AN ANALYSIS OF ROAD PRICING AND A STUDY OF ITS FEASIBILITY ON THE M50

BY COLM FAHEY

Senior Sophister

Traffic congestion has become a pressing issue in Dublin over the last few years. The ever-increasing negative externalities call for policy action. Colm Fahey evaluates the case of introducing road pricing on the M50. He uses economic theory of road pricing and illustrative cases of London and Singapore in building up his argument and, after considering congestion externalities, concludes that there is a case for the introduction of road pricing in Dublin.

Introduction

The theory of road pricing has existed for decades. This theory will be discussed and the link between economic theory and the reality of road pricing in Singapore and London will be investigated. Next the literature on road pricing in Dublin is reviewed. Returning to economic theory, the externalities of the M50 are discussed in order to establish if road pricing can internalise them. Next the feasibility of road pricing on the M50 is discussed by examining the capacity of the motorway and its connecting roads.

The Economic Theory of Road Pricing

Traffic congestion is an economic issue with an economic solution, road pricing. Traffic congestion occurs because a market for road space does not exist. Each vehicle on the road creates a negative externality. A negative externality occurs when those who are external to the market are adversely impacted upon. Each vehicle occupies road space and as a result increases the traffic congestion and delays all other motorists on the road. Road space is a scarce resource. At present it is allocated by queuing. The potential for an allocation improvement exists if the pricing mechanism is used to allocate road space. The economic characteristics of roads distinguish them from other public goods. "Road use is rival in consumption and also excludable with adequate costs of the pricing technique. For that reason

road infrastructure…[can be]…a private good with some degree of externalities" (Rolle, 1994).

The current system of road space allocation leads to a market failure as the supply and demand of road space does not equate. There is excess demand for road space. CBA does not recommend indefinitely increasing supply (Barrett, 2003). The ability to solve the problem by increasing supply is limited due to the high level of latent demand for road space. As the supply of road space increases, more of the latent demand for road space becomes actual demand (information provided by Eoghan Madden).

This reduces the effectiveness of increasing supply. The reason for the market failure is that a gap exists between the private cost to the motorist and the cost to society of the motorist's actions. Foster et al explain why this is occurs when road space is allocated by queuing.

> "Assume a road with fixed starting and end points. The impact of an additional driver can be measured by the average cost or the marginal cost. As the number of drivers increases, the amount of road space decreases and travel time will subsequently rise. In other words, the cost of *one additional driver* is an increase in travel time. This is the marginal or social cost. The marginal cost is the cost added to all drivers for one more driver on the road. Therefore, the marginal cost increases as the number of drivers increases. However, the average cost will decrease in the same period. The presence of a road price…on drivers is to increase the average cost and to deter those who value the use of the road as less, thus equating marginal and average cost" (Foster et al, 2003).

Road Pricing in Reality

Singapore

Road pricing has been a reality in Singapore for many years. Motorists are required by law to have an electronic device fitted into their cars. Each time they enter the Central Business District, their journey is recorded on the device through the use of laser. Cards can be slotted into the device, allowing drivers to deposit credit. The fee varies, from $3 to free, depending on congestion in the area 25 (BBC News, 2002). Electronic Road Pricing has worked well in Singapore. After its introduction, there was a reduction of 24,700 cars during peak times. Average traffic speed increased by 22% (Rolle, 1994). However, it has also been observed that as it approaches 7 pm cars queue, patiently waiting for the charge to disappear. This has caused gridlock of 15 minutes on approaches into the Central Business District (BBC News, 2002).

London

In 2003 a road-pricing scheme was introduced in London. A charge of £5 was placed on all cars that enter central London, with the aim of reducing congestion by 15%. The technology used was different to that in Singapore. 230 cameras are positioned at entry points to Central London. These scan the license plates. Any driver who has not paid by the end of the day then receives a fine of £80.

