles-per-hour (17 km/hr) after pricing was introduced. Peak period congestion delays declined about 30%, and bus congestion delays declined 50% (Todd Litman, 2011).

Congestion charging is claimed to reduce traffic levels and smooth traffic flow leading to shorter and more predictable journey times. In London, after a sharp initial decline fewer vehicles entered the central zone in 2011 than in 2002 whilst the population increased by 6.8% (Greater London Authority, 2010).

The number of people entering central London by car (and motorbike) has clearly been trending downwards since the early 1980s, but just as clearly there was a very big drop in the early 2000s. What's really interesting is that although there was a big drop (of about 20,000) in 2003, the first year of the Congestion Price charge, that was preceded by two years of almost equally big drops in 2001 and 2002. More recently the decline in car traffic has slowed a bit and in 2011 there was even a small increase, though hardly a noteworthy one.

Figure 4.1: People entering central London by car and motorcycle in the weekday morning peak



Source: Transport for London

Figure 4.2: People entering central London in the weekday morning peak – road traffic by main mode of transport

Now according to TfL's the Underground runs 5 percent more train miles on the Tube, and traveler delays are down around one-third, versus a decade ago. Bus usage reached a 50-year high in 2011, with 65 percent more service and 20 percent less waiting compared to 2000/01 and it is the dominant mode of trips in and out of the ring slightly forward compared to car. Bike trips increased 79 percent from 2001 to 2011, after having stagnated between 1993 and 2001 and travel fatalities and serious injuries were the lowest on record in 2011. Another interesting factor is the number of passengers who have been travelling in a car which has been increased by 4.8 percent.

However the most significant indicator is the one describing the alternation in all modes. There was an enhancement of 17 percent in the same period for trips of all modes. This means that the implementation of Congestion Pricing measure encourage usage of alternative mode shifts, in order to transfer people in the centre of London. This index shows that Congestion Pricing was not only another traffic congestion measure, but a way of thinking for London's drivers.

Table 4.1 Aggregate travel volumes in Greater London. Estimated daily average number of journeys stages by mode, 1993 to 2011. (Seven day week)

Millions of journeys stages

Year	Rail	Underground	DLR	Bus (incl. tram)	Taxi/ PHV	Car driver	Car passenger	Motor cycle	Cycle	Walk	All modes
1993	1,4	2	0	3,1	0,3	6,8	3,7	0,2	0,3	5,2	23
1994	1,4	2,1	0	3,1	0,3	6,8	3,8	0,2	0,3	5,2	23,2
1995	1,5	2,1	0	3,3	0,3	6,8	3,7	0,2	0,3	5,2	23,4
1996	1,5	2,1	0	3,4	0,3	6,9	3,8	0,2	0,3	5,2	23,7
1997	1,6	2,2	0,1	3,5	0,3	6,9	3,8	0,2	0,3	5,3	24,1
1998	1,7	2,4	0,1	3,5	0,4	6,9	3,8	0,2	0,3	5,3	24,4
1999	1,8	2,5	0,1	3,5	0,4	7,1	3,8	0,2	0,3	5,4	25
2000	1,8	2,6	0,1	3,7	0,4	7	3,8	0,2	0,3	5,4	25,3
2001	1,8	2,6	0,1	3,9	0,4	6,9	3,7	0,2	0,3	5,5	25,6
2002	1,9	2,6	0,1	4,2	0,4	6,9	3,7	0,2	0,3	5,5	25,9
2003	1,9	2,6	0,1	4,6	0,4	6,8	3,6	0,2	0,4	5,6	26,2
2004	2	2,7	0,1	5	0,4	6,7	3,6	0,2	0,4	5,7	26,7
2005	2	2,6	0,1	5	0,4	6,6	3,5	0,2	0,4	5,7	26,7
2006	2,1	2,7	0,2	5,2	0,4	6,6	3,7	0,2	0,5	5,8	27,3
2007	2,3	2,9	0,2	5,9	0,4	6,4	3,9	0,2	0,5	5,8	28,5
2008	2,4	3	0,2	6,2	0,4	6,3	3,6	0,2	0,5	5,9	28,7
2009	2,3	2,9	0,2	6,3	0,4	6,3	3,7	0,2	0,5	6	28,8
2010	2,5	3	0,2	6,3	0,3	6,3	3,8	0,2	0,5	6,1	29,3

