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# DETERMINING THE CORRECT PRICE OF A CONGESTION CHARGE FOR DUBLIN

Joe O'Doherty

*Senior Sophister*

*After outlining the theoretical case for a congestion charge in Dublin, Joe O'Doherty estimates, using three different methods, what such a charge should be. In determining the optimal charge, he firstly examines congestion charges elsewhere, secondly he employs empirical estimates of the market fundamentals, and finally he looks at other examples of transport pricing in the economy.*

## Introduction

A "large increase in driving has been identified" in Dublin in recent years (Dublin Transportation Office 2004: p.i). Transport policy has not kept pace with this increased demand and the inevitable result has been a congested road system. Such congestion was predicted by many; "Gridlock beckons" wrote *The Economist* (2002). Efforts to improve the situation have been discussed by politicians, consultants and academics but it is my conviction that the most comprehensive solution will involve a system of congestion charging.

This essay will be divided into four sections. The first will outline the theoretical case for congestion charging. The next three sections will discuss recognised methods of determining a charge:

- Looking at possible international comparisons,
- Using empirical/quantitative methods, and
- Looking at similar examples within the Irish economy.

The conclusion will draw inferences from each method in order to assist in determining the correct charge for entry to the Dublin City road network.

## The theoretical case for congestion charging

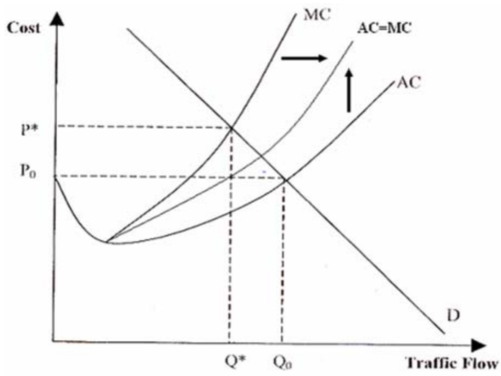
Urban road transport economics is fundamentally reliant on basic economic principles. That is, its basis involves a transaction that equates to an exchange of resources. Undertaking a journey should result in an increase in the utility of either the individual or society in general. Countering this, there are costs associated with road transport. These costs "are distributed across individual and social dimensions" (Foster et al. 2003: 226).

Individual costs include vehicle maintenance, fuel, insurance, tax, and, in many areas, tolls and road-charges. Social costs (externalities) affect the commons and society in general. Cole groups these social costs into three categories: "environmental pollution, (noise, fumes, vibration, visual intrusion, etc.), social group severance, and congestion costs" (1998: 90).

In a world of ever-increasing numbers of users of road transport networks it is generally agreed that the combination of social costs outweigh the individual costs associated with a given journey as well as in aggregate (Button 1993: 114). That is, as the number of drivers using road networks increases, the average cost for each driver (total costs divided by total number of users) decreases. At the same time 'the amount of road space decreases and travel time will subsequently rise' (Foster et al. 2003: 228). This is the marginal cost of having extra road users, and it rises with each additional user. In short, as the number of drivers increases, the average cost decreases, but the marginal cost increases at the same time (Button 1993: 114).

At the margin new entrants place a lower value on the use of the existing road space. This problem would not exist if only average costs could be equated with marginal cost. There are two ways of achieving this. Firstly, by increasing the amount of road space per vehicle the marginal cost of undertaking a journey is reduced. Secondly, by increasing the cost of a journey – by introducing a shadow price – the average cost of that journey is obviously increased. At the same time, by the law of demand, the number of users will fall.

**Figure 1:**




Button, K (1993) Transport Economics Fig 5.8, p 114

This is not the only advantage of the second method over the first. Increasing road space is both costly and time-consuming. It can be harmful to the environment and unsightly to have wider roads. Finally, it is not always possible to construct better roads in a built-up area. In short, in order to try and reduce some social costs (congestion and social group severance costs) and thus reduce the marginal cost of undertaking a journey you may end up increasing other costs; such as higher taxes, environmental, and maintenance costs, and achieving little overall.

