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European pricing doctrines and the EU reform

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1 Introduction

European Union has launched a pricing reform aiming at achieving a uniformized system of infrastructures charges based on Social Marginal Cost. This reform has encountered some objections and obstacles ; the national systems move slowly, while a variety of doctrines are supported - and remain the bases - for policy decisions in each country. In order to achieve the goal of uniformization, it is necessary to have a clear view of these doctrines, to analyze their discrepancies,-and to examine whether they can be reconciled.

This paper explores these issues. In the second section, the benchmark of the European Union reform, ie the principle of Social Marginal Cost (SMC) is presented along with the framework of the European reform in which it is embedded. The third section is devoted to the presentation and classification of countries standpoints according to the infrastructure charging issue. In the fourth section is presented an assessment of these standpoints in terms of the concerns of the decision-makers, and in terms of economic analysis, comparing SMC with the alternative doctrines. The last section is devoted to the ways through which it is possible to reconcile these doctrines.

~~2~~ The benchmark : the Social Marginal Cost pricing principle

The proposals of the Commission for infrastructure charging reforms have been expressed in many documents, but more extensively in the now well-known Green Paper of 1995 and White Paper of 1998 and, more recently, the 2001 White Paper. The proposals contained in these documents are based on the principle of Social Marginal Cost pricing, which implies that each user of transport infrastructure should pay - at or close to the point of use - the full marginal social cost imposed by that use.

The well-known traditional justification of marginal social cost pricing is that it is "allocatively efficient" in the sense of optimising the allocation of resources and thus maximising the welfare of society as a whole. The argument, founded on well-established principles of economic science, is summarised in the White Paper :

"Where charges are too low, excessive demand is likely, generating higher costs than benefits, and individual operators have less incentive to reduce the costs that they impose on society. Where charges are too high, some users who would be able to pay the costs they impose would be discouraged from using the infrastructure, thereby reducing its social benefit".

This result can be rigorously demonstrated through several theoretical presentations (see for instance LAFFONT 1984) ; these presentations enlight the conditions of validity of this result : as a whole, it is valid in situations which are called "first best" by economists, ie when markets are competitive and when there is no external effect nor fixed costs. When these conditions are not fulfilled, economic theory provides indications on the corrections to apply to the pure and strict SMC principle.

These results are valid for any kind of good, but the adaptation to the case of transport must take into account the fact that the cost of transport does not comprise only the cost for the operator or infrastructure manager, but also the cost incurred to the other members of the

society ; this means that, over and above the marginal operating cost of each trip, each user - in practice: each transport unit (truck, car, bus, train, *et cetera*) - should pay for:

- the marginal cost of infrastructure damages
- the marginal external cost of congestion and scarcity,
- the marginal external cost of pollution,
- the marginal external cost of accidents,

caused by an additional transport unit using the infrastructure.

A first important point to notice is that it is a short run cost :

"Marginal costs are those variable costs that reflect the cost of an additional vehicle or transport unit using the infrastructure. Strictly speaking, they can vary every minute, with different transport users, at different times, in different conditions and in different places" (EC White Paper, 1998)

Another important point is that, in the previous considerations, the cost was the cost of the extra-unit, ie the marginal cost ; it implies that the charges should not include the fixed costs of infrastructure provision, nor any other taxes over and above the applicable rate of VAT. This point may lead to deficits for the infrastructure manager, the revenue from the charges being lower than the expenses. In order to cope with this point, generally recognized as a drawback for the management of infrastructures (this point will be discussed below), the White Paper also accommodated institutional financial constraints by acknowledging the need for departing from SMC - through two part tariff or similar devices- aiming at cost recovery strategies for infrastructure terminals and some new infrastructure.

These principles have lead to a lot of studies aiming at allowing for workable and common methodologies to implement these principles, setting up what concrete pricing instruments are most efficient in different contexts and what the appropriate price levels Furthermore, in order to have the public and political acceptance for the suggested pricing principles, more knowledge on the impacts - costs and benefits - of pricing and the relationship of pricing to financing was required as well.

Research activities under the 4th and 5th Framework Programmes look into most of the above mentioned questions and issues, through programs such as CAPRI, DESIRE, AFFORD, MC-ICAM. UNITE or IMPRINT.

3 The variety of countries standpoints and doctrines.

Vis à vis this benchmark, what are the believes and doctrines currently in use in European countries? The first sub-section (3.1) presents a survey on pricing doctrines in a selection of European countries ; the answers to this survey, achieved in the framework of the unite project,are very scattered. The second sub-section (sub-section 3.2) tries to find out why this is the case and provides a classification of the answers

3.1 A survey of pricing doctrines and behaviours in a selection of European countries

A small survey was made, in the framework of the UNITE project (UNITE D4, 2001), among the partners of the consortium, in order to have an overview of views in a selection of European countries.

Three questions were asked :

- What are the differences between the picture given by the theoretical review and the current teaching at universities about transport infrastructures pricing ?
- What are the current doctrines expressed by the political authorities (Government, Parliament, etc.) on the subject of transport infrastructure pricing?
- What is the real situation of present infrastructure pricing?

The surveyed countries are Austria, France, Germany, Ireland, Spain, Switzerland and United Kingdom. A summary of the answers is presented in Tables 1 to 3

Table 1 : What are the differences between the picture given by the theoretical review and the current teaching at universities about transport?

