WORKSHOP 2

Changing Behaviour in Passenger Transport

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CHANGING BEHAVIOUR IN PASSENGER TRANSPORT
WITH A VIEW TO TACKLE THE CHALLENGE OF CLIMAT CHANGE

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From the many studies and discussions on the theme of this Forum, it is clear that three avenues of exploration consistently emerge. These are: developments in technology, mobility control and changing the modal split. All three involve passenger behaviour, particularly the last two, which will be addressed in this paper. However, the very concept of changing behaviour must itself be approached with some caution.

1. The three oversimplifications to avoid

As a reduction in carbon consumption by the transport system is now a well-established objective, the issue of how to go about producing changes in travel behaviour should not be oversimplified, for instance, by reducing the entire issue of the sustainable city to this one dimension. There are at least three others that can be overlooked and they lead to glaring errors.

1.1 Overlooking complexity

First, one may fail to remember that a trip is only one constituent part of a highly complex system which involves, at one and the same time, the location of activities and housing, a whole gamut of social practices and relations and, of course, transport networks and supply. A measure which, on first analysis, seems to encourage less energy-intensive travel alters a number of components in the system and can end up having an impact contrary to the objective sought.

The first thing to be aware of is that the change in behaviour that decision-makers expect, based on a simple stimulus-response relationship, can often be counter-intuitive. A classic example, to take just the transport sector, is provided by Richard Arnott’s analysis of deterrent measures for illegal parking. In a given urban space, stepping up measures to deter illegal parking is quite naturally regarded as discouraging the use of the private car and one might expect to see some alleviation of congestion as a result. In reality, this kind of measure may actually make congestion worse if motorists are driving around the destination area as long as is needed for them to find a legal parking space.

Over and above just travel behaviour, many other dimensions that have to do with social practice and social relations obviously have to be taken into consideration. In this regard, telecommuting or e-commerce are often cited as practices likely to develop all the faster the more the general costs of travel increase, as a result of urban tolls or a carbon tax, for instance. Yet, it has been quite clearly demonstrated that the substitution of telecommunications for transport has its limits and is part of a broader, fast expanding communications background (Claisse, 1997) and that, in the case of e-commerce, it could actually induce additional trips or even generate free time that could be used for more travel.

Another example that leaves room for doubt is the provision of good public transport services for the main radial arterial routes from city centres to quite distant suburbs. Examples that spring to mind are the regional express network (réseau express régional, RER) in Paris or the tram-trains developed in Germany. These are services with good frequency, running at commercial speeds faster than car transport with reasonable fares and low (or no) use of fossil fuel. The carbon balance should be very positive under these conditions.

Yet, the carbon balance only becomes meaningful over time and, where climate issues are concerned, over a long time. This is where the development of the spatial location system -- and in this particular instance the urban sprawl which inevitably encourages such services -- must be factored in. This is actually « tentacular » sprawl in a population catchment area which is served by good radial public transport, but in which not all travel behaviour is radial. Hence, although a « tentacle » that is well served by public transport can ensure a large share of home-to-work trips, it has to be borne in mind that not all trips are radial and, moreover, that those that are account for only around one-third of motorised trips. It is well established that in zones far from the centre, travel destinations for purposes other than work do not necessarily coincide with efficient public transport supply.

Hence, in all of these urban sprawl catchment areas, it has been observed that a dispersed population has much higher car ownership than in the city centre and that the vast majority of motorised travel is by private car. Actually, such travel is for quite long trips related to the dispersed locations of shops, services and even jobs which are not all located along the same « tentacle ».

One final example is urban road pricing which on first analysis may be assumed to be highly conducive to a switch to low pollution modes of transport. The impact of different cordon and zone-based pricing scenarios with varying charges were calculated for the Lyon urban area using a « strategic model of trips for the Lyon conurbation » (Raux, 2002) in the limited context of a given demand for travel as measured by household travel surveys in the urban area. The relevance of these different road pricing scenarios was evaluated in terms of vehicle-kilometres travelled, trip time, atmospheric emissions and pricing revenues. As a general rule, an across the board improvement in these criteria required the introduction of zone pricing at least, to reduce private car use by drivers resident in the urban area and raise funding for the supply of alternative transport (Raux and Andan, 2002).

However, these findings are valid only in the limited context of the simulation as it was run, that is without any change in the spatial location of housing and jobs (hence in trip origins and destinations) and cannot be extrapolated for any other assumption (we will again make this assumption in section 2.2). This is a restriction imposed by the limits of our knowledge about the interactions between transport and urbanisation.

Since that is the case, one might well wonder, at least from the qualitative standpoint, how these findings would change if such interactions were to be taken into account. Unfortunately, there is no straightforward answer given the multiple potential effects which pull in opposite directions. Some examples of these effects are that: an increase in speed following a decline in traffic in the pricing zone has the opposite effect to raising monetary costs, with the result that the generalised cost of trips by car (a combination of costs in money and time, i.e. the value placed on the time taken to make the trip) may remain stationary or even decrease; in the medium and long term, city residents can change job more easily and go to work in the outskirts and this can have an added impact on the decline in traffic to and in the city centre; conversely, if city traffic « flows » more smoothly, companies may be encouraged to maintain or provide more jobs there. One cannot know with any certainty what the net effect of these many mechanisms will be.

