IMPACT OF ROAD PRICES ON TRAFFIC: A SYNTHESIS OF INTERNATIONAL EXPERIENCE

R. Maggi
Istituto di ricerche economiche, Università della Svizzera italiana, Svizzera
Rico.maggi@lu.unisi.ch

1. INTRODUCTION

Economists agree on the usefulness of road pricing in general, but on very little beyond this (see e.g. the controversy between marginal cost pricing to alleviate congestion and average tolls to finance infrastructure – see Lindsey 2006). First, they agree that anything offered for free will create an excess demand and hence - in the case of congested roads – prices are usefule. Second, with time varying demand, omnipresent in urban commuter traffic, peak load pricing is common practice elwhere in the economy, and should be introduced in urban traffic (see Vickrey 1963).

Road pricing (RP) in a large sense has along tradition in economic literature and in application. In literature already Adam Smith advocated it and in practice, road tolls date back to the 19th century. It would be too much for a short contribution to overview all this. We therefore concentrate on RP in a narrow sense, i.e. the pricing of (ideally) the marginal cost created by users of a road or a network. The focus is on recent experiences in urban areas where the main goal has been to alleviate congestion. In this limited perspective the number of practical applications is significantly reduced, or, as the ESRC (2005) document puts it: "Aside from the various tolled bridges and motorways which are commonplace in Europe and also found elsewhere in the world, the only really comparable schemes [to London] were in Norway and Singapore". But apart from the traditional motorway tolls there is some interesting new experience of how to use tolls for regulating congestion rather than just for financing road maintenance. We will present two examples for this, i.e. the Sunday evening toll on the A1 motorway north of Paris, France, and the pricing of several value lanes (former HOV lanes) in the US. In what follows, we will introduce a logic for discussing impacts and then discuss these practical applications.

2. IMPACTS?

As the title says, the focus of this presentation is on traffic impacts, not on overall economic impacts in terms of cost and benefit. First attempts to achieve the latter have been undertaken (Morisugi & Ravinder 2006, Prud'homme & Bocajero 2005), however, the period of operation is too short and the urban context, e.g. of London too complex for definitive results.

By impacts we understand in the following phenomena like the reduction of car traffic, increase of public transport, change of traffic distribution among routes and/or lanes and over time of day, attributable to the introduction of a pricing scheme. These changes in traffic distribution are the result of drivers' behavior, i.e. their individual reactions to the introduction of a price for the road service. To give some logic to our discussion of the cases, it seems useful to distinguish the following choice options, known from literature, available for an individual driver:

- Don't react and pay price
- Change route or lane

Introduction RP
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- Change mode
- Change departure time
- Change destination

Aggregate impacts do entirely depend on the reaction of individual drivers, i.e. their price elasticity which depends on the availability of alternatives and the respective user costs. Note, that the distribution of the revenues from pricing in form of improved alternatives or cheaper gasoline (practically irrelevant) has also an impact.

3. CASES

3.1 The Singapore "laboratory" - pro memoria

In 1975 Singapore implemented the world's first application of congestion pricing, widely known as the Area Licence Scheme (ALS), consisting in a 3 S$ per day fee for entering the restricted zone between 7.30 and 9.30 in the morning. The traffic impact was impressive. Commuter traffic shifted to before restricted hours and to after restricted hours while traffic during the restricted hours diminished by 76.2%. From the table below it emerges that the overall restrictive impact was lower (- 45.3%) than the one for private cars and the shift for business vehicles was more specifically towards the later morning off peak hours. This looks like a pure success story. However, as Phang & Toh (2003) note, three new traffic patterns had emerged, namely first, the above shift in time patterns, second, a diversion to escape corridors, and third, evening travel patterns did not change. In terms of congestion this was equivalent to an underutilization of road space during peak hours, a shift of congestion to before and after the peak and no change in the evening peak. But rather than adapting the fee to a lower level, the same year saw an extension of the morning restricted hours to 10.15 and an increase of the fee to 4 S$ (later in 1980 to 5 S$).