The level of congestion has decreased by 38%. It is expected to have raised £80 million by April 2004. The charge has been so effective, that it has reduced the number of cars entering the city by 50,000 per day (The Evening Standard, 2004). This is a remarkable achievement, considering that before the introduction of the charge, the same number of cars entered central London per hour at peak times (BBC News, 2002). Over half of the motorists who stopped driving into the city centre as a result of the charge, use public transport while approximately a quarter of them are now divert the zone (The Evening Standard, 2004). Simultaneously to the introduction of the charge, bus fares were reduced, bus capacity was increased, bus routes were improved and bus lanes were enforced (BBC News, 2002). 15,000 extra passengers are using buses in the morning rush hour. On average, 110,000 congestion-charge payments are made each day. Over 1.1 million fines have been issued. Worryingly, approximately half of motorists have won appeals against the fines (The Evening Standard, 2004).

The charge penalised cars because they are an inefficient use of road space. The charge benefited buses, which are a more efficient use of road space. Before road pricing, buses were being subsidised for sitting in traffic. The reduction in congestion has increased their productivity. Their load factor has also increased (Barrett, 2003). The charge prevented low utility journeys from being travelled. It appears that 38% of motorists gained less than £5 worth of utility from driving into London city center.[1] The charges have reduced the costs of business, as trucks are not stuck in traffic. It is estimated, that London's economy has benefited by £50 million per annum due to shorter journey times and fewer accidents (Ibid). The majority of motorists in London now agree that eliminating traffic congestion from the city centre is worth £5. Polls show that support for the charge is at 57% and that opposition is at 36% (Ibid).

Dublin?

The success of road pricing in Singapore and London makes us question its feasibility in Ireland. The main obstacle is the lack of enthusiasm amongst policy makers:

[1] In Singapore 24,700 motorists valued their peak time journeys at less than $3.

> "It is important that the Oireachtas Transport Committee relays a clear message…the London experience can never be repeated here…The cost of implementing congestion charges in Dublin would be prohibitively expensive compared to the revenue yielded…The cost would be crippling" (The Sunday Business Post, 2003).

The Oireachtas committee is wrong. It would appear that they only considered the technology used in London. The system used in Singapore would be far most cost effective for Dublin. The Oscar Faber report (1999) also disagrees with the Oireachtas committee: "The technology for such systems exists and implementation is feasible." The report lists a selection of low cost methods to implement a congestion charge. It confirms the potential of road pricing in Dublin. The report recommends that the canal ring around the city centre should be the cordon for a congestion charge. It concludes that a peak charge of €3.81 would cause a trip reduction of 8%. The revenue generated is expected to exceed €50.8 million. It is estimated that bus fares could be halved through the use of this money (Oscar Faber, 1999). This measure would increase the opportunity cost of travelling into the city by car and should result in a further reduction in congestion. Alternatively, the revenue generated could be invested in increasing the road capacity into and out of the city. Another study attempted to bridge the gap between the marginal cost to motorists and the marginal cost to society of a motorist. It recommended a congestion charge of €13.25 (Foster et al, 2003). It is my intention to analyse the feasibility of a price charge to be levied at the interchanges of the M50.

Externalities caused by the M50

Newbury identified accident costs, road damage costs, environmental costs and congestion costs as the four main externalities of motoring (Newbury, 1990). The externalities of motorways are not entirely consistent with the externalities of other road types.

Accident Costs

More traffic on the road increases the probability of traffic accidents (Foster et al, 2003). This is a serious externality in Ireland. A total of 376 people were killed in 346 fatal accidents on Irish roads in 2002. Based on fatalities and injuries sustained the cost of these accidents was €728 million. These figures give credibility to the argument that accident externalities are greater than the sum of all other motoring externalities (Newbury, 1988). However, this is not true for the M50. Motorways have a far higher safety rate. Statistics show that they have at least 65% fewer fatal accidents than ordinary roads (The Sunday Business Post, 2001). None

of the 376 fatalities in Ireland in 2002 took place on the M50. There was only one fatal accident on the M50 in 2001 and this was blamed on inadequate safety features on the motorway (The Irish Independent, 2001). The low level of accident externalities on the M50 must be accepted when it is considered that during the 4-year period previous to the 2001 fatality, over 90 million trips were made on the motorway, but there were only 2 fatal accidents. While the small number of fatal motor accidents on the M50 is tragic, they are insignificant on the overall scale. In years when there have been fatal accidents on the motorway, they account for approximately 0.2% of national fatal accidents. Road pricing would not be the most effective method of reducing accidents on the M50. The installation of median crash barriers for the entire stretch of the motorway would be a more effective method of reduced this externality. This is standard on most European motorways and it would have prevented the fatal collision in 2001 (RTÉ, 2003).