In short, one cannot presume know *a priori* whether this or that road pricing scenario will result in an expansion or a contraction of the city in terms of urban sprawl. That requires the construction of tools to simulate the dynamics of the transport-urbanisation system.

Whether in Arnott's paradoxical example, or in the case of a good public transport corridor or urban road pricing, very clearly the mechanisms behind the behaviours that have to be taken into account are far from simple. To establish a meaningful carbon balance, one would have to be able to calculate it over time and therefore to have robust simulations available. In our last example, not the least complex of its kind, that would entail integrated modelling of transport and spatial location systems. In short, one would have the mechanisms illustrated in Figure 2, below under control (cf. section 2.1). We know that this is a field (*Transport and Land Use Modelling*) in which a great deal of research is going on, but that the very long-term models are still rife with uncertainty as several comparative studies have established (Fuerst & Wegener, 1999; Hunt *et al.*, 2005) and this despite the impressive development of models such as UrbanSim (Waddell *et al.*, 2007).

This report will not address this difficulty and we will proceed on the almost certainly rash assumption that government is capable of properly simulating these interactions or, at least, of foreseeing major trends in social practices, social relations and the spatial location system without going too far wrong.

1.2 Overlooking the socio-economic assessment

Secondly, the negative repercussions of a measure to influence behaviour may be neglected: while a reduction in greenhouse gases may be considered equivalent to wealth generation, the measure which achieves that reduction may require or entail changes in costs, revenues or user surpluses for the transport system. Such changes may mean a loss of wealth which has to be compared with the wealth generated. This comparison is called, quite simply, the economic calculation, as posited by Jules Dupuit In 1844.

Let us take an example from a recent national debate on environmental issues which has been going on in France since the summer of 2007. Quite naturally, transport has been central to that debate from which some rather extraordinary suggestions have emerged. The conclusions suggested constructing some 1 500 km of new segregated tram lines or bus lanes, which would mean a fivefold increase in the number of lines in service today in 10 years time. This would take away an estimated 18 billion passenger - kilometres from private car traffic, but the overall cost was also an estimated EUR 18 billion.

This would mean that the public would be investing EUR 1 for a reduction of approximately 140 g of CO_2 per year. This would amount to investing more than EUR 7 000 for every tonne less of CO_2 emitted. Assuming, optimistically, that the operating costs of these new lines were covered by commercial revenues and taking the value per tonne of CO_2 given in official French estimates, it would take 291 years to make a return on the investment!

If the abatement in CO_2 emissions was the only benefit that could be expected from the operation, it would of course be a foolish investment. In reality, it would make sense only in the broader context of all of the costs and benefits involved, which clearly brings us to an analysis of wealth generated, saved or lost, in other words, to the economic calculation.

A practical illustration will allow us to demonstrate how this calculation can shed light on the issue, but also how it has to be consistent with what behaviours reveal (Baumstark *et al.*, 2007). The calculations were based on an assessment of a section of motorway roughly 100 km long. Although heavily trafficked, the section was far from saturation point. The situation at baseline took the same values as the current speed limits, as indicated in the first column of Table 1. The differences assessed are for a situation in which the only parameter changed is the speed limit (private car and HGV). Let us recall that at speeds of this order, the elasticity of speed with respect to fuel consumption is close to 1. The cost-benefit analysis conducted complies with the official texts in every respect. These are taken directly from the eponymous report produced under the Chairmanship of Marcel Boiteux (Commissariat Général du Plan, 2001).

The « Boiteux Report » specifically defined the value of externalities exactly as mobility behaviour revealed them to be, notably time values, which play a role in the exercise described here, but also reference values determined on the basis of specific appraisals, such as the marginal costs of abatement and policy trade-offs. Based on these texts, the value attributed to a tonne of carbon was estimated at EUR 100 at 2005 rates (and +3 % per year from 2010).

The calculations upon which the following table was based take into account all of the welfare factors that can be linked to speed: those which decline when speed decreases, such as user surplus or *concessionnaire* revenues as well as those which improve, such as road safety and fuel consumption. The last column of the table gives the overall result for the welfare function calculated on the basis of EUR 100 in 2005 per tonne of carbon increasing at 3 % from 2010.

However, the most significant point for our purposes is in the penultimate column. It is the reference values per tonne of carbon which, at the reduction in speed under consideration would balance out the corresponding losses and particularly the loss of user surplus. It is quite clear that, in every case, even with a notional decline in speed, there appears to be net wealth creation only at values a great deal higher than the official value per tonne of carbon. For a significant speed reduction to 110 km/h, the value would have to be over 12 times higher for this measure to be appraised as a making society better off.

