Dependency on the car: foundations and treatment

Category:	Plenary session
In case of a workshop:	(None)
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At the end of the 1990s, the French Ministry of Transport commissioned an internal forecast of urban mobility up to 2020. Simply by extrapolating past trends they arrived at the following results.

A simulation of the urban transport of people in France up to 2020 (number of passenger-kilometres)

City size	Mode of transport	82-94 growth and 94 market share	Growth 1996-2020	Rate of change 1996-2020
IUPZ[1] of less than 300,000 inh.	PC	+4.7 (88%)	+ 80 to 90%	+2.5 to +2.7%
	PT	-0.1% (9%)	+ 10 to 20%	+0.4 to +0.8%
IUPZ of more than 300,000 inh.	PC	+3.5% (83%)	+ 50 to 60%	+1.7 to +2%
	PT	+0.6% (12%)	+20 to 30%	+0.8 to +1.1%
Ile de France (Paris region)	PC	+3.1% (62%)	+ 40 to 50%	+ 1.4 to +1.7%
	PT	+1.3% (32%)	+ 30 to 40%	+1.1 to +1.4%

Source: *Commissariat général du Plan Groupe de travail*, chaired by A. Bonnafous 1998

A first look at past trends shows that even in an urban zone, the relevance of public transport decreases with the size of the city. The smaller they are, the more the share of travel by car has increased. Moreover, even in large cities, including the Paris region, where the densification of flows makes public transport possible and even necessary, it can be noted that travel by private car increased faster in the period 1982-1994. A simple extension of the trends to 2020 only amplifies this phenomenon, giving it sufficient dimensions to underline the probable unsustainability of the phenomenon. In other words, even if, or rather *because* the development of “auto-mobility” is so entrenched with the vast majority of the population, we have to think about dealing with this condition of dependency. The development of road traffic implies increasing external costs in urbanised regions (pollution, noise, etc) and increasingly unbearable costs of infrastructure for the public budgets.

Faced with this situation, for many years economists have proposed a relatively simple solution in the form of tolls. Without rejecting this idea, it has to be noted that it is only gaining ground very slowly, and in all industrialised countries it seems as if a large silent majority is voting with its feet, or rather its gas pedal, for increased dependency on the car. We can talk of dependency here in the medical sense of the word, insofar it leads to many negative effects, for individuals and for society, with the triangle of pollution, traffic congestion, and increased public expenditure on infrastructure being ubiquitous.

Faced with what can be called an impasse, there is no simple solution. That is why we propose starting by analysing the phenomenon of dependency on the car. We do so within the field of economics and thus essentially by reasoning in terms of comparative costs. Clearly, numerous other scientific disciplines (sociology, psychology, even psychiatry, etc.) could be mobilised to explain the real passion that we all have to a greater or lesser extent for

[1] IUPZ = Industrial and urban population zone, which corresponds to a way of defining a city. PC = Private car. PT = Public transport.

the car. But our objective in this paper is essentially to analyse mobility and not car ownership. We will thus concentrate on the costs of mobility (**1**).

By endeavouring to highlight the rationality rather than the irrationality of the choice of the car, we do of course abandon any idea of vilifying the car. Like anger, hatred is ill-advised, including hatred of the car. But for all that it does not reduce our scope for action. Once we have brought to light the objective factors of dependency on the car, it is possible to consider dealing with the problem with some chance of success **(2)**.

1. Dependency on the car and auto-mobility: the logic of comparative costs

Using mobility to deal with the question of dependency on the car raises some useful points. Mobility, like the use of the car, is rarely an end in itself. Travel is in fact a means of combining three subsystems: a transport system, a location system and an activity programme. Putting these three subsystems together with the most flexible variable, i.e. travel, is at the heart of the satisfaction of these needs. It is what we will remember when we look at the concept of generalised cost (**1.1**), which provides a good understanding of the reasons for dependency on the car (**1.2**) and the origins of the perverse effects it causes (**1.3**).

1.1 Mobility and the generalised cost of travel

From the point of view of an economist, mobility is the result of a simple cost-benefit calculation. Any person who travels compares, albeit implicitly, the benefit of the travel (for leisure, work, shopping, etc) and the cost it represents. Initially we will concentrate on the costs alone, by assuming for the time being that the result of mobility is the same, irrespective of the chosen mode of travel. The choice of mode will depend on the comparative costs of the different modes. What then are the main components of what transport economists call the "generalised cost" of travel? The generalised cost does not include external costs but only those which are directly borne by the travelling person.

The answer is relatively simple. The monetary cost of the travel first has to be considered and then the cost of the time spent travelling has to be added to it. Because a single indicator is needed, a monetary value has to be allocated to time, i.e. a conversion rate has to be defined so that we can add together the monetary cost and the time cost. We then arrive at the first definition.

Generalised cost = Monetary cost + Time cost (evaluated in money)

Of course things become more complicated when these two main costs are broken down into their various subcategories.