Before continuing it seems worthwhile to note, that Singapore car drivers in 1975 did not have a relevant public transport alternative, the main option being busses - also stuck in traffic. The first line of the Mass Rapid Transit system was opened in 1987. In the short run, therefore, the elasticity was extremely high with respect to change of departure time and relevant in terms of change of route.

Table 1 – Departure time shifts in Singapore

	Private Cars		**Total**	
Time	**March 1975 (Before ALS)**	**June 1975 (After ALS)**	**March 1975 (Before ALS)**	**June 1975 (After ALS)**
7.00 am to 7:30 am (Before Restricted Hours)	5’384	6’565 (+21.9%)	9’800	11’576 (+18.1%)
7:30 am to 9:30 am (Restricted Hours)	32’421	7’727 (-76.2%)	55’313	30’272 (-45.3%)
9:30 am to 10:00 am (After restricted hours)	7’059	7479 (+5,9%)	12’775	15’040 (+17.7%)

Source: Phang & Toh (2003), p. 18

In the long run, i.e. over the following decade, road traffic into the city increased, indicating that with increasing wealth a growing number of individuals were willing to buy entrance to the city. Consequently, in 1989 the evening peak - 4.30 to 7.30 pm - was also priced and the fee was reduced to 3 S$, provoking a decrease in traffic to 1975 (after the introduction of the pricing scheme) levels, an increase in average traffic speed reaching 35 kph as compared to 10 kph in New York and 18 kph in London and again a shift to befor pricing hours. In 1994 a whole day Area Licensing scheme from 7.30 am to 6.30 pm with reduced “shoulder prices” immediately before and after these hours was introduced resulting in a smoothing out of peaks. But with increasing complexity (16 different licenses) the paper scheme became too complicated for drivers and too costly for management and control (visual enforcement). As a consequence, in 1998, Singapore introduced an electronic road pricing scheme and continues since with the “fine tuning” of it.

Inspired by the apparent success of the ALS in Singapore, Hong Kong tested an electronic road pricing system (ERP) in 1986. The ERP experiment as a whole was a success but privacy concerns arising from the technology resulted in abandonment of the scheme (Dawson and Catling, 1986).

3.2 Norway: (a short note)

By the end of 2006, 44 toll projects including 6 urban toll rings were in operation in Norway. The main purpose of tolls in Norway is to raise funds for infrastructure, not to regulate traffic (a smart way to supply infrastructure rather than smart demand management) as Fortun & Furuseth (2007) put it. They remark that the strategy to speed up road investments via this mode of financing has been largely successful in the cases of the toll rings in Oslo and Bergen, contributing to reduce congestion and environmental problems and improving public transport. Without entering into detail, the economist remarks, that Norvegian geography and the diameter of the toll rings will most probably make that price elasticity of demand is close to zero and hence impacts are only indirect via new infrastructure. As this is not in the focus of this contribution we will not insist.

3.3 London Congestion Charge

London introduced its widely discussed and presented congestion charging scheme in 2003 in form of an access charge of 5£ (in the meantime 8£) to the inner city between 7 am and 18.30 pm. With its basic strategy to charge car access on the one hand and invest in improved public transport (especially busses), London can be considered a mix of the Singapore and Norway strategies, i.e. reducing road use and using revenues for improving traffic, with the obvious difference that in Norway the money is used for new roads, in London for new busses.

There is widespread agreement that the congestions charge succeeded in reducing congestion, though there is ongoing debate on how much this was. This is certainly due among else to the discussion about the correct reference state (the before 2003 situation or a "without charge trend"). As times goes by, we seem to start seeing something similar to the development in Singapore: with a growing economy, people are adapting and traffic starts rising again, as people will have made some adaptations in their budget allocation and are now willing to pay for a seemingly more performing road network.