Table 1. **What the economic calculation tells us: Lowering speed limits on French motorways**

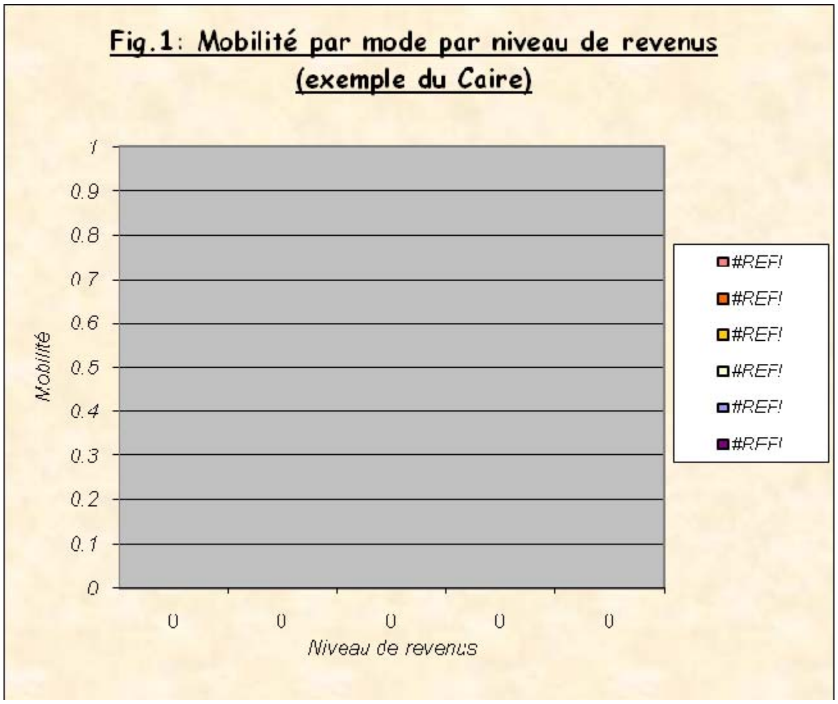
	Lowering speed on motorways by:	Speeds in km/h Car/HGV	Value per tonne of carbon that would offset loss of surplus	Loss in net present value (NPV) with carbon at EUR 100/tonne
Motorway Speed Cars: 130 km/h HGVs: 90 km/h	-1 %	128.7 / 89.1	165	-1 %
	-2 %	127.4 / 88.2	232	-2.1 %
	-5 %	123.5 / 85.5	401	-4.8 %
	-10 %	117 / 81	754	-10.5 %
	-15 %	110.5 / 76.5	1250	-18.5 %
	-20 %	104 / 72	1833	-27.9 %

What we can learn from this exercise is that the economic calculation can lead to unexpected results, which is one more reason why it should be used with caution. The latter example also tells us that behaviour change may well be interpreted as less mobility or a modal switch that goes in the right direction for greenhouse gas emissions. However, there are inflexible components in these behaviours which are subject to resident's system of preferences and reveal those preferences. Our analysis and evaluation tools consider this system of preferences a given, legitimately expressed in observed behaviours, but one also has to determine whether it can be changed by a slowly growing awareness of the environmental issues.

1.3 Overlooking the redistributive dimension

When the question of how to influence mobility behaviour arises, the answer most frequently given is: taxes or road pricing. The question can be put in more specific terms, such as, « should we choose the pricing system that produces the most significant changes in behaviour? ». If the sole objective of transport policy is to reduce CO_2 emissions, then the answer is, of course, yes. It becomes a great deal more complicated if the three aspects of sustainable development are taken into consideration. We have just seen this all through the preceding paragraph on growth-development aspects.

The answer to the question is no simpler when we turn to the redistributive dimension. The goal of changing mobility behaviour itself brings up a well-known redistributive problem, since trip distribution between modes is obviously highly revenue-sensitive. To illustrate this, let us consider the situation in a developing country, where the good point is that there is more of a mixed pattern still than is possible in industrialised countries, as shown in Figure one illustrating the findings of a mobility survey in Cairo.



Source: Systra (Jehanno and Metgé, 2007)

If we are agreed that sustainable mobility policy should direct car users towards less polluting modes, can one overlook that fact travel by private car among users in the two lowest income levels (less than EGP 500) is ten times lower than for users in the higher income level (over EGP 2000)? The simplistic argument that the wealthiest categories are the hardest hit, say by higher taxes on car use, is not useful for addressing a situation such as this. In actual fact, taxes of this sort obviously have an income effect -- in the sense that economists use the term – which has a far greater impact on captive automobile users who are less well off than on wealthier users.

For those users who are not totally captive, the price elasticity of demand is higher for low incomes, if only because of the income effect itself. This means that the use of road pricing, by its very nature has more of an impact on those users who have the least capacity to pay.

2. Strategy coherence and its influence on behaviour

From the foregoing, the point to note is that the transport system must to be analysed in its complexity, that the appraisal of policy initiatives has to take into account all of the socio-economic aspects that our methods are capable of elucidating and that redistribution is obviously a very important aspect among the others.