The second method of equating marginal and average costs relies on increasing the individual cost of undertaking a journey. It is apparent from the increasing levels of urban congestion (particularly in the Dublin area) that new users still value the benefits of driving in urban areas. If some of the social costs associated with driving could become individual costs many of the economic and social problems associated with urban road transport could be overcome. For this reason a 'congestion charge' should be levied for entry to the Dublin City road network.

Many questions arise in relation to such a charge. Where exactly should it be applied? Who, if anyone, should be exempt? When should it apply? Should it replace motor taxes? How much should it be? It is this last question that will be the primary focus of the remainder of this essay, leaving the other questions to be discussed elsewhere.

## International Comparisons

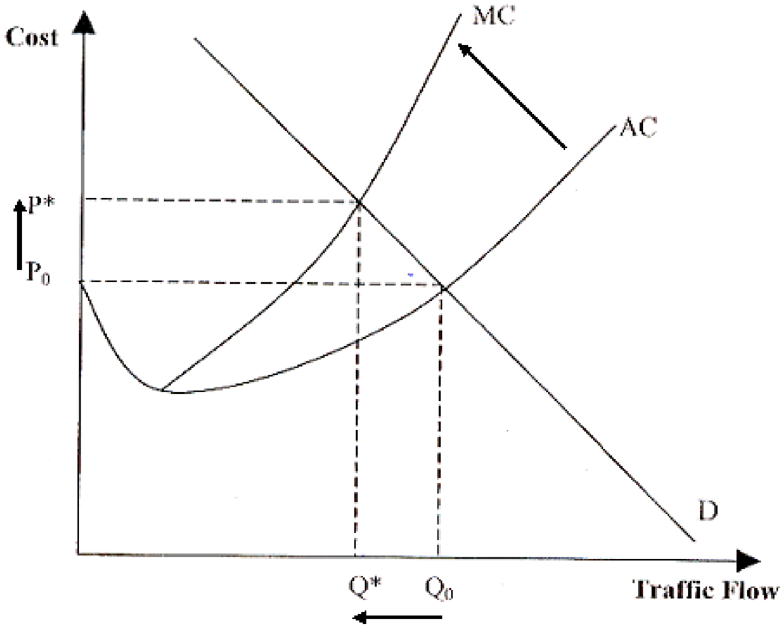
The most obvious way to implement a system of congestion charging is to copy an existing system; however there are equally obvious problems associated with this approach. To start, every city is unique and any system implemented will have correspondingly unique characteristics. For example, the council of Trondheim in Norway charge 15Kr (€1.81) for entry to the city's road system via booths at twenty entry-exit points (BBC). Dublin, a much larger city, would require more booths and have resultantly higher initial and running costs if it were to adopt such a system. The charge would thus be more. Does this suggest that larger cities require a higher charge? If one were to look at congestion charging in London, a bigger city than Dublin, one might be tempted to answer 'yes', as they charge £5 (€7.25) for entry. However, the answer is more complex. The price for entry to any city is rarely arbitrarily set, and although it might be affected by the relative size of the city, it will have much more to do with the ambition of those levelling the charge as to what the resulting revenue will be spent on. Only then should population or size be considered. Officials in Trondheim plan to remove the charge (after 12 years of tolling) because the initial purpose of the charge – subsidising the construction of orbital routes around the city – is now complete, whereas London's mayor, Ken Livingstone, plans to increase the charge to £8 (€11.60) in order to further subsidise public transport, widen the charging area and improve the road system (The Economist 2005). Although it was stated above that the intricacies of any proposed congestion charging system would not be discussed in this essay, it is assumed that it would be levelled in order to equate individual costs and social costs in the short term and the long term. As such, any proposed system would be closer to the British than Norwegian model. Other British cities have implemented congestion charging for similar reasons to those offered by Mr. Livingstone. Edinburgh City Council had calculated a charge of £2 (€2.90) a day to drive in the city, but this was rejected by the people of the city in a poll in March. Durham, a considerably smaller city, has already levied a charge at this price and Nottingham, whose council has employed a consultancy to assist in tailoring a charging system to their requirements, is at an advanced stage in introducing a charge (BBC). The BBC also noted in 2003 that "councils in cities such as Leeds, Birmingham, Bristol, Cambridge, Chester, Reading, Milton Keynes, and Derbyshire have drawn up plans to impose charges" and that other British and European cities "could follow London if the scheme succeeded" (BBC). "Success" in these terms surely compares any potential new congestion system with Singapore, where authorities have levied a varying charge as part of a much larger plan to reduce congestion in one of the world's most urbanised countries. This example has since been mimicked by the likes of San Diego (Meredith and Jones 2001: 223). It has proven to be largely successful in achieving its goal, but is greatly assisted by a government that faces little real opposition in charging motorists up to 59¢ per mile travelled. Again, Dublin's circumstances are closer to those of the British cities, although San Diego's are also similar. Taking those cities that have comparable reasons to Dublin's for implementing a charge, and *then* allowing for population differences the correct charge should be €7 per day. This result is derived in the appendix.