2011	2,7	3,2	0,2	6,4	0,4	6,1	3,9	0,2	0,6	6,2	29,9

Percentage charge

2010 to 2011	7,7	4,7	11,2	2,4	6,8	-2,3	1,9	-1	5,2	1,2	1,9
2001 to 2011	48,4	20,9	106,7	65,1	0	12,1	4,8	-19,7	78,9	11,8	16,8

(Source: TfL Group Planning, Strategic Analysis)

1. A journey stage is a part of a trip made by a single mode of transport.

2. Each rail interchange between train operating companies is a new journey stage.

3. Bus journey stages are counted by starting a new stage each time a new bus is boarded.

4. Underground journey stages are counted by station entries: interchanges within stations are ignored.

5. Walks are counted only when they form complete trips (i.e. walking all the way), not when they are part of trips using other modes of transport.

4.2 Environmental Pollution Impacts

Analyses of the air pollution impacts of the CCS directly from measurements have proved to be difficult, because in 2003 there was an increase in concentrations of the pollutants PM_{10}, NO_2 and O_3 compared with 2002 as the result of exceptional meteorological conditions (*Environmental Research Group, 2004*). For 2003 it was reported that a large number of incidents of high PM_{10} concentrations occurred in February, March, April and August and were caused largely by secondary sources. During 2003 the average of all inner London background PM_{10} sites measured an additional 24 days where the daily mean PM_{10} concentration was above 50 μg m^{-3}, compared with 2002. During August 2003 the highest hourly O_3 concentration in the 10 year history of the London Air Quality Network (LAQN), was measured at 260 μg m^{-3}. In inner and central London the annual average NO_2 concentration, calculated from all background sites combined, also increased from 45 to 50 μg m^{-3} or 11%. These conditions have therefore made it difficult to detect any changes in concentration of key atmospheric pollutants *(Beevers & Carslaw, 2004)*.

4.2.1 Analysis of the Data from Environmental Research Group, King's College London

Online database of different parameters of the air pollutants is available on the website 'www.londonair.org.uk', Environmental Research Group, King's College London. Two data points were selected with urban background whose data was available from 2002 to 2012. The data available was in daily mean value, that data was extracted and using that annual daily mean was calculated. This has been tabulated in the table 4.1, which shows the temporal change in different parameters.

Table 4.2 Data of different environmental parameters extracted from Westminster – Horseferry and Camden – Shaftesbury station.

Westminster - Horseferry					Camden - Shaftesbury			
Year	CO (mg/m^3)	NO_2 (ug/m^3)	NO_x (ug/m^3)	SO_2 (ug/m^3)	CO (mg/m^3)	NO_2 (ug/m^3)	NO_x (ug/m^3)	PM_{10} (ug/m^3)
2002	0.52	43.29	79.54	3.82	0.39	50.25	96.12	37.46
2003	0.48	49.96	82.42	5.90	0.46	56.25	100.60	29.85
2004	0.35	45.65	76.67	4.01	0.33	58.47	98.37	24.55
2005	0.52	47.51	83.16	4.26	0.46	57.11	103.00	25.07
2006	0.37	50.59	83.74	4.25	0.42	58.68	96.80	25.84
2007	0.50	37.08	67.56	3.46	0.31	61.01	116.77	25.93
2008	0.23	39.93	68.71	3.53	0.32	55.33	94.67	23.20
2009	0.25	43.99	71.83	2.81	0.32	54.23	92.38	22.75
2010	0.31	49.07	74.59	2.46	0.25	55.13	99.28	17.88
2011	0.30	41.29	64.48	2.36	0.24	49.97	81.30	22.52
2012	0.34	39.17	68.57	2.98	0.23	55.21	91.81	18.68

(Environmental Research Group, King's College London)

This data was then analyzed by calculating the difference between the values in 2002 and 2012 from each station and then mean was taken for both the values. Table 4.2 shows the comparison of parameters and the percent change.

Table 4.3 Comparison of different environmental parameters for year 2002 and 2012 and their mean values.