- For example, the monetary cost consists of a variable cost that is immediately felt (price of the ticket for public transport, road toll, parking ticket, etc), another variable cost that is felt less directly (cost of fuel and vehicle maintenance), and fixed costs that are often hidden from view (fixed costs linked to the acquisition of a vehicle or the purchase of a season ticket).
- With regard to the time cost, things are no simpler because travel is generally a sequence of stages. The first and last stage are generally on foot, and the intermediate stages, irrespective of the mode of transport, are marked by breaks in transport (i.e. changes of mode) which are associated with waiting time. It turns out that waiting time is considered to be the most burdensome. The value of time thus changes according to the stages of travel.

In total, and contrary to what might be believed, the objective elements forming the generalised cost of travel cannot be easily measured. Only calculation conventions can yield an estimate of the relative weightings that individuals attach, on average, to a particular type of expense or loss of time. It is in fact well known that private car users underestimate the real cost of their vehicle by not including the fixed costs in their daily calculation. In the same scheme of things, the time gained by taking a less congested toll road is often overestimated.

1.2 The comparative generalised costs of different modes

Despite all these imperfections, and at the cost of some simplifications, we can nevertheless use this concept of generalised cost to understand the reasons for increased dependency on the car. To do so we assume that when people choose between two modes of transport, they mainly compare two things: the direct monetary cost on the one hand and the total travel time on the other. As for a given distance, the time decreases with speed, a playoff arises within the generalised cost. If the value of time is rather high for a person, he will accept, or even look for, an increased monetary cost if it provides a reduced time cost, i.e. an increase in the speed of travel. If, moreover, the increase in speed also circumvents changes of mode and other waiting time, it is a good bet that this person will be prepared to bear a marked increase in the monetary cost. All the more so as his purchasing power increases.

The increase in purchasing power of the majority of social categories has been a characteristic feature of economic growth of the last 50 years in industrialised countries. The average value of time has also increased and that has resulted in strong demand for faster travel and connecting modes. It explains, for example, the substitution of the boat by the aeroplane for intercontinental travel, and the success of high-speed trains for long distance trips, on a national or European scale. With regard to the car, this also explains the success of high-quality roads such as motorways, even if tolls have to be paid like in France and southern Europe.

If we apply this reasoning to daily and local mobility, we consider that for a given trip[2], a person faces a choice between several modes of transport. We will select three of them in increasing order of average speed of travel from door-to-door: walking[3], public transport, car. Generally this order also corresponds to increasing average monetary cost, assumed to be zero for walking. Also, when the value of time is zero, walking has a generalised cost of zero, and the car is the most expensive mode. But as soon as the value of time increases, the relative positions of the comparative costs change, as the graph below shows.

Because of its low speed, the cost of travel by foot increases rapidly (with the value of time), while it is not the same for the other modes. The increase in the value of time increases the preference for speed. In relation to these relative speeds, which determine the gradients of the lines, and the distribution of the value of time within the population, three groups appear in our example. For a given trip, the private car is the most attractive for around half of the population as that is the one with the lowest generalised cost. The other half of the population is split between walking (a minority) and public transport (a majority).