Road Damage Costs

Heavy vehicles cause almost all the damage that is done to the road surface (Newbury, 1988). It can be argued that heavy vehicles cover this externality as they pay a higher level of road tax. However, the local authorities collect road tax, whereas it is the Department of Transport that is responsible for the maintenance of the M50. This justifies the use of road pricing to internalise the road damage costs externality. The level of the charge could be set so that heavy vehicles pay the majority of the cost and cars only pay a fraction of the cost.

Environmental Costs

A third externality is the environmental costs associated with motoring. Motorists damage the environment on both a local and a global scale. As the government will be fined if Irish emission levels are not reduced in accordance with the Kyoto agreement, it is important that a method is found to internalise the externality. While road pricing is an option to internalise these externalities, it is not the most efficient option. A more cost effective method of internalising the externality caused by emissions is to increase the tax on fuel. Noise pollution is also a feature of motoring. Road pricing would be an effective tool in combating this.

Finally, the effect of land use is identified as a negative externality. This refers to the destruction of wildlife habitats and the visual impact on the landscape. In the absence of the M50, it is unlikely that the site would not be developed. Therefore I reject the argument that there is an opportunity cost regarding the destruction of wildlife habitats. Road pricing will have no effect on the landscape. Once the motorway is built the level of traffic on the motorway does not affect the landscape.

Congestion Costs

The final externality that was identified was congestion costs. The M50 has been called 'Europe's largest car park' due to its congestion problems. It is unclear how much traffic congestion costs the economy. In 1999, the Chambers of Commerce of Ireland claimed that traffic congestion costs the economy €12.7 million per working day or €2.54 billion per annum. In 2002, Seamus Brennan claimed that traffic congestion costs Dublin €635 million per annum. The following year, the Dublin Chamber of Commerce estimated that congestion costs the economy €1 billion per annum, and directly costs business €650 million. Despite the disparity of the figures there is consensus that traffic congestion costs the economy hundreds of millions per year and that it the cost is increasing each year. Dublin Bus provides reliable annual statistics to estimate the trend of how much traffic congestion is costing the economy. Their traffic congestion costs soared to €50 million in 2003. This is a 42% increase on 2001 (The Sunday Business Post, 2003). None of the above sources mentioned costs related solely to the M50. The M50 is a unique case for a congestion charge. It is both a cause of and a solution to traffic congestion.

The M50 has positive externalities as it diverts traffic from the congested narrow streets of the city to motorway that can support a higher capacity of traffic. This allows more road space to be used for shorter local journeys within the city. However, the volume of traffic that uses the entire stretch of the M50 is very small. It is estimated that, on average, 30% of the motorway traffic exits at each interchange. If the traffic flow is followed south from the M1 interchange, 30% of it will exit at the first interchange. 30% of the remaining traffic plus the traffic that entered on the first interchange will exit at the second interchange and so on (Information provided by Eoghan Madden). In Dublin, there is a trend that an increasing amount of journeys are only short distances (Keegan, 2004). If this trend is replicated on the M50 an even higher percentage will exit at each interchange. Therefore, the amount of traffic that the M50 prevents from passing through the city centre cannot be compared with the volume of traffic that uses the M50. Only a small fraction of M50 traffic would have passed through the city centre. This positive externality is smaller than it first appeared. The negative externalities are those mentioned in the section on economic theory. They exist due to the gap between the private cost to the motorist of motoring and the cost to society of each motorist. Road pricing is an effective solution to internalise this externality.