## An empirical/quantitative method

Another way of determining a shadow price is to form a quantitative model. As explained above, the purpose of congestion charging should be such as to "equate the social and individual costs" by levying a Pigouvian Tax (Button 1993: 114).

In the below diagram, the demand curve, D, illustrates how there will be greater demand from road users at lower costs and a higher resultant level of traffic. Before the introduction of a charge the number of vehicles, given a fixed amount of road space, will be $Q_0$. The cost to each road user is $P_0$. Increasing this by ($P^*$-$P_0$) will increase the cost for each user to $P^*$ and reduce the number of vehicles to $Q^*$. This has the combined effect of equating AC and MC

**Figure 2:**




A report by Oscar Faber Consultants in 1999 suggested a charge of €3.81 for cars (subject to certain stipulations). I will use a simplified form of their analysis in order to determine a theoretically correct price for the use of roads in Dublin City. The Oscar Faber Report assumed a constant elasticity of demand equal to –0.5. Foster et al used this figure in their subsequent analysis, yet they suggested a charge of €13.25 for cars to enter Dublin. The assumption that demand elasticity is at this level for road shadow-prices and tolls is countered by Mankiw who, when citing from *The Washington Post*, posits that consumers are much more responsive to the imposition of a toll than price changes in other areas (Mankiw 2000). The suspicion that Oscar Faber Consultants and Foster et al. have set the value of demand elasticity too low is supported in a paper on Spanish tolls by Anna Matas and José-Luis Raymond, who state that "price elasticity of demand for tolls could be as high as –0.83 if alternative transport is available" (Mathas &

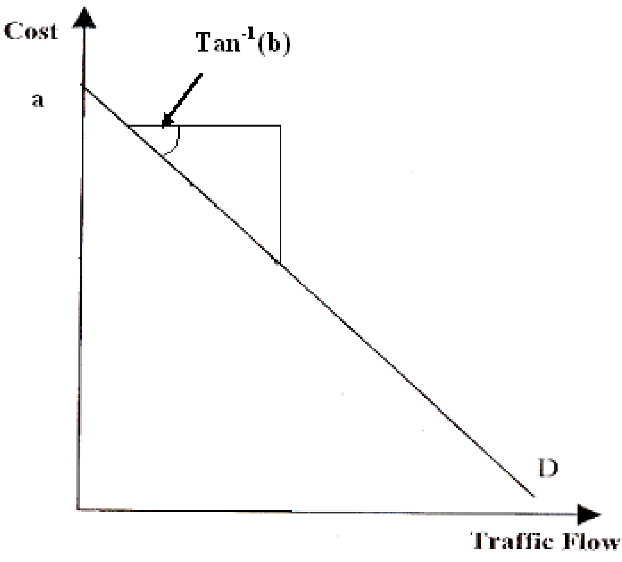
Raymond 2002: 2)(Oscar Faber Consultants 1999; 2003). This is the case in Dublin, with both public transport and orbital routes reducing the necessity for driving through the city centre. I will thus assume a value of –0.75 for the elasticity of demand.