The first requirement, quite clearly, is never properly met, since one can never capture the system in *all* of its complexity. The trick that economists use is to simplify the representation of what they think they know about the system. They call this a model and, to construct it, they select whatever aspects they consider fundamental. Briefly put, that is what we do with the conceptual framework presented in the following paragraph, which endeavours to represent the factors and levers of the urban system which can influence mobility behaviour.

2.1 The levers of the transport system

If we consider just the main components of the transport system, those that have the most direct influence on mobility behaviour are certainly the speeds offered by competing networks and their relative price and comfort. These factors, in short, add up to a generalised cost that is found in all trip models. They depend, of course, on the five main levers available to public authorities for regulating the transport system, which are:

- financing for public transport and road networks;
- pricing, firstly, of public transport and, secondly, of parking and road use;
- regulation applicable as much to traffic planning and shared infrastructure use as to the highway code or parking regulations.

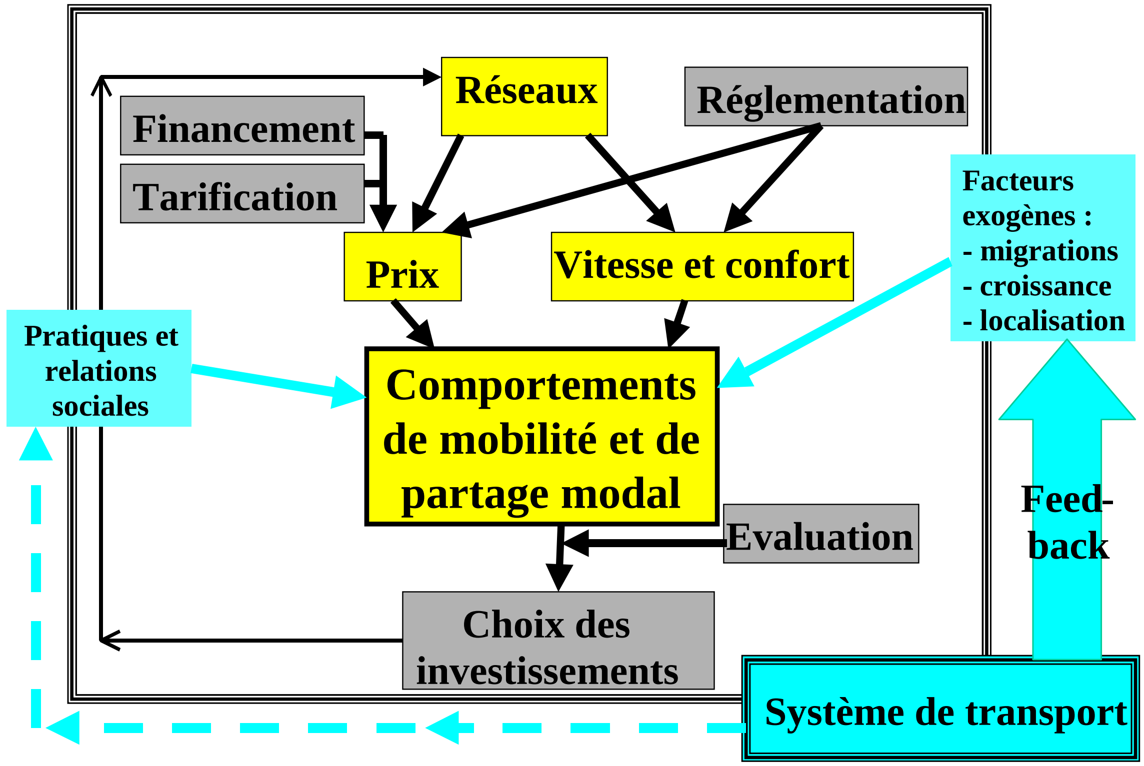
For the levels of mobility and modal split thus determined, government could use two other levers, which are:

- investment choice, obviously dependent on the state of demand, but also likely to influence it;
- appraisal of these investments (or of a particular policy measure) by methods which are not, of course, neutral and can factor in environmental aspects in very different ways (Hayashi and Morisugi, 2000).

The transport system components selected for this simplified representation thus form a closed loop insofar as investment policy will determine how the networks develop.

Of course, the transport system is also dependent on two other sub-systems which shape the city and which we have already mentioned, i.e. the sub-system of social practices and social relations -- which are determining factors in many trip choices, for instance trips to do with the consumption of goods or services -- but also on the spatial location sub-system and, more generally, on exogenous demographic and economic variables.

Figure 2 : Le système de transport et ses cinq commandes



In theory, if one wishes to avoid too serious an omission, one should never model changes in behaviour in transport without also taking into account changes in behaviour in the other two systems, as we said in paragraph 1.1. One should event take into account the fact that the transport system feeds back into the spatial location system (as in *Transport and Land Use Modelling* mentioned above) and into the system of social practices and relations. In Figure 2 this feedback is shown as a dotted arrow in order to indicate clearly that we are far from mastering this type of interaction today.