But let's look for a moment at the short history of the London Congestion Charge. Transport for London provides a yearly monitoring of the impacts of the charge. One year after introduction, in-bound traffic was down by 14%, outbound traffic by 18% while bus ridership increased by more than 20%. Overall, traffic within the charging zone has dropped by 15%. During peak hours, congestion measured in average flow speed has decreased by 30%, travel times have on average been reduced by 37%. In terms of the above behavioural reaction, it seems that more than half of the commuters have changed to public transport and to soft modes (increase of Taxi ridership by 17% and bikes by 15%). Again as in Singapore a seemingly perfect success story, but this time based on mode change, rather than departure time change (note that the London Congestion Charge is for the whole day). But like in Singapore there is also a relevant price elasticity with respect to route change: 20-30% of traffic participants seem to circumvent the charging area creating additional traffic on the ring road.

The latest monitoring report dating from June 2006 gives a slightly more differentiated picture. Traffic patterns in and around the charging zone remained largely stable during 2005 and overall traffic patterns are close to those of 2003 and 2004. Reductions in congestion inside the charging zone over the whole period since the introduction of the scheme now average 26%. In July 2005 the congestion charge was increased from 5 £ to 8 £ provoking a further reduction of traffic entering the area of an estimated 4% and a relevant increase in revenue. In early 2007, the charging zone has been extended westward.

Indirect traffic impacts on the economy and the environment seem inconclusive. While the figures of the development over the last years are positive, it is for the moment, with the data available and given the short observation period impossible to attribute the wider economic and environmental changes to congestion charging rather than to other, exogenous reasons.

The revenues created were mainly used for improving bus services within London. This overall positive picture from the official monitoring, which is neither necessarily neutral nor does (and can – given the short observation period) apply advanced methods to analyze the impacts, does not go un-contradicted. Prud'homme and Bocajero have found net negative benefits of the scheme due to high cost, but as Raux (2005) has shown this is partly due to very low values of travel time taken from Paris rather than from London statistics.

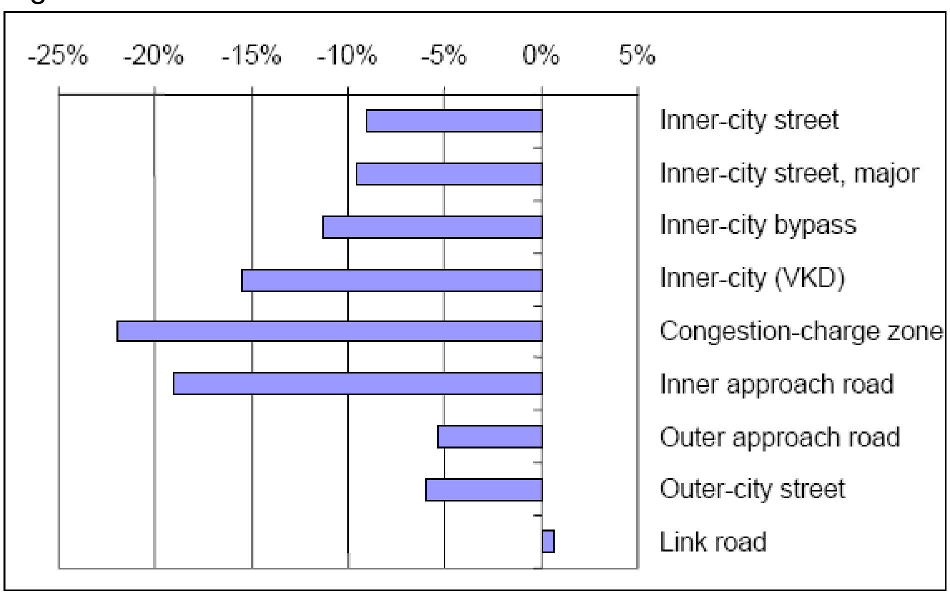
3.4 Stockholm experiment

What holds for London holds even more so for the recent experiment in Stockholm: studies produce somewhat contradictory evidence on impact, particularly on the effect on businesses, as Wolmar puts it in an ESRC Seminar Series paper on a Public Policy Seminar on Road Pricing (2005).