The Capacity Dilemma of Motorways

Theory

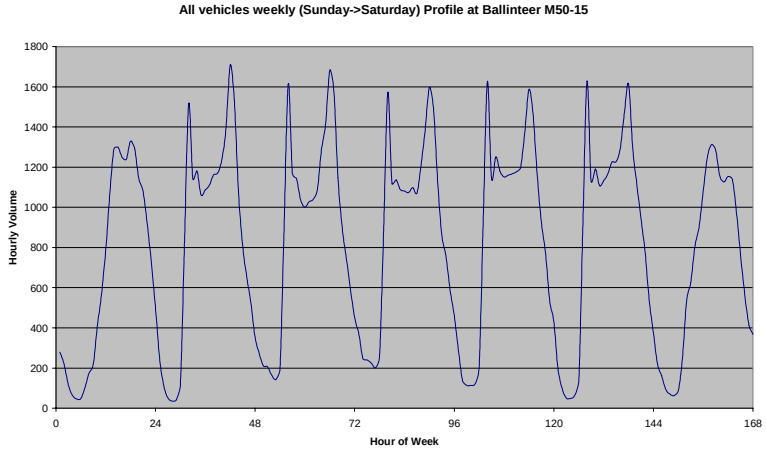
In this discussion of road pricing, I am not attempting to eliminate the gap between the social and private cost of motoring. I am discussing introducing a congestion charge that would ensure that the road network is operating to the maximum capacity possible, without causing traffic congestion. All roads have an optimum capacity of 1800 cars per lane, per hour, regardless of the road type. The optimum capacity is the maximum amount of cars that can safely travel on a road without congestion, assuming free flow conditions. In other words, assuming that there are no impediments such as traffic lights or junctions (Ibid). This is a fair assumption for a motorway. However this assumption cannot be made for the roads that feed into the interchanges. These roads are plagued with junctions, traffic lights and roundabouts. These combine to reduce the capacity of the roads to far below 1800 cars per lane, per hour. Therefore the motorway has a higher capacity than the interchanges. If the motorway is operating to full capacity the result will be congestion at the interchanges because the vehicles will have to queue for space on the local roads. The supply of space on local roads falls as peak hours are approached because local roads have the same peak times as motorways (from local traffic that does not use the motorway). So, at peak times the demand for road space on local roads is at its highest, but the supply of road space on local roads is at its lowest. The result is traffic congestion at the interchanges. If the situation is drastic enough a tailback onto the M50 will occur. This causes an impediment to free flowing traffic on the M50, reducing the optimum capacity of the motorway.

Therefore, a congestion charge that encourages a flow of traffic that ensures that the M50 is operating at its optimum capacity will not solve the traffic congestion problem. A higher charge is needed. This charge must be related to the availability of road space on local roads. This scenario will ensure that the motorway is not running to its optimum capacity. There is a trade-off between maximising the efficient use of the M50 and preventing congestion in areas surrounding the interchanges. This is the dilemma that is faced when trying to introduce road pricing for the M50.

Reality

The National Roads Authority's data confirms this theory.

Graph 1: Southbound to Ballinteer



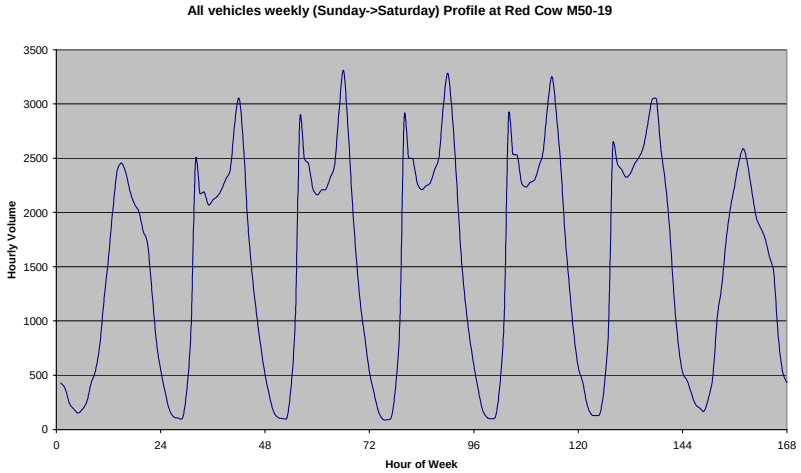
Source: National Roads Authority (NRA), Website 2004