In the text that follows, feedback mechanisms are not described as we confine ourselves to short and medium term changes in behaviour.

2.2 Changes in behaviour and comparative effectiveness of system levers

In order to illustrate the above by order of the scale of impact of various system levers, we will look at a study (Morellet, 2002), which takes the Paris region as its example. As with all big cities, various avenues that can promote a modal shift to public transport are currently being explored with the twin aims of regulating congestion and reducing transport-related pollution.

The author estimated the impact of different policies on the modal split between private car transport and public transport. These regulation measures are intended either to improve the supply of public transport (*pull measures* in the international jargon of transport policy) or to make car use more expensive or less convenient (*push measures*). Each of them, of course, makes use of one of the levers mentioned above.

The metropolitan area under consideration totalled nearly 11 million inhabitants living in a surface are of 12.000 km² in 1999. Daily travel in the area accounted for approximately 148 million passenger-kilometres (in 1996) of which 52 per cent by private car or motorcycle, 44 per cent by public transport (metro, bus, tramway and regional trains) and 4 per cent on foot or by bicycle. Of the passenger -kilometres by public transport, 82 per cent were by rail (metro and regional trains). Total user expenditure (not including vehicle maintenance and amortisation) amounted to EUR 14 million per day and time spent in transport to 11 million hours per day.

Some significant findings are given in Table 2 for four hypothetical measures, which provide quite broad coverage of the spectrum that transport authorities may be considering. The simulated influence on travel behaviour is translated into total passenger-kilometres (actual demand) by mode. So as to have some elements of economic evaluation for each of the measures for comparison purposes, public transport revenues and the money and time spent by transport users are also given. The calculations are for the socio-economic conditions (population, income, employment) applying in 1996. The measures can be assessed by the size of reduction achieved in the number of vehicle-kilometres travelled by private car.

We are unable to give a comprehensive evaluation, in the sense of the variation in the collective utility function that the economic calculation uses, since we do not have all of the information required for this function: for example, the value of time for users, or the effects of variations in car traffic on environmental values. Nevertheless, the elements we do have give us quite a clear idea of the socio-economic assessment of each measure.

The « PT investment » measure involves influencing the speed of public transport: it would extend the public transport network, cutting network access costs and time by half as well as eliminating connections for half of public transport journeys. The measure would lead to a 5 per cent rise in the demand for public transport and a 3 per cent fall in demand for transport by private car; public transport revenues would increase by 9 per cent, but that would not be (nearly) enough to finance the extension of the network, while the time and money spent by users would be virtually unchanged.

One can observe a surprising inertia in travel behaviour, which has a very negative influence on socio-economic impact: given the substantial investment on network extension that this scenario assumes, the benefits of this policy seem minor compared with its costs. Strictly speaking, the total investment behind this variant should be stipulated so that the exact cost to the public can be calculated. The documentation for a few recent projects suggests that it would amount to several billion Euros in addition to which operating costs would increase substantially.

The « public transport pricing » measure would make public transport cheaper: it assumes a 50 per cent reduction in all urban and regional public transport fares (tickets and season tickets). This measure would lead to an increase of over one-third in passenger-kilometres by public transport, whereas kilometres travelled by private car would decline by only 6 per cent. The resulting mobility increase would benefit mainly public transport users, but at the price of a reduction of nearly one-third in revenues. It would therefore seriously increase the deficit to be financed and increase total time spent in transport by users. The weak influence on modal switch suggests that the energy and environmental assessments for the operation would not necessarily be positive.

The «road pricing » measure for private cars would charge EUR 0.8 per kilometre travelled in central Paris. In London the flat-rate charge was roughly EUR 7.7 per day. This measure would result in a decline in demand for transport by private car similar to the previous measure (-6 per cent) as against a slight increase in demand for public transport (+4 per cent), which would result in an increase of a similar order in public transport revenue (+ 5 per cent). Nevertheless, total user expenditure would rise by 7 per cent, because of the charge, while less congestion would lead to savings in time spent in transport (2 %). It should be noted that an impact of the same order of magnitude would be achieved by increasing the price of all car fuel by 50 per cent, according to another simulation which is not illustrated in Table **Error! Reference source not found.**2. There would therefore be no “explosive” increase in the use of public transport, the effects of urban road pricing would be positive for both the environment and public finances.

Lastly, the « regulation » measure is a lever with an impact on car speed: a one-third reduction in car speed is achieved through regulation and restrictions. It is the measure that has the most pronounced impact on transport by car, achieving a 22 per cent decline in vehicle-kilometres travelled. The decline is not offset by a comparable rise in demand for public transport and the result is a 9 per cent reduction in overall mobility, a 20 per cent fall in transport user expenditure and an increase of 6 per cent in time spent in transport. While the environmental impacts are positive, they are « paid for » by very substantial generalised costs for car users. To puts this in the terms used in the economic calculation, they are paid for by a significant loss in user surplus.