Station	Year	CO (mg/m^3)	NO_2 (ug/m^3)	NO_x (ug/m^3)	PM_{10} (ug/m^3)	SO_2 (ug/m^3)
Camden - Shaftesbury	2002	0.39	50.25	96.12	37.46	-
	2012	0.23	55.21	91.81	18.68	-
	Difference (%)	-42.6%	9.9%	-4.5%	-50.1%	-
Westminster - Horseferry Road	2002	0.52	43.29	79.54	-	3.82
	2012	0.34	39.17	68.57	-	2.98
	Difference (%)	-35%	-10%	-14%	-	-22%
Mean Difference		-38.8%	0.2%	-9.1%	-50.1%	-22.0%

Table 4.4 The percentage change in CO_2 emissions (based on 2002) by vehicle type and speed change brought about by the CCS

	IRR	Charging zone
Charging zone speed changes	−4.7	−9.5 %
Charging zone vehicle km changes	4.7	−10.0 %
Charging zone overall change	0.0	−19.5 %
Additional benefit of improved vehicle technology	−0.6	−0.40 %
Total change in emissions	−0.6	−19.9 %

(Beevers & Carslaw, 2004)

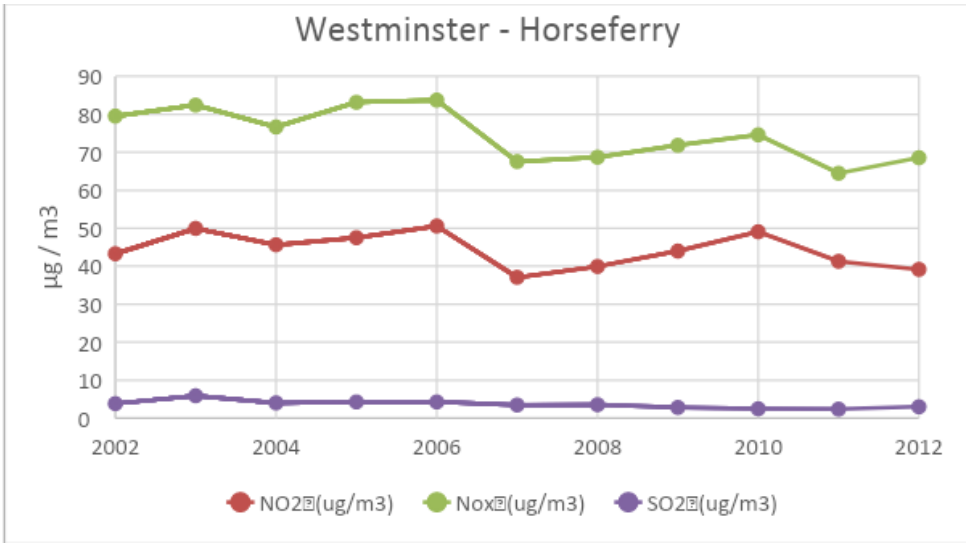


Figure 4.3: Graph of different environmental parameters for different years extracted from Wersmister Station *(Environmental Research Group, King's College London)*

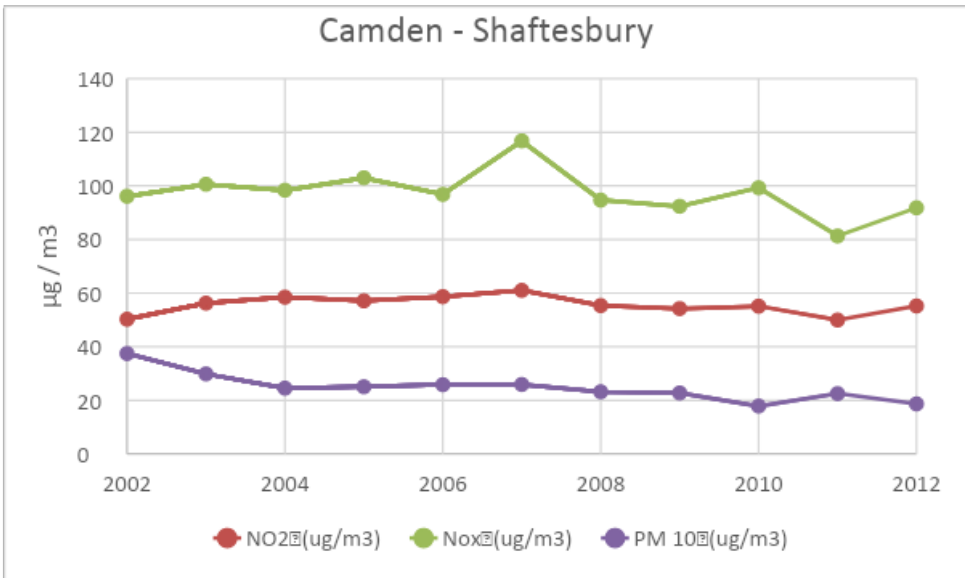


Figure 4.4 : Graph of different environmental parameters for different years extracted from Camden - Shaftesbury Station *(Environmental Research Group, King's College London)*

From this analysis it can be seen that there was a considerable reduction in these parameters from 2002 to 2013. Overall there is a substation reduction of 38.8 %, 50.1%, 19.9 % and 22% in the emissions of CO, CO_2, PM_{10} and SO_2 respectively. There is a slight difference of 9% in NO_2 emissions whereas there is not any notable difference in emission of NO_2.