In the framework of an experiment lasting from January to July 2006, Stockholm introduced a toll of to enter the city center between 6.30 am and 6.30 pm. The toll amounted to 10 and 20 SKR depending on the time of the day. As this was an experiment, results on impacts are necessarily short run and to some extent provisional.

Weekday traffic dropped in average by 20% during the trial, while pollution dropped by 9-14%. More specifically the results were as presented in the figure below, drawn from the expert report by the City of Stockholm (2005).

Figure 1 – Distribution of traffic reductions in Stockholm



Source: City of Stockholm 2006, p. 6

The reductions are significantly different across the road network indicating a differentiated behavior with respect to route choice. The traffic on the already congested bypass increased. As regards change of mode, travel by public transport increased by 4.5% due to the introduction of the toll. Interestingly, Stockholm chose to invest heavily in public transport (expanded bus and rail services, park-and-ride facilities) prior to the introduction of the experiment which obviously made mode change a relevant option, but makes the estimation of the toll impact more difficult.

Unlike in the cases of Singapore and London, no mid to long term conclusions can be drawn. In a referendum in fall 2006 the population approved with a majority of 51.7 the congestion toll.

3.5 Paris – A1 Sunday evening toll

In April 1992 a toll is implemented on the A1 motorway entering Paris from North to solve the Sunday evening congestion problem stemming from weekend return trips in general and more specifically from a large leisure park. This time differentiated toll consists in a 25% increase on the normal toll between 4.30 and 8.30 pm on Sunday afternoon (red period) and a 25% discount between 2.30 and 4.30 pm as well as 8.30 to 11.30 pm. (see Delache & Alibert 2003). Other experiments with varying tolls were performed successfully on the Motorways around Paris in the mid nineties, but have later been abandoned.

The effect of this simple pricing was a reduction of traffic during the red period of 4.4% and the traffic peak has been shifted to the time between 9 and 10 pm. Hence, the only relevant reaction in a pure leisure context seems to have been a shift in departure time. Like in the following examples of the US pay lanes, pricing a single lane or road, leads, much like in the textbook to a significant reaction in congestion.

3.6 US pay lanes (HOT lanes):

US reality in many urban agglomerations is given by congested freeways with many lanes, (one of them often reserved to HOV's for many years). The idea behind HOT lanes is value pricing, i.e. value for money in road traffic. In contrast to area pricing schemes or pricing of bridges and tunnels, where the alternatives are to change departure time, change mode or change route, the driver can at any moment decide whether to use the uncongested lane at a variable tariff announced on the roadside. Billing is made electronically. This obviates many of the current critiques to other road pricing schemes because road users of any income class may consider a certain situation (visit to hospital, sleeping late, etc.) as being a good reason for paying some extra dollars. (see e.g. Goodin 2005).

HOT provide drivers who are willing to pay for a faster trip an option to avoid congestion. Typically, HOT lane tolls are set to control the number of vehicles using the lane in order to maintain reliable travel.

The following US roads are among those currently using HOT Lanes (list from Wikipedia):

- Interstate 15, San Diego, California, USA (SOV toll, HOV2+ free)
- 91 Express Lanes, Orange County, California, USA (SOV toll, HOV3+ discount/free off-peak)
- Interstate 10 ("Katy Freeway"), Houston, Texas, USA (HOV2 toll, HOV3+ free, SOV prohibited)

- U.S. Highway 290 ("Northwest Freeway"), Houston, Texas, USA (HOV2 toll, HOV3+ free, SOV prohibited)
- Interstate 394, MnPASS Minneapolis, Minnesota, USA (SOV toll, HOV2+ free)
- Interstate 15, Express Lanes between 600 N in Salt Lake City, Utah and University Parkway in Orem, Utah (SOV toll, HOV2+/clean-fuel free)
- Interstate 25, Express lanes between 20th Street in Downtown Denver and the US-36 interchange (SOV toll, HOV2+ free)

The following roads are being reconfigured for HOT Lanes, which have not yet opened for toll-paying traffic

- Interstate 495 (Capital Beltway), between Springfield, Virginia, and the State Route 193 exit in McLean, Virginia. Officials of the Virginia Department of Transportation signed an agreement with two private companies in April, 2005.