The model which follows is similar to Foster et al. (2003):

$\mathbf{Q_d = a + bP}$,

Where $Q_d$ is the demand for travel in Dublin, P is the cost of undertaking a journey in the city centre, a is the intercept and b is the slope coefficient.

**Figure 3:**




$Q_s$, the available supply of road space in Dublin, is 90,000 vehicles per day (Oscar Faber 1999: 18). This is assumed to be inelastic, as it cannot be adjusted in the short term. Foster et al. adopt a value of 211,400 for $Q_d$ (2003). However, in a presentation to TCD economics students in January 2004 Owen Keegan, Director of Traffic and Assistant City Manager, showed that there had been a 16% drop in traffic entering the city centre between 1999 and 2003 (Foster et al. 2003). This amounts to a demand for road space in Dublin of approximately 177,700 vehicles per day. P, the average cost of undertaking a journey in Dublin, is assigned a value of €11.54 (per day, €4200 per year) by Foster et al.[1]. This is the value I will use and, at the moment, this represents all the individual costs for a driver in Dublin.

We thus have values for $Q_s$, $Q_d$, P and E (the elasticity of demand) and are almost ready to calibrate the model. In order to find a value for b, the slope of the demand curve, we make use of the fact that

$E = dQ/dP$ and that $E = dQ/dP.P/Q$.
Thus $b = dQ/dP = E.Q/P$
$\Rightarrow b= -0.75(177700)/11.54$
$\Rightarrow b = -11548.96$

Also, if $Q = a + bP$
Then $a = Q - bP$
$\Rightarrow a = 177700 + 11548.96\ (11.54)$
$\Rightarrow a = 310975$

The calibrated model is then:
$Q_d = 310975 - 11548.96P$

For marginal and average cost to be equal, supply and demand must be equal too.
Thus $Q_s = Q_d = 90000$

If $Q_d$ is to equal 90000 we need a new (higher) value for $P = P_T$, or P-total, the combined individual and social costs.

$Q_d = 90000 = a + bP_T$
$\Rightarrow P_T = (90000 - 310975)/(-11548.96)$
$\Rightarrow P_T =$ €19.13

The social cost that is currently not paid for directly by road users is
$P_T - P = 19.13 - 11.54$
= €7.59
≈ €7.50
This is the quantitatively correct congestion charge for entry to the Dublin road network.

[1] Adopted from "The route to sustainable commuting" by the Dublin Transportation Office 2001.

## Similar examples within the Irish economy

The third method of determining a shadow price is to look at examples from within the same economy. As well as subsidising the cost of road transport in Ireland, the Irish government also subsidises other forms of transport, such as bus and rail within the country.

### Rail

In the Booz Allen Hamilton (2003) critique of the Irish Rail Network in Autumn 2003 they suggested that CIE required €8.5bn in subsidies over the following 19 years. CIE are hoping this will encourage growth in passenger numbers to 44mn per annum, meaning that on average each passenger would be subsidised by the government by €10.17.

### Bus

State subsidies for busses (Bus Eireann and Dublin Bus) are €275m per annum and passenger numbers are 295m per annum, meaning an average subsidy of 93¢ per passenger (transport.ie; Bus Eireann; Dublin Bus).

Subsidies for trains are eleven times more (per passenger) than for busses. Taking a weighted mean for the two suggests that the government values public transport at €2.13 per passenger. If this were used to calculate congestion charge for motorists, assuming 1.5 people per vehicle[2], a congestion charge of around €3 is what emerges (AA Ireland 2005).

## Conclusion

Having discussed the theoretical case for congestion charges, I have used three different methods of determining shadow prices in order to derive a potential charge for Dublin. Firstly, by investigating other instances of congestion charging I came up with a figure of €7 for entry to the Dublin City road network. Secondly, I used quantitative methods and derived a price of €7.50. Lastly, I discussed other cases where government subvention for transport has implied a gap between average and marginal costs, requiring a shadow price. Subsidies to rail and bus companies suggest that a potential congestion for Dublin could be levied at €3 per vehicle. It must be stated, however, that this method of derivation is largely

[2] www.aaireland.ie

inaccurate and has a provided a result – according to the results of the other two methods – far too low to achieve the goals desired from congestion charging.