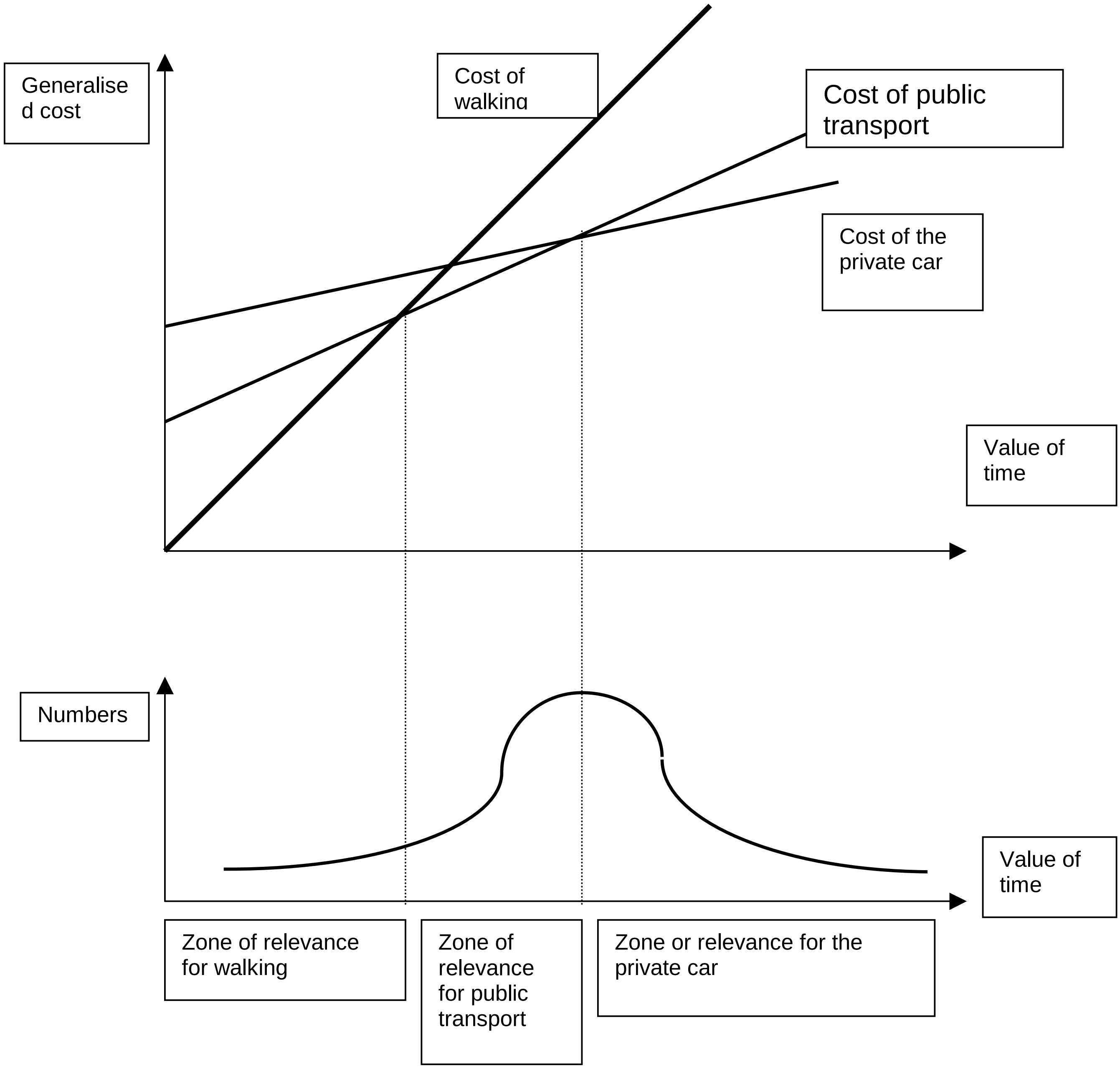
With this reasoning we can thus largely explain the development of relative modal shares for walking, public transport and the private car. The car has only increased its zone of relevance for two main groups of reasons:

- Improvement in the average speed of travel by car. Even if that does not apply to all itineraries and at all times of day, generally the development of road infrastructure has improved the relative speeds of cars.
- The average increase in purchasing power, which results in an increase in the value of time, has also increased the zone of relevance for the car by moving the distribution curve for the value of time of individuals to the right.

[2] Here we assume a trip of a relatively long distance (several kilometres).

[3] In the reasoning below, the bicycle could replace walking.

Graph 1: Relative generalised costs according to the value of time



In view of all these factors, dependency on the car is explained very rationally. With the car, an increasing proportion of the population discovers the benefits of speed, to which a certain comfort can be added which reduces the burden of travel. Auto-mobility thus becomes a basic variable in the organisation of our activity programmes and we are prepared to accept the monetary costs that give access to this guarantee of mobility. We very quickly get used to this situation to the point of becoming prisoners to it, to a greater or lesser extent. That is where dependency on the car starts, a source of many perverse effects.

1.3 The perverse effects of becoming accustomed to auto-mobility

In a first analysis we should applaud this growing penetration of the car in the organisation of our mobility as it is the choice that enables generalised costs to be minimised. This positive assessment could even be reinforced by re-introducing a factor that we left out the first time around when only dealing with the costs: the benefits of travel. It goes without saying that a reduction in the average generalised cost can also open up new opportunities for travel. With lower costs, certain trips become justified, and that is where we come to the question of the sustainability of car mobility. How in fact can we avoid car mobility resulting in an increase in mobility in the form of greater distances, whether for leisure, work, or more importantly the choice of residence?

To illustrate this last point, take the case of commuting between home and work in France[4] for people who work in a different borough to the one they live in. By comparing the 1990 and 1999 censuses, it seems that the total distance covered by inter-borough commuters has gone from 165 to 211 million kilometres per day, i.e. an increase of close to 28% in less than ten years. Part of this increase comes from the increase in the average distance travelled each day (around 7%) but essentially from the number of people travelling (close to 20%). As these are two cumulative trends, it is clear that that is where the main problems of sustainability of daily mobility reside.