HOT lane pricing is not targeted at reducing traffic but at improving road service to users. Therefore, acceptance is no big issue. Tolls are set to assure that these lanes keep flowing even when regular lanes are congested. They can be built for this purpose or can be converted high occupancy vehicle (HOV) or general-purpose lanes.

The impacts on traffic are a free flow on the HOT lane and slightly reduced congestion on the other lanes.

4. CONCLUSIONS

With respect to our scheme of possible reaction of drivers determining traffic impacts of pricing, the examples discussed here show the following:

- A majority of drivers remains on the road;
- The most important reaction in the case of area licensing is either change to public transport (if good service available) or change of departure time (if not);
- Detour travel is always present with area licensing, but not too relevant;
- With link or lane pricing, the expected reaction in terms of more fluid traffic on the priced facilities and less congestion on the remaining holds for the US lanes, while in the case of a motorway trunk that is priced there may be congestion on parallel network.

Impact assessment is not only relevant on the traffic level as undertaken here. The translation into costs and benefits and their distribution would be of great relevance from an economist's point of view. However, as in practice, road pricing, like many other transport policies and infrastructure investments are mainly introduced in view of their traffic impact and their expected distributional impacts, the chosen perspective may still contribute to the discussion about this tool.

References

1. City of Stockholm (2006): Facts and Results from the Stockholm Trials (http://www.stockholmsforsoket.se/templates/page.aspx?id=183)

2. Dawson H. and I. Catling (1986) Electronic Road Pricing in Hong Kong; *Transportations Research* **20A** (2) 129-134

3. Delache X. and C. Alibert (2003) Toll experiments in French interurban and suburban motorways: case studies (http://www.thepep.org/en/workplan/urban/documents/France.pdf)

4. ESRC (2005) Public Policy Seminar on Road Pricing; ESRC Seminar Series: Mapping the public policy landscape (http://www.esrc.ac.uk/ESRCInfoCentre/Images/road_pricing_seminar_tcm6-7921.pdf)

5. Fortun A. and E. Furuseth (2007) Road Tolling in Norway – a brief introduction. (http://www.environmentaldefense.org/documents/6018_Norway_Cordon_Charging_Jan07.pdf)

6. Goodin G. (2005) Managed Lanes: The Future of Freeway Travel; ITE Journal, February 2005 (http://managed-lanes.tamu.edu/products/articles/JB05BA22.pdf)

7. Lian J.I. (2005) Impact of main road investments in Bergen and Oslo; Paper presented at the 45th ERSA Congress, Amsterdam

8. Lindsay R. (2006): Do Economists Reach A Conclusion on Road Pricing? The Intellectual History of an Idea; *Econ Journal Watch*, **3** (2) 292-379

9. Morisugi H. and K. Ravinder (2006) Quantitative Welfare Analysis of Road Pricing/Toll Pricing – Post Evaluation; (Discussion paper PIARC TC 1.1)

10. Prud'homme & Bocajero (2005): The London congestion charge: A tentative economic appraisal; *Transport Policy* **12** (3) 279-287

11. Raux C. (2005) Comments on "The London congestion charge: A tentative economic appraisal"; *Transport Policy* **12** (4) 368-371

12. Sock-Yong Phang S-Y. and R. S. Toh (2003) Road Congestion Pricing in Singapore: 1975 to 2003; *Transportation Journal*, **43** (2) 16-25

13. Transport for London (2005, 2006): "Impacts Monitoring (www.tfl.gov.uk)

14. Vickrey W.S. (1963) Pricing in Urban and Suburban Transport; *American Economic Review*, **53**, 453-465