The various arguments for and against congestion charging are largely ignored in this essay. Issues such as political will, the redistributional effects of levying a charge, the 'Big Brother' nature of electronic congestion charging, and changes in business revenues are neglected in order to focus on the theoretical and quantitative arguments involved with the level of the charge itself. The fundamental principle remains that by limiting the demand for road space using the price mechanism congestion in Dublin can be reduced. The intricacies of such a system will be discussed elsewhere, but by using comparative examples (€7), forming a quantitative model (€7.50) and by looking at other cases in the Irish economy (€3) I have attempted to determine the correct level of a congestion charge for Dublin.

## Appendix

| City | Population | Price (€) | Price per person (€) |
|---|---|---|---|
| London | 7172091 | 7.25 | $1.01086*10^{-06}$ |
| London (new) | 7172091 | 11.6 | $1.61738*10^{-06}$ |
| Edinburgh | 448624 | 2.9 | $6.46421*10^{-06}$ |
| Durham | 87709 | 2.9 | $3.30639*10^{-05}$ |
| Trondheim | 154351 | 1.81 | $1.17265*10^{-05}$ |
| Singapore | 3263200 | 2.1 | $6.4354*10^{-07}$ |
| San Diego | 1223400 | 1.72 | $1.40592*10^{-06}$ |
| Dublin | 1058264 | | |

The average of the charges imposed by London (£5), Edinburgh, Durham, and San Diego, divided by their respective populations, is multiplied by the population of Dublin. This returns a figure of €11.10. Durham, due to its low population, has a lot of influence on the overall average. Thus, €3.13 is the weighted average of the charges imposed by London (£5), Edinburgh and San Diego .In order to account for the other cities twice as much as Durham, we get the average of the previous two results, which is €7.11 (the mean of €11.10 and 3.13). The charge for Dublin should be amended to the more round figure of €7 for practical payment purposes.

## Bibliography

AA Ireland (2005) <www.aaireland.ie>.

BBC (2005) <www.bbc.co.uk/london/congestion/>.

Booz, Allen & Hamilton (2003) *The Irish Rail Network: a critique*. Dublin: Booz, Allen & Hamilton, Ireland.

Bus Eireann (2005) <www.buseireann.ie/site/news_centre/pressreleasses.asp?action= vieo &news _id=192>.

Button, K. (1993) *Transport Economics*. Aldershot: Hants.

Cole, S. (1998) *Applied Transport Economics*. London: Kogan Page.

Dublin Bus (2005) <www.dublinbus.ie>.

Dublin Transportation Office (2004) *First User Monitoring Report, September* <www.dto.ie>.

Dublin Transportation Office (2001) *The Route to Sustainable Commuting*. <www.dto.ie>.

Foster, K. et al. (2003) "Road Congestion Pricing: theory, analysis and critique – the case for Dublin City." *Student Economic Review,* Vol. 17, pp. 225-244.

Keegan, O. (2004) *Presentation to TCD Transport Economics Students*. 28 January 2004.

Mankiw, N.G. (2000) *Principles of Economics*. London: Harcourt Brace College.

Matas, A. & Raymond J. (2002) *The Demand Elasticity on Tolled Motorways*. Barcelona: University of Barcelona.

Meredith, S. & Jones N. (2001) "Road Pricing - An Economic Analysis." *Student Economic Review*, Vol. 15, pp. 207-227.

Oscar Faber Consultants (1999) *A study of road pricing in Dublin*. Unpublished report available from Oscar Faber offices.

The Economist (2005) "*Fares Please*" The Economist 01/01/2005.

The Economist (2002) *Getting There Faster*. The Economist 31/08/2002.

The Sunday Business Post (2003) *Six Provincial Air Routes may go up for Tender*. The Sunday Business Post 11/05/2003.

Transport.ie (2005) <http://www.transport.ie/viewitem.asp?id= 5551&lang= ENG&loc=1803>.