Inter-borough commuting in France (1990-1999)

	Total daily distance in thousands of km	Change 99/90	Number of daily commuters in thousands	Change 99/90	Average daily distance in km	Change 99/90
Cites-centres	36,982	+28.0%	1,988	+ 21.8%	18.6	+ 5.0%
Suburbs	68,887	+18.2%	5,939	+10.1%	11.6	+ 7.4%
Total urban centres *Of which urban Paris*	105,869 *35,555*	+ 20.6% *+11.8%*	7,927 *2,914*	+ 12.7% *+ 8.1%*	13.3 *12.2*	+ 8.1% *+ 3.4%*
Outlying suburbs *Of which urban Paris*	52,003 *12,828*	+34.0% *+ 23.8%*	3,133 *539*	+ 29.3% *+ 24.5%*	16.6 *23.8*	+ 3.8% *+ 1.3%*
Multi-centre boroughs	15,382	+39.0%	855	+ 31.3%	18.0	+ 5.9%
Rural zones	39,377	+36.7%	2,128	+ 33.1%	18.5	+ 2.8%
Total outside urban centres	106,762	+35.8%	6,116	+ 30.9%	17.5	+ 3.7%

It should be noted in passing that the distances travelled and the number of commuters are in fact changing in markedly different ways depending on the place of residence. As the above table shows, the changes are highly variable from one zone to the next, generating structural effects.

– A first type of structural effect comes from the fact that residents of urban centres (city centres plus suburbs) on average travel shorter distances than the others. However, the number of inter-borough commuters is increasing much faster in the outlying and rural zones, and the total distance is increasing a lot faster in this second category (+35.8% instead of 20.6% for urban centres), which now represents a slightly greater total distance.

[4] Julien Talbot, *les déplacements domicile-travail, de plus en plus d'actifs travaillent loin de chez eux* (commuting between home and work, increasing numbers of people are working far from where they live), INSEE Première, No. 767, April 2001.

– The same phenomenon is even seen within the urban centres themselves. Rather curiously apparently, the average distance travelled is increasing much faster than the average distance travelled by the residents of city centres or the suburbs taken in isolation. This is explained by the simple fact that the first category, which paradoxically travels longer distances, is increasing faster than the second. It is thus clear that an understanding of urban mobility and car mobility must take these structural phenomena into account.

Thus the current urban forms, more spread out and often multi-centre, involve relatively long distances over extremely varied itineraries. Even when the public transport system works well, it is not enough to absorb the demand for mobility, which can only be satisfied by the car. And the more the share of the car increases, the more it leads households and firms to locate in outlying locations, further accentuating the dependency on the car.

2. Dealing with dependency on the car: three key variables

By focusing on the question of mobility and not on ownership of the car, our analysis of dependency on the car results in a disturbing finding that raises some key questions. The finding is that the increase in the distances travelled is linked to an apparently inexorable increase in mobility. As Y. Zahavi assumes, it seems that when the speeds of travel increase, in particular as a result of the car, individuals do not reduce their travel time, but increase the distances they travel. As the bulk of that is done by car, which involves substantial costs for society (greenhouse gas emissions, infrastructure) the trend is rather unsustainable. If a reorientation is desired, economic logic requires an increase in the monetary cost in the form of tolls or taxes (**2.1**). Without rejecting this type of measure, we would also like to emphasise two other complementary ways of combating dependency on the car: a reduction of speed (**2.2**) and a marked improvement in the speed and comfort of public transport together with the imposition of certain constraints on the car, in particular car pooling (**2.3**).

2.1 Action on the costs of car mobility

Free access to road infrastructure is not devoid of economic foundations. In a first approach, roads can be considered as a collective asset characterised by a certain form of indivisibility of use (non-excludability and non-rivalry) to which are added positive external effects for society in the form of reduced cost of mobility. Thus systematically charging for the road would be expensive to organise (cost of toll collections and control of users) and above all it could lead to a harmful fall in demand. You do not need to look any further to explain the fact that in the majority of countries access to roads is overwhelmingly free of charge. As Jules Dupuit (1804-1866) explained a long time ago, the social utility of the road network, measured here by consumer surplus, is maximised when it is free. The financing for this type of free public asset then has to be through the most general possible forms of taxation (of the VAT or income tax type) in order to guarantee a low amount per capita. The first form of charging for infrastructure is not exactly one of these general forms as it consists of associating free use with taxation[5]. We would like to emphasise this point: recourse to the logic of taxation is not necessarily more anti-economic than a more specific charging system.

In order to justify the substitution of a pricing logic for a tax system, we can turn to Jules Dupuit, also known for having founded the idea of specific charges for transport infrastructure, consisting of taking users' ability to pay into account. When looking at all of the road infrastructure, it is important to distinguish between what has been around for a long time, more or less depreciated, and that which does not yet exist, or which has to be financed even when the users are relatively identifiable. This is so for a bridge or a tunnel, a structure intended to satisfy a specific need and located to improve traffic conditions. Jules Dupuit

[5] For a detailed presentation of the reasoning of Jules Dupuit, see Maurice Allais, *Théorie générale des surplus* (General theory of surpluses), PUG, 1989, pages 159 and onwards.

demonstrates that financing by the user is possible (tolls) and more emunerative if the price takes account of the ability to pay of users, i.e. a certain discrimination is applied[6].