Table 2. **Effects of selected MANAGEMENT measures on travel and model split (Paris metropolitan area)**

Lever used	Measure simulated	Passenger .km PT	Vehicle.km PC	Total passenger. km	PT revenues	Total user costs*	Total time
PT investment	Extension of PT network in suburbs	+ 5 %	- 3 %	+ 1 %	+ 9 %	- 0 %	- 0 %
PT pricing	Lower PT fares by 50 %	+ 34 %	- 6 %	+ 12 %	- 32 %	- 10 %	+ 9 %
PC pricing	Charge of EUR 0.8 /km in Paris	+ 4 %	- 6 %	- 1 %	+ 5 %	+ 7 %	- 2 %
Regulation	Lower PC speed by 33%	+ 6 %	- 22 %	- 9 %	+ 6 %	- 20 %	+ 6 %

* Including PT pricing, charges, fuel and pay parking, excluding car maintenance and repairs.

*Source: Olivier Morellet (*2002, working document for the Commissariat Général du Plan not published*); results rounded by author of this paper.*

As we can see, it is not easy to attract users to public transport and this example confirms that doing so always carries a collective cost. The problem this poses for appraisal is: do the benefits of each of these measures outweigh their costs? Nothing is less certain, if we consider the few elements we have in each case.

True, these are simulations for the Paris region and, as such, may be considered a little atypical. While comparable simulations are a bit different for smaller cities, as we will see below, the good thing about this particular case is that it reflects the great inertia in behaviour and when there is a major upheaval in behaviours -- such as a significant policy measure on speed, for instance – there appears to be a loss of user surplus which may be much higher than reasonable abatement costs, as demonstrated in the example on intercity transport in 2.1 (cf. tableau 1).

This said, the above simulations suggest opportunities for a mix of measures. For instance, the introduction of road pricing (measure 3) which brings in additional revenue of EUR 1.5 million per day would offset the loss of EUR 1.4 million from halving public transport fares (measure 2). There is still the fact that fuel tax and road pricing scenarios come up against the problem of public and political acceptability from motorists and taxpayers, respectively, and of course that acceptability is not unrelated to the redistributive dimension.

2.3 From socio-economic efficiency to acceptability

In this section, we will confine ourselves to the highly illustrative case of urban road pricing. The array of potential consequences can be explored from either of two standpoints: evaluating the efficiency of this type of instrument or evaluating its feasibility and social acceptability.

The efficiency of urban road pricing is again to be understood in the context of evaluating the impact on automobile traffic, the modal split between private cars and other modes of transport, accessibility to employment or urban amenities and on the environment and in the broader context of the economic calculation, i.e. in terms of maximising the collective surplus. Previously, we referred to simulations, but we can also mention very practical cases which can be evaluated on the evidence. This is the case for London, where charging was introduced in March 2003 and data were published by *Transport for London*. This scheme let to controversy, at least for French economists, following the article by Prud'homme and Bocajero (2005) and Raux's response (2005): the results of the evaluation of user surplus (car and bus users) are highly sensitive to slight variations in speeds observed before and after the introduction of the charge; the value of time normally used to evaluate time savings may be underestimated given the specific features of the central zone with its concentration of wealthy residents and highly-paid jobs; failure to place a value on journey times is another factor which encourages underestimation of the surplus; lastly, other ways of regulating and viewing pricing schemes, such as the Norwegian road pricing system, which uses in-car electronic equipment, can reduce collection costs and so increase the net surplus.

Given the foregoing, the collective surplus is estimated by default in the case of London, but it nevertheless shows a clearly positive surplus. Obviously, this concurs with what theory tells us about user charging for congested infrastructure. The effects on air pollution, in particular on CO2 emissions were more limited, taking into account the configuration and narrowness of the levied zone. In general, such effects are more significant as emissions diminish due to the decrease in traffic as well as to improved fluidity.

Thus, over Stockholm's enlarged toll zone, a decrease of nearly 3% in CO2 has been observed, representing 42 000 tonnes per year (Eliasson, 2007). In the case of London, it has been estimated that a westerly extension of the toll area would diminish CO2 emissions from traffic by 12% (Santos & Fraser, 2006).

However, the production of a positive global surplus enhanced by favourable effects on the environment does not automatically imply that charging will be accepted, because a change of this sort is obviously not a Pareto process in which there are only winners.

Although studies by economists demonstrating the benefits of tolls date back to over 150 years ago (Dupuit, 1844), as a tool for regulating the transport system they not always won instant support, far from it. The more so since alongside the signal success of Singapore (1975), the Norwegian cordon systems (the first of which dates from 1986) and the London scheme (2003), one can point to the failures of Hong Kong (in the 1980s), Stockholm -- where the “Dennis Package” as it was known was abandoned in the 1990s -- the semi-failure of the northern ring road in Lyon (1998) and the blunt refusal of the population of Edinburgh in a referendum (2005).