This graph shows that the traffic volume on the final stretch of the M50, towards Ballinteer, never reaches even half of its optimum capacity. This explains why there is not traffic congestion on the motorway as Ballinteer is approached. All of this traffic must pass through the Ballinteer interchange, as this is currently the end of the motorway. Based on my observations, the overwhelming majority of this traffic then takes a one lane road to Dundrum. The capacity of this road is far less than 1800 cars per hour because of the presence of four roundabouts, several junctions, several pedestrian crossings, and traffic lights at the crossroads for Dundrum village and Sandyford. This is why congestion on the local road from Ballinteer to Dundrum is intense during peak times even though the motorway is operating at less than 1800 cars per hour. Unfortunately, Dun Laoghaire-Rathdown county council has not collected data on traffic volumes on this road, but from my observations the demand for local road space by vehicles that do not use the M50 would correlate very closely with the NRA's data.

At the Red Cow segment of the motorway (between the N7 and N4 interchanges) the M50 is not operating at its optimum capacity of 3600 cars per hour in either direction. The traffic congestion surrounding the Red Cow (also known as the 'Mad Cow') interchange has become legendary due to the gap between the

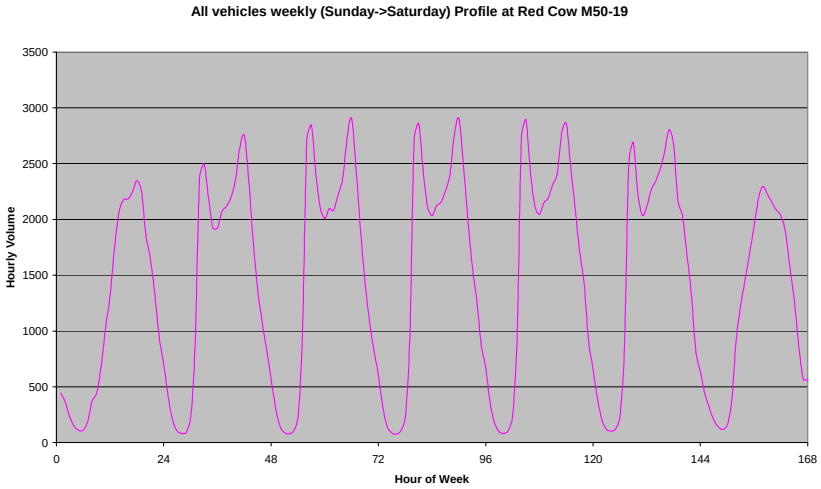
optimum capacity of the motorway and the optimum capacity of the local road network. This can be seen from graphs 2 and 3.

Graph 2: Red Cow Segment: Northbound towards M1



Source: National Roads Authority Website 2004

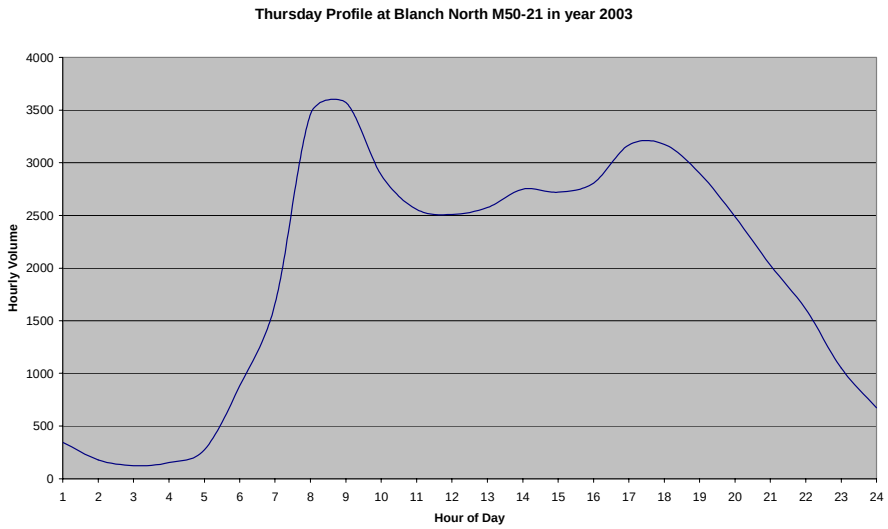
Graph 3: Red Cow Segment: Southbound towards Ballinteer



Source: National Roads Authority Website 2004

According to the NRA's data the only time when any segment of the M50 is operating at its optimum capacity is on Thursday mornings between 7am and 8am on the northbound segment of motorway between the N2 and N3 interchanges, as can be seen from graph 4. I assume that these interchanges are not famous for traffic congestion, because the local road network has a capacity that is high enough to prevent 'mad cow roundabout' style tailbacks.