Charging for congestion is a form of discrimination which not only consists of changing the price in relation to the type of user, but also of changing the price over time in relation to the degree of infrastructure congestion. A person who is prepared to pay more to travel better during the rush hour derives greater utility than the one who prefers to pay less and move his travel time to quieter periods. Thus with time differentiation of prices, society gains a dual benefit:

- On one hand it optimises the use of infrastructure by taking account of the differential utility of users. The price signal plays its full role, it indicates relative scarcities and generates a selection between consumers.
- On the other hand it yields financial resources to cover the costs of the infrastructure.

Differentiated charges in relation to the levels of congestion on the roads, in particular in urban zones, may thus contribute to directing demand, by spreading out those who cause congestion and thus degrade the quality of the service, and to directing supply by giving priority to the construction of infrastructure for which such charging ensures costs will be covered. The three objectives that generally set the charging of public services (cover of costs, directing demand, and redistribution) are thus jointly taken into consideration with this type of charging: the reason why it is recommended in the road sector[7]. But its application is far from widespread and it is still presented as an extreme case, just as in a certain way free access is another extreme case insofar there are intermediate forms of charging.

By limiting ourselves to existing forms of direct or indirect charging for the use of the road, we obtain four categories:

- Fixed taxes upon purchase of the vehicle (grey card in France) or necessary for its use (tax disk).
- Variable taxes more or less proportional to the distances covered insofar they are levied on fuel. Even if they are not there for that purpose, taxes on fuel are presented as a way of internalising external costs such as accident prevention, pollution or noise. Internalisation here means that the funds received are used in one way or another to cover the costs of the residual damage of pollution on a national scale.
- Tolls intended to finance new infrastructure, whether a motorway, bridge, tunnel or car park.
- Tolls covering a certain type of use of the road in a specific place and at a given time.

This disparate set also includes fees for parking on the public highway as well as toll zones set up in certain Norwegian cities, and rarer still, congestion tolls[8].

It is important to emphasise that the fourth category is clearly distinguished from the other three as it is not just aimed at covering costs. On the contrary, it relates to a stronger ambition for charging: regulating demand and, perhaps, finding financial resources for other needs of society (for example, public transport[9]). With this done, we will see that there are two ways of considering charging for car mobility.

- One comes within the logic of traffic flow. It is aimed at optimising the use of the network and at developing traffic, including through building new infrastructure.

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6 In a famous example, he proposed those who wear a hat and suit pay more for using a bridge, and those who wear a cap less! The transposition of this identification of ability to pay through appearance would today consist of making cars with large engines pay more, for example.

7 Transport White Paper, European Commission, 2001.

8 There are few examples of this. The most well known has been set up on a Californian highway near San Diego. A toll road whose price increases with traffic has been inserted in the central section of a free highway.

9 In Norway, some of the proceeds from the toll zone set up in the city of Trondheim are paid to public transport. Another proportion is used for financing a tunnel under the port to improve car traffic. The third covers the costs of collection.

- The other, more recent and more attentive to the question of sustainable development, is on the other hand aimed at persuading against the use of the car. The price signal no longer satisfies the desire to impute the costs that users generate to the very same users. Beyond its accounting dimension, the price constitutes an incentive that is not aimed at ensuring the flow of traffic but at rationing traffic, in particular by not constructing new roads.

2.2 The paradoxical effects of action on relative speeds

We can draw an important idea from the preceding comments. Increasing the taxes and tolls paid by car drivers does not necessarily combat dependency on the car. Any charges which in one way or another lead to increasing the relative speed of cars reinforces dependency on the car. What is really required in order to attack this dependency is a marked increase in the generalised costs of travel by car. In order to do that, it is not only necessary to act on the monetary cost, but also on the time cost and thus the speed. That is why in order to curb increasing congestion on urban roads, in particular urban motorways, the practice is increasingly not to increase the size of the road, but to reduce it. The aim of this paradoxical action is to reduce the speed of vehicles and thereby hope for a certain reduction of traffic through a modal shift in the favour of public transport. If we refer to graph No. 1, the envisaged solution consists of increasing the gradient of the line of the generalised cost of private car travel in order to increase the zone of relevance for public transport.

It goes without saying that presented as such, the policy of travel seems somewhat cynical. It is thus clear that several measures have to be combined. A first form of combination consists of not only taking a single measure (reduction of speed <u>or</u> charging of travel) but rather a battery of measures where the reduction of speed <u>and</u> the charging of travel go hand in hand.

This charging - lower speed pair, an unexpected one if we consider the logic of charging for congestion, is not as incongruous as it seems. Within the logic of seeking to stabilise, or even reduce mobility, it becomes legitimate for the two components of the generalised cost of travel to develop in the same direction, towards an increase in the total cost. If such a perspective seems unacceptable from a strictly individual point of view, it makes sense when it is inserted in an urban project and from the point of view of reducing dependency on the car.