This said, the public acceptability of policies implementing urban road pricing can be analysed *ex post*, as shown by the recent vindication of urban toll supporters in Stockholm where, contrary to expectations (and contrary to the surveys), the renewal of an experimental toll was accepted by referendum; and above all as shown by 15 years of experience of urban tollways in Norway (CERTU *et al.*, 2002). A great deal can be learned from the relative acceptance of road pricing there. One may use the term acceptance even when the percentage opposed remained high over the years: still at 50 to 60 per cent « against » in Oslo 10 years after the introduction of road pricing with only 35 to 45 per cent « against » the scheme in Trondheim, but 25 per cent who « didn’t care ». There are at least five main reasons for this relative support:

- The benefits of road improvement programmes were clear to everyone and particularly to motorists. Although there were no comprehensive socio-economic assessments of the infrastructure, the need for them was felt after years of sharply increasing traffic and little improvement on the road supply side in urban areas. The aim was to provide extra finance, not to reduce traffic, as can be seen from the moderate rates charged and the discounts offered to account holders. Nevertheless, channelling automobile traffic onto the new infrastructure meant that space could be reclaimed and the quality of life reinstated in the city centre, to the detriment of transport by car.

- Revenues from charges were topped up by government funding which would not otherwise have been obtained.

- Those opposed to the development of the road network (mainly environmentalists) welcomed the fact that motorists had to pay to drive in the city and that a share of programme funding went to public transport.

- The political parties agreed not to make the issue a political controversy. For urban pricing, the agreement of the two main parties, conservative and labour, was a key factor in the success of the projects.

- A shared feature of these urban road pricing schemes – and an added acceptability factor – was that they were put in place for a limited period, long enough to complete the measures financed. Bergen, where the pricing scheme was to expire at the end of 2001, decided to prolong it. The Oslo scheme is to end in 2007 and discussions and studies are under way. In contrast, for the Trondheim scheme, which was to end in 2005, the decision was taken to cease to operate the scheme on 1 January 2006 and dismantle the roadside equipment.

What makes road pricing acceptable seems to be a rather complex mix, but it does appear that the arguments advanced and the reasons given are rarely to do with the presumed economic efficiency of the projects concerned and are more often about fairness.

It is common to find that what seems to be economically efficient (the entire basis of the economic calculation) is not necessarily considered fair. Building on the work of Zajac (1995), Raux and Souche (2004) were able to identify at least five principles of positive fairness that could usefully apply to transport charging policies:

1. although public debate does not often mention economic efficiency specifically, certain inefficiencies are perceived as unfair, especially if they perpetuate advantages for certain identifiable groups;

2. in a seminal paper, Kahneman, Knestsch and Thaler (1986) established by empirical methods that an entitlement to the terms of the « reference transaction» exists, i.e. an entitlement deriving from the *status quo*, which makes a public decision rescinding the toll-free use of roads seem particularly unfair;

3. we expect society to protect us from the negative consequences of economic changes over which we have no control; for instance, the introduction of charging for access to city centres may be perceived as fundamentally unfair by people who have borrowed heavily to move to the suburbs and find themselves in an economically difficult situation;

4. we demand a say in public services when they are monopolies, especially when the service they provide is considered an entitlement as is the case, for example, with public transport or roads operated by public authorities;

5. we demand equal treatment with regard to the various dimensions of equity (vertical, horizontal and spatial) which are further explained below.

As the implementation of this type of measure creates winners and losers, the issue of the redistribution of road pricing revenues is central. Goodwin (1989) proposed a rule for allocating revenues from urban tolls to road improvements, public transport supply and the urban environment. He also outlined (1995) the principle of treating environmental improvement and economic efficiency as converging and no longer as contradictory. Small (1992) proposed a strategy for distributing the effects of programmes funded by road pricing revenues; it included interest groups and compensated users who were negatively affected.

Building on the principles set out by Rawls in his theory of justice (1971), Raux and Souche (2004) developed a framework for analysing the acceptability of pricing changes in the transport sector which combines economic efficiency with three dimensions of equity: vertical equity in the sense of attention to the welfare of the most economically underprivileged; horizontal equity by sharing the burden between taxpayers and transport users and between users of different modes; and above all spatial equity with reference to guaranteed access to amenities and the freedom to come and go.

In order to demonstrate its potential, this theoretical approach was applied to the northern ring road in Lyon, France. This, firstly, was a political failure in the first months following the opening of the toll road in 1997. When the road opened, with toll charges perceived as high, motorists were confronted with the closure of an alternative toll-free route, depriving them of freedom of choice. This closure had been decided without any real public discussion: the situation was somewhat similar to congestion charging and was met with fierce social and political opposition. In the end, the toll was partially removed and the toll-free alternative route was reinstated. Using a strategic model, the various dimensions of efficiency and equity underlying this project were analysed and illustrated by quantitative results expressed in terms of variations in surplus. The analysis showed the conjunction of these dimensions, each one reinforcing the negative aspects of the other. The case study demonstrates that the penalty for ignoring the different dimensions of equity is failure.