4.3 Congestion Charge

The Congestion Charge is a £10 daily charge for driving a vehicle within the Congestion Charging zone, 7.00am to 6.00pm, Monday to Friday, excluding public and bank holidays, and between 25 December and 1 January inclusive. Payment of the daily charge allows you to drive into and within the zone, leave and re-enter as many times as you wish on that day. You can also pay by midnight the next charging day, but you will pay £12.

A big question appears due to this Charge: Is the pricing reasonable or not? Critics claim that transaction costs exceed total benefits (Prud'homme and Bocarejo, 2005), but others respond that congestion reduction benefits are higher, there are other categories of benefits to consider, and experience in London will allow development of more cost effective pricing programs in other cities (Mackie, 2005).

From one point of view this charging system is not considered optimal because of the following reasons:

• The fee is not based on how many miles a vehicle are driven within the charging area.

• The fee is not time-variable, that is, the fee is not higher during the most congested periods and lower during less congested periods.

• The fee does not vary by location. It would be more efficient to have higher rates on more congested roads.

• The system has relatively high overhead costs.

• Transit service (particularly the Tube) is crowded and unreliable, although this is changing as bus service improves and pricing revenue is used to upgrade the system.

Moreover, according several surveys presented in the *"Impacts Monitoring – Fifth Annual Report: June 2007"*, shift and key workers view the cost of travel in London as a significant issue for them; about half of key and shift workers (53 percent) agree that they find it difficult to afford travel costs. They try to minimize their travel costs, with 67 percent key workers and 62 percent shift workers trying to find the cheapest option when travelling in London. Also, around half view public transport as the easiest way to travel around London. Those currently using less expensive forms of transport to get to work such as buses, walking or cycling are more likely to look for the cheapest travel options than those who use a car or rail.

Finally, another issue considered as disadvantage of the Congestion Charge is that the Visitor's vehicle is not eligible for an exemption or for a discount from the Congestion Charge.

From the other point of view, there are many people claiming that the pricing is reasonable. According them, there are many exemptions and discounts on Congestion Pricing's taxation that promote the traffic decongestion of the city, the use of vehicles more friendly to the environment, and economic relief of frequent travelers in the center of London. Some of these exemptions and discounts among others are the following:

Residents who live in the charging zone may be eligible for a 90% discount from the Congestion Charge. Some residents living just outside the charging zone may also be eligible for the Residents 90% discount because they live so close that their day-to-day travel will be affected.

Cars and vans that emit 75g/km of CO2 or less and meet the Euro 5 standard (vans must not exceed 3.5 tones gross vehicle weight) including electric vehicles and plug in hybrid electric cars and vans that are on the TfL approved (tfl.gov.uk). Also, in October 2008 cars with emissions of >200kg/km will have to pay £25/€34 promoting in this way the reduction of air pollution in the center of London.

Vehicles automatically exempted from the Charge according the *'Travel for London. (2012), Transport in London Fifth Report*':

• Motorbikes, mopeds and bicycles

• London licensed minicabs and taxis (licensed with Taxis and Private Hire)

• Emergency services' vehicles exempt from Vehicle Excise Duty (VED)

• Any vehicle belonging to the Ministry of Defense

• NHS (National Health Service) vehicles that are exempted from VED

• Vehicles used by disabled persons that are exempt from VED

• Disabled passenger-carrying vehicles (e.g. Dial-A-Ride) exempt from VED

• Vehicles with nine or more seats licensed with the DVLA (Driver & Vehicle Licensing Agency) as a bus. Please note, vehicles registered in a European Economic Area state outside the UK are not automatically exempt but they can receive 100% discount as long as they have registered with TfL.