Graph 4: Segment between N2 and N3 interchanges: Northbound towards M1



Source: The National Roads Authority Website, 2004

Varying Prices Depending on the Availability of Road Space in the Locality of the Interchanges

If the aim of the congestion charge was to prevent the M50 from exceeding its optimum capacity, it is clear that such a congestion charge would be of little benefit to Dublin. It would only be effective on one segment of the motorway for one hour of one day, per week. As the M50 is operating below its optimum capacity, its users are not causing congestion externalities while they are on the motorway. The externalities arise as vehicles queue for road space at the interchange. If road pricing is to become a reality at M50 interchanges, the charge must vary depending on the availability of road space on the local road network surrounding the interchanges. The local authorities must record data regarding the volume of traffic

that use these roads, if such a scheme is to be undertaken. Only those motorists that gain the highest utility from their journeys would travel on the motorway. Road pricing on motorways may cause other problems though.

Substitution Effect of Road Pricing

Motorists do not travel on the M50 for the pleasure of driving on a motorway. They travel on it to get to their destination in the quickest time possible. If the congestion charge is higher than the utility they derive from the time savings of travelling on the motorway, but the utility that they derive from the journey is greater than the extra time costs associated with using local roads to travel to their destination, they will travel to their destination using local roads. Local roads will then have a higher level of congestion. When they approach their destination, they are using up road space in the area surrounding the interchange. This increases the traffic congestion in the area surrounding the motorway interchange, and, as a result, increases tailbacks onto the motorway. This would reduce the effectiveness of a congestion charge. There is evidence from London of the substitution effect of road pricing. Approximately a quarter of motorists who stopped travelling into the centre of London due to the congestion charge are now diverting around the zone (The Evening Standard, 2004). Furthermore, approximately half of the aforementioned motorists are now using public transport (Ibid). While this is to be welcomed, it would not happen if road pricing becomes a reality on the M50 interchanges. Buses are not permitted to travel on the motorway. At present there are no public transport routes connecting the M50 interchange areas. This must be established if M50 interchange road pricing is to be successful. The absence such a public transport system would increase the number of motorists who occupy road space, causing congestion to motorway traffic, but dodge the congestion charge. This questions the viability of road pricing on the M50.

Conclusion

The idea of road pricing is based on sound economic theory. There is a strong match between economic theory and reality in Singapore and London. There would be benefits to Dublin of introducing a cost effective road pricing system in the city centre. Road pricing is not the most effective option of reducing accident externalities on the M50. The only environmental externality where road pricing is the most effective mechanism of internalising the externality on the M50 is noise pollution. Road pricing would also be effective at internalising the externality of road damage costs. Road pricing has potential to improve the congestion externalities caused by the M50. The M50 is not being used over its optimal

capacity. The lack of road space on the local roads that feed into the interchanges is the cause of traffic congestion. Road pricing at the interchanges is a possible solution, but the substitution effect of introducing a congestion charge at the interchanges is likely to be higher than has been observed in Singapore and London. Congestion on the M50 is caused by the shortage of supply of road space on local roads. Therefore, it would be more sensible to charge traffic at their destination. Electronic tolling must be introduced on the M50 toll bridge as a matter of urgency. The cost of such a system is small. A 'smart sticker' can be digitally checked as vehicles speed past the bridge. It costs 64 cent per sticker (Oscar Faber Consultants, 1999). The congestion charge recommended by the Oscar Faber Report would the most beneficial use of road pricing in Dublin. The level of technology used should be no less than an "automated data collection read only tag" and no more than "Electronic road user pricing", the system used in Singapore. When this has achieved an acceptable reduction in congestion, the issue of road pricing in the suburbs should be addressed. This would be effective in reducing demand for local roads, and therefore alleviating the difficulties associated with the M50.

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