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Even the concept of behaviour is not easy to analyse. We have attempted to show that preference systems which explain observed behaviour send messages which we have to know how to interpret, whether we wish to define the collective optimum, better secure the acceptability of one measure or another or control its impact.

REFERENCES

Alligier, L.(**2007)**, *Mesurer l'impact du commerce électronique sur la logistique urbaine,* Thèse de l'Université de Lyon, LET.

Andan O., Bonnel P., Raux C. (1988), *Les analyses des comportements de mobilité individuelle quotidienne - Une synthèse bibliographique*, Laboratoire d'Economie des Transports, Lyon.

Baumstark L., Chevasson G., Crozet Y. (2007), Valeurs tutélaires et calcul économique à l'envers, 11th World Conference on Transport Research, Berkeley, June, 25th-29th.

Bonnafous A. (1996), "Le système des transports urbains", *Economie et Statistique*, n° 294-295, pp. 99-108.

Bonnafous A. (2004), *Le choix entre voiture et transport collectif* in « Villes et Economie », Institut des Villes, La documentation française, 2004, pp. 185-206

Bonnafous A. et Masson S. (2003), Evaluation des politiques de transport et équité spatiale, Revue d'Economie Régionale et Urbaine 2003-4, pp 547-572.

Bouf D. et Gargaillo L. (1985), Les modèles QUIN-QUIN, in Villes déplacements et transports : quelles évolutions ? *Transport Urbanisme Planification*, volume 7, Paris.

CERTU, DREIF, IAURIF, LET, (2002), Les Péages urbains en Norvège : Oslo et Trondheim, CERTU, Lyon.

Claisse G., **(1997)**, *L'Abbaye des télémythes: techniques, communication et société*, Aléas.

Commissariat général du Plan. *Transport : choix des investissements et coût des nuisances*, Rapport du groupe présidé par Marcel Boiteux, Documentation Française, 2001.

Dupuit J. (1844), « De la mesure de l'utilité des travaux publics» (On the Measurement of the Utility of Public Works), *Annales des Ponts et Chaussées,* 2ème semestre, n° 116.

Fuerst, F., Wegener, M. (1999), Land-Use Transport Interaction: State of the Art, Berichte aus dem Institut für Raumplanung, 1999 (http://129.3.20.41/eps/urb/papers/0409/0409005.pdf).

Goodwin, P.B. (1989), The «Rule of Three»: a possible solution to political problem of competing objectives for road pricing, *Traffic Engineering and Control*, pp.495-497, Oct.

Hayashi, Y. and Morisugi, H. (2000), International comparison of background concept and methodology of transportation project appraisal, *Transport Policy,* 7-2000, Special Issue.

Hunt J., Kriger D. & Miller E. (2005), Current operational urban land use-transport modelling frameworks: A review, *Transport Reviews*, 25:3, pp. 329-376.

Jehanno A. et Metgé H. (2007) Stratégies de mobilité durable pour les villes en développement, Villes en développement, ISTED, n°78, pp. 5-6.

Kahneman, D., Knestsch, J.L., Thaler, R., (1986), Fairness as a constraint on profit seeking: entitlements in the market, *American Economic Review*, vol. 76, N°4, pp.728-741.

Prud'homme, R., Bocajero, J.P. 2005. The London congestion charge: a tentative economic appraisal. Transport Policy 12 (3)

Raux, C. (2005) Comments on "The London congestion charge: a tentative economic appraisal" (Prud'homme and Bocajero, 2005), *Transport Policy*, 12 (2005) 368-371

Raux, C., Andan, O. (2002) « Comment les péages urbains peuvent-ils satisfaire une politique d'agglomération ? » (How can road tolls serve urban policy?) *Recherche Transports Sécurité* 75 (2002) 115-130.

Raux, C., Souche, S. (2004) The acceptability of urban road pricing: A theoretical analysis applied to experience in Lyon. *Journal of Transport Economics and Policy*. Vol. 38, Part 2, May 2004, pp. 191-216.

Rawls, J., (1971) *A Theory of Justice.* Harvard University Press, 607p.

Small, K.A., (1992), Using the revenues from congestion pricing, *Transportation*, 19, pp.359-381.

Tfl, Transport For London, (2003). Congestion Charging Central London. Impacts Monitoring - First Annual Report, June 2003, 120 p. (see http://www.tfl.gov.uk/tfl/cclondon/cc_monitoring-1st-report.shtml)

Tretvik, T., (2003), Urban Road Pricing in Norway: Public Acceptability and Travel Behaviour, pp. 77 - 92, In: Schade, J., Schlag, B., 2003, *Acceptability of transport Pricing Strategies*, Elsevier.

Waddell, P., Ulfarsson, G. F.,. Franklin, J. P. & Lobb, J., (2007), Incorporating land use in metropolitan transportation planning, *Transportation Research Part A: Policy and Practice*, Volume 41, Issue 5, pp. 382-410

Zajac, E.E., (1995), *Political economy of fairness*, The MIT Press, Cambridge, Mass., 325p.