One of the particular features of European cities, and their residents, lies in the common desire to avoid the car devouring the city. The car is a considerable consumer of space in an architecture that was not designed for it. At the same time, nobody wants to demolish cities to rebuild them around the car. This seems to be a public choice marked by contradiction.

- On the one hand the large majority of the population wants to keep the traditional image of the city and its multiple roles (commercial, cultural and residential) without giving up access to urban amenities by car.
- On the other hand, an increasing proportion of the population wants, at least for a period of time and at an affordable cost, to benefit from the advantages of good housing and a certain proximity to nature.

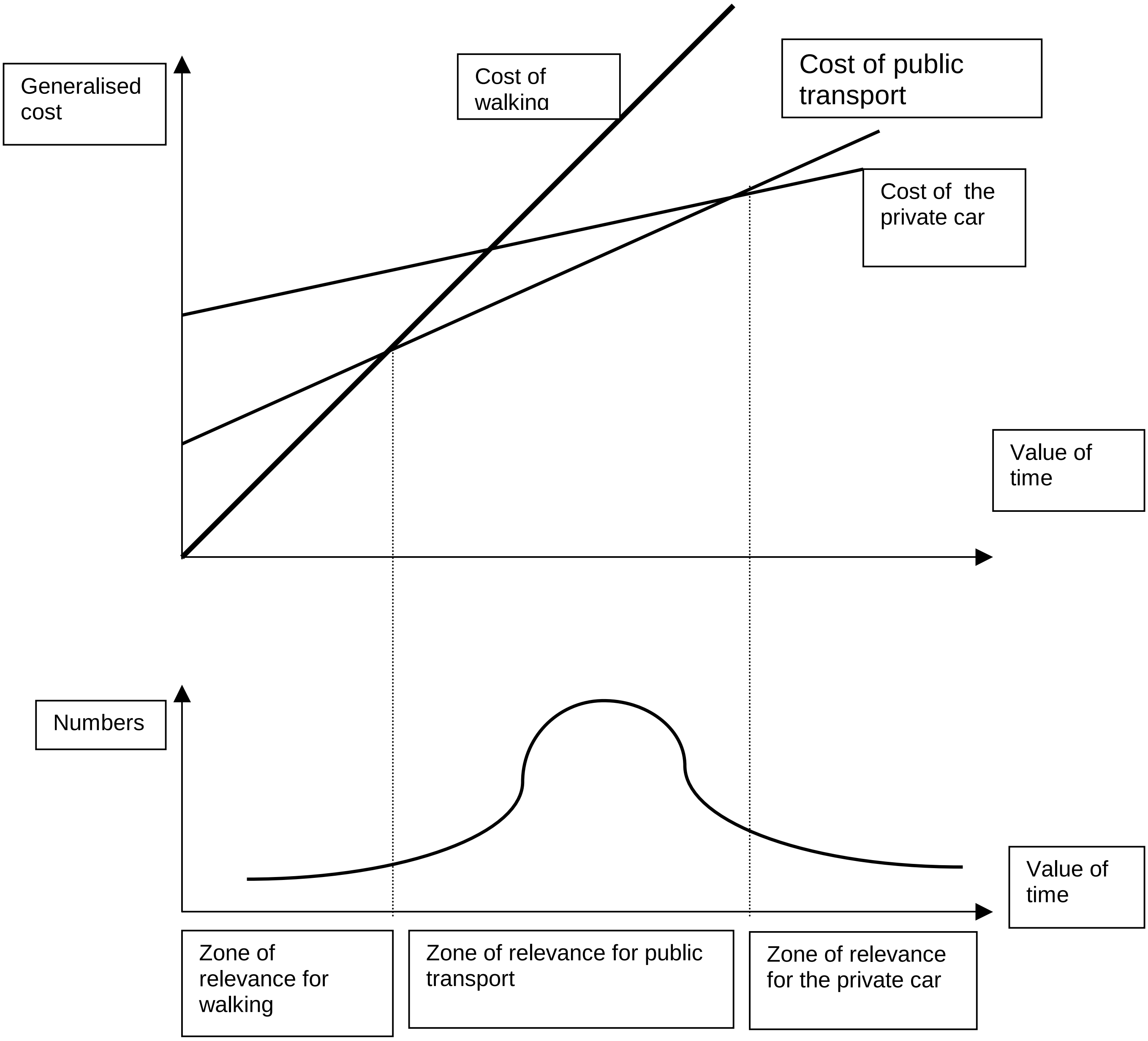
This relatively contradictory requirement cannot be satisfied by confining people to house arrest in high-density urban zones. It cannot be resolved either by simply resorting to very high charges for travel so as to reduce it drastically. Rather it is necessary to engage in a policy of gradual “disaccustomisation” by pulling on several levers at once:

- Charging for car mobility in the form of tolls or tax disks.
- Continued increase of fuel prices.
- Non-development of roads except for certain inter-urban arteries, which means a falling trend in the average speed of cars in urban zones.
- Development of public transport for access to city centres, including intermodal formulae to help feed residents from the periphery to the main arteries.