Moreover, the supporters of Congestion Charge claim that because all net revenue earned from Congestion Charging is invested in improving transport in London so everyone can benefit. In 2011/12 Congestion Charging generated £137m that was put towards making improvements to transport in London, such as bus network improvements, road safety measures, Carbon offsetting schemes and better walking

and cycling facilities. All these things help make London a better, cleaner and safer place.

According to them, a key consideration when trying to ascertain if the benefits outweigh the costs is how the revenue from the tax is redistributed to society. The imposition of charges in the central area leads to reduction of traffic congestion, a reduction in vehicle kilometers in the inner and outer areas, which in turn leads to higher road speeds in these areas, savings in accidents and in the quantity of CO 2 and other air pollutants generated by vehicles.

Another big question about the reasonability of the pricing appeared. Has the congestion charge made a lot of money for London?

The media has reported £1.2 billion of revenue since it was introduced (with gross revenue of £2.6 billion). This suggests costs of 54% of revenue. The 2012 annual report noted £226.7 million in gross revenue from the congestion charge, with £81.2 million in "toll facilities and traffic management" costs and another £8.7 million in "administration, support services and depreciation", leaving net revenues of £136.8 million. This suggests that had London wanted a new source of revenue, this wasn't an efficient way of delivering it. Certainly costs were significantly reduced from when it was introduced, but it suggests there is a long way to go. Bear in mind also that the nominal charge has increased from an average £5 to £9.50 (given half of current users pay £9 and the others £10). Yet, the "costs" line in the accounts suggests that more than the mere costs of running the scheme are included, given "traffic management" is included.

Total gross revenues of the congestion charge are small, representing only slightly more than 5% of total revenues for Transport for London. So talk about it being about money would seem to be misleading, but there would appear to be some scope to get costs down further.

5. Conclusion

This paper presents an ex post facto evaluation of the quantifiable costs and benefits of the Central London congestion charge. It also summarizes other published economic evaluations of the London congestion charge and addresses some of the issues raised in those evaluations. A recent monitoring program to evaluate the transport, economic, social and environmental impacts of congestion charging has led to the conclusion that the benefits of its implementation clearly overweighs the negative impacts. Various surveys conducted shows that the imposition of charges in the central London leads to reduction of traffic congestion, a reduction in vehicle kilometers in the inner and outer areas, which in turn leads to higher road speeds in these areas, savings in accidents and in the quantity of CO_2 and other air pollutants generated by vehicles.

The London congestion charge has been both a practical success in reducing congestion and a popular success in terms of a political decision. Traffic delays inside the zone have decreased by around 30 percent, with a reduction of 15 percent

in traffic circulating within the zone and 18 percent in traffic entering the zone during charging hours. Journey time reliability has improved by an average of 30 percent. This has significantly increased traffic speeds within the zone. Average traffic speed during charging days (including time stopped at intersections) increased 37%, from 8 miles-per-hour (13 km/hour) prior to the charge up to 11 miles-per-hour (17 km/hour) after pricing was introduced. Bus usage reached a 50-year high in 2011, with 65 percent more service and 20 percent less waiting compared to 2000/01 and it is the dominant mode of trips in and out of the ring slightly forward compared to car. Bike trips increased 79 percent from 2001 to 2011, after having stagnated between 1993 and 2001 and travel fatalities and serious injuries were the lowest on record in 2011. Another interesting factor is the number of passengers who have been travelling in a car which has been increased by 4.8 percent. Congestion charging is claimed to reduce traffic levels and smooth traffic flow leading to shorter and more predictable journey times.

By reducing the amount of traffic in and around the charging zone, congestion charging was expected to contribute to improving the general environmental amenity in the zone. From the surveys conducted my Environment Research Group, King's College London it can be seen that there was a considerable reduction in the levels of various emissions from 2002 to 2013. Overall there is a substantial reduction of 38.8 %, 50.1%, 19.9 % and 22% in the emissions of CO, CO_2, PM_{10} and SO_2 respectively. There is a slight difference of 9% in NO_2 emissions whereas there is not any notable difference in emission of NOx.

In a nutshell the congestion charge has brought various positive impacts to the economy of London. The media has reported £1.2 billion of revenue since the congestion charge was introduced and all the net revenue earned from congestion charging is invested in improving transport in London so everyone can benefit. So overall the application of London Congestion Charge is a great success story in many aspects and provides a model to be followed by the authorities of other congestion hit cities like New York, Shanghai and Mumbai etc.

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