2.3 Improving the share of public transport and the occupancy rate of private cars

By combining charging of car mobility and reducing speed, in the graph below we see that the zone of relevance for the car is greatly reduced. With respect to graph 1, the origin of the generalised cost line for travel by car is higher up (because of the toll) and its gradient is steeper (because of the reduction of speed). However, being content with such a measure alone risks costing the local politicians dear. That is why it is essential to improve public transport services at the same time (speed and comfort, and also the price) in order to facilitate the modal shift. By playing on all these fronts, it is possible to encourage the majority of people to use public transport, as seen in certain German and Swiss cities.

Graph 2: Acting on the relative generalised costs to change the modal shares



The reasoning outlined above cannot be implemented easily, as generally it increases the travel time for many people and ultimately increases generalised costs. That is why it should not be put into practice clumsily. But by clearly setting this movement in the perspective of sustainable urban development, it is possible to gradually limit dependency on the car for daily travel. That will certainly not reduce the amount of car owners or enthusiasts. It is only about initiating a process for the well reasoned use of the car.

If, for environmental reasons, it is necessary to go faster and further, constraints could be placed on the use of the car in a way to increase the occupancy rate. With car pooling it is possible to convert the cart into a public form of transport. To illustrate the relevance of such measures let us go back to table No. 2. How do we reduce the total distance travelled by cars for daily mobility?

In order to consider a reorientation it is necessary to break down the general figures. Table 2 is based on the following equation:

$$DT = NM \times DM \qquad (1)$$

Where DT = Total distance in thousands of km
NM = Number of commuters in thousands
DM = Average distance in km

We can then further detail equation 1 to show the total distance travelled by private cars (DTpc). In order to do that, we have to take the share of travel by private car into account (%PC) and the rate of vehicle occupancy (VO). We then obtain:

$$DTpc = NM \times DM \times (\%PC/VO) \qquad (2)$$

Then let us crudely apply this relationship to table 2, by considering a private car occupancy rate of 1.2, irrespective of the zone, and a share of private car travel of 90% outside the urban zone and 70% in the urban zone. Then for 1999 we obtain:

– for urban zones, total private car km of 61.5 million kilometres

  i.e. 7,927 x 13.3 x (0.7/1.2)

– for non-urban zones, total kilometres of 80.3 million kilometres

  i.e. 6,116 x 17.5 x (0.9/1.2)

On the basis of these basic data, how do we most easily reduce the total distance travelled by cars? By playing on the modal share of public transport or on the occupancy rate of cars? Let us try to give an answer for the urban zones. Let us suppose that we want to reduce the 61.5 million km driven by private car users by 10%, thereby limiting it to 55.35 million km. By leaving out the two parameters of the number of commuters (7927 in thousands), and the average distance (13.3), there only remains two variables for action: the modal share of private cars (0.7) and the occupancy rate (1.2). If we consider action on one or the other as being exclusive, we end with the following two identities for equation (2)

$$DTpc = NM \times DM \times (\%PC/VO)$$

Becomes

55.35 = 7 927 x 13.3 x (**0.63**/1.2) or 55.35 = 7 927 x 13.3 x (0.7/**1.33**)

The same result can thus be achieved either by reducing the modal share of the private car by 7 points, or by increasing the occupancy rate of vehicles from 1.2 to 1.33 people per car. In both cases, approximately 10% of car users would have to change their habits, but the costs would not be the same, for society who in the first case would have to bear the increased public transport traffic, and for individuals who in the second case would have to agree to share the private fortresses of their cars. It is however clear that the increase in the occupancy rates of vehicles is the least expensive solution for society and for individuals, in money terms. It is necessary to develop strong incentives for car sharing, in particular in companies and public departments. This would in fact yield a marked increase in the "productivity" of travel by car while promoting a different, more public vision of the car, conducive to reducing dependency phenomena. Dealing with this dependency does not just come from acting on comparative generalised costs, it is also necessary gradually to break the close link between car ownership and usage.

Bibliography

ARNOTT R., DE PALMA A., LINDSEY R. [1998], "Recent developments in the bottleneck model" *in* BUTTON K., VERHOEF E. [1998] *Road Pricing, Traffic Congestion and the Environment*, Aldershot: Elgar.

BAUMOL, W.J., OATES, W.E. (1988), *The theory of environmental policy*, Cambridge: Cambridge University Press.

BOUF D., CROZET Y., (1992) in M. Lee-Gosselin and C. Raux, De la paralysie au péage, Actes du colloque J. Cartier

CEC [1998] *Towards Fair and Efficient Pricing in Transport*. Brussels.

COASE R. (1988), *The Firm, the Market and the Law*, Chicago: Chicago University Press.

COASE R.(1960), "The problem of Social Cost", *Journal of Law and Economics*, 3 (1): 1-44.

CROZET Y., MARLOT G.(2001), Péage urbain et ville "soutenable": figures de la tarification et avatars de la raison économique, Cahiers Scientifiques du Transport,

DALES J. "Land, water and ownership", *Canadian Journal of Economics*, Nov 1968, vol.1, p797-804.

ELSE P. [1981] "The theory of optimum congestion taxes", *Journal of transport economics and policy*, vol.15, no. 3.

EVANS A. [1992] "Road congestion pricing: when it is a good policy?", *Journal of transport economics and policy*, vol.26, no. 3.

GIULIANO G. [1992] "An assessment of the political acceptability of congestion pricing", *Transportation,* vol. 19 no. 4.

GUIHERY L., MARLOT G., "La tarification de la congestion: efficacité *versus* équité?", communication au Symposium "Financement de la route", ENPC, November 1998.

HAU T. [1992], "Economic fundamentals of road pricing: a diagrammatic analysis", WPS 1070, Washington DC: The World Bank, pp 1-96.

HAU T. [1998], "Congestion pricing and road investment", *in* BUTTON K., VERHOEF E. [1998] *Road Pricing, Traffic Congestion and the Environment*, Aldershot: Elgar.

HENDERSON J. [1974] "Road congestion: a rconsideration of pricing theory", *Journal of Urban Economics*, 1, pp. 346-365.

HENDERSON J. [1981] "The economics of staggered work hours", *Journal of Urban Economics*, 9, pp. 349-364.

HENDERSON J. [1992] "Peak shifting and cost-benefit miscalculations", *Regional Science and Urban Economics Journal*, 22, pp. 103-121.

HOTELLING, "The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates" *Econometrica*, no. 6 (1938), pp 242-69.

HURIOT J.M. (ed.) [1998], La ville ou la proximité organisée, Editions Anthropos

KNIGHT F. [1924] "Some fallacies in the interpretation of social cost", *Quarterly Journal of Economics*, vol. 38.

KOLM S-C. [1968], *Théorie Générale de l'Encombrement*, Paris: Futuribles.

LAVE C. [1994] "The demand curve under road pricing and the problem of political feasibility", *Transportation Research*, vol. 28A, no. 2.

LYON R.M. [1982] "Auctions and alternatives procedures for allocating pollution rights", *Land Economics*, 1982, vol 58 (1), p 16-32

MASSE P. [1988], "Public Utility Pricing", *New palgrave Dictionnary of Economics*, London: MacMillan.

MONTGOMERY W. [1972] "Markets in licenses and efficient pollution control programs", *Journal of Economic Theory*, vol 5(3), p395-418.

MOHRING H. HARWITZ M. [1962] *Highway Benefits: An analytical framework*, Evanston: Northwestern University Press.

NOWLAN D. [1993] "Optimal pricing of urban trips with budget restrictions and distributional concerns", *Journal of transport economics and policy*, vol.27, no. 3.

PIGOU [1932] 1962, *The Economics of Welfare*, London: Macmillan.

STAVINS R. "Transaction costs and tradeable permits", *Journal of Environmental Economics and Management*, 1995, vol. 29, p 133-148.

VERHOEF E., NIJKAMP P., RIETVELD P. "Tradeable permits: their potential in the regulation of road transport externalities", 1996, working paper Tinbergen Institute, 26 p.
VERHOEF E. [1994] "External effects and social costs of road transport", *Transportation Research*, vol. 28A, no. 4.
VERHOEF E., NIJKAMP P., RIETVELD P. [1995] "Second best regulation of road transport externalities", *Journal of transport economics and policy*, vol.29, no. 2.
VERHOEF E., NIJKAMP P., RIETVELD P. [1996] "Tradeable permits: their potential in the regulation of road transport externalities", working paper Tinbergen Institute, 26 p.
WALTERS A.A. [1988], "Congestion", *New Palgrave Dictionnary of Economics*, London: MacMillan.
WALTERS A.A. [1961], "The theory and measurement of private and social cost of highway congestion", *Econometrica*, Vol. 29 no. 4, pp 676-699.
ZAHAVI Y., (1973), *The TT-relationship: a unified approach to transportation planning*, Traffic engineering and control, pp. 205-212.
ZAHAVI Y., (1974), *Traveltime budgets and mobility in urban areas*, report prepared for the U.S Department of transportation.
ZAHAVI Y. and RYAN J. M., (1980), *Stability of travel components over time*, Transportation Research Record, 750, pp. 19-26.
ZAHAVI Y. and TALVITIE A., (1980), *Regularities in travel time and money expenditures*, Transportation Research Record, 750, pp. 13-19