Country	Answer
Austria	Marginal cost pricing is taught in the context of microeconomics but is not considered as a possible implementation principle. Pricing has been discussed first as a funding generator.
France	Economic theory is taught in the more advanced economics courses in universities; but in other courses (equivalent to MBA) less sophisticated methods are taught; they are based on principles of cost allocation.
Germany	Marginal cost pricing is considered as a theoretically interesting approach but not as an important input for transport pricing in practice. Comments on the White Paper on Infrastructure Charging (CEC, 1998)[1] were very critical from the academic world as well as from representatives of the relevant parts of the public administration.
Ireland	Not known. Transport economics is not widely taught.
Spain	Students generally are shown the main principles of economics theory. But most of transport courses in Spain are more often offered by engineering schools and tend to stress more the technical analysis.
Switzerland	Transport economics is not widely taught. The two national technical universities in Zurich and Lausanne offer courses in transport science, but the approach is rather engineering and planning than economics. In the last years, transport economics has been the subject of two National Research Programmes, which included research on the question of different pricing approaches in transport.
United Kingdom	Advanced theoretical courses cover classical economic theory, but there is still a tendency to teach traditional cost allocation procedures.

[1] Commission of the European Communities (1998) *Fair Payment for Infrastructure Use: A Phased Approach to a Common Transport Infrastructure Charging Framework in the EU*, White Paper, COM (1998) 466 final. European Commission, Brussels.

Table 2 : **What are the current doctrines expressed by the political authorities (Government, Parliament, etc.) on the subject of transport infrastructure pricing?**

Country	Answer
Austria	The priority objective of environmental protection was implemented through regulatory and pricing measures. Nevertheless, pricing measures introduced so far serve first of all for the generation of funds for the general budget and the financing of the transport infrastructure, though a on-going project on road transport infrastructure costs will most probably result in an opening of the discussion about this issue.
France	The doctrine has varied over the years. About twenty years ago, the principle was that freight should pay the marginal cost, and passenger traffic should pay the full cost. More recently, the main stream of ideas shifted towards the use of long run marginal cost principle, based on concerns about the manipulability of short run marginal cost and on (intermodal) equity considerations.
Germany	The current pricing doctrine is dominated by financing issues and not by considerations referring to marginal cost pricing. The discussion on environmental taxation relates more easily to MC pricing.
Ireland	There is no move for pricing of inter-urban road networks (with the exception of tolled bridges, for the purposes of project finance). There is no pressure for road pricing in Dublin, although studies have been commissioned in the past (e.g. with a view to developing finance sources for light rail). For other sectors, there is no political momentum behind changes in charging policy.
Spain	The previous administration launched plans based on publicly financed investments. After 1996, the new government has shifted the balance slightly towards a model of charging infrastructure costs to users.
Switzerland	Recently, it has become clear that short run marginal cost pricing is considered as an interesting economic approach but not as central future guideline. In practical transport policy short run efficiency is not considered as a very important objective of pricing in comparison with financing and environmental objectives. Environmental costs play a role in pricing policy. However, the basic idea of marginal cost pricing is not considered as feasible because of uncertainties in the calculation of marginal costs. Short run marginal cost pricing has become an issue within the context of railway reform (as a baseline for track pricing).
United Kingdom	There is a tradition going back to the 1960s in favour of long run marginal cost pricing, combined with a current strong encouragement towards congestion pricing for both road (delegated to local authorities for urban roads) and rail, which may be taken to indicate a move towards short run marginal costs. There is a minimal interest in charging issues in the ports, aviation or inland waterways sectors.

Table 3 : What is the real situation of present infrastructure pricing?

Au	**Road:** The taxation of fuel is not earmarked. There is a purchase tax and an annual vehicle tax. At the local level, there are parking fees. Passengers cars and light goods vehicles (< 12 t) have to buy a vignette to use the motorways. On 5 roads and several tunnels there are road tolls. In addition to the tolls, heavy goods vehicles >12 t pay an annual road user charge ("STRABA"). Furthermore, an eco point system for transit traffic through Austria exists. A distance-related charge ("Maut") for vehicles >3.5 t is planned by 2002 on motorways and other trunk roads for funding the extension and maintenance of the high-ranking road network, operated by a state owned company. **Rail:** The infrastructure access charge is a tariff based on two variable parameters: train-km and gross-ton-km. It is not based on marginal cost estimates. **Air and Inland Waterways:** The level of the charge is derived from total cost estimates and not from marginal cost considerations.
Fr	**Road:** Road is charged through many devices: fuel taxes, toll motorways, vignettes, parking fees. Though not determined by the same authority, their main motivations are financial and not economic. The outcome is that, roughly, road as a whole covers its charges, but with a lot of discrepancies between categories of traffic. **Rail:** Rail transport is subsidised, the infrastructure charges cover about 25% of the total expenses. Charges approximately follow the Ramsey-Boiteux principle. **Air and sea transport:** They roughly pay their expenses, as they are run by (public) firms and do not receive much subsidy from public authorities.
G	**Road:** The main pricing scheme is the taxation of fuel. An annual vehicle tax is levied by the different states in Germany. At the local level parking fees are levied. Heavy goods vehicles using the German motorways pay for the Eurovignette. Only part of the revenues from the duties on fuel is earmarked for the financing of road infrastructure costs. For the short to medium term the approach is to base the financing of infrastructure more on user and less on budgetary funding. Distance-related user charges should be introduced on motorways for heavy goods vehicles (> 12 t), then extended to other road types. The introduction of road pricing for cars has been rejected. The level of the user charge will be derived from estimates of total and not marginal infrastructure costs. In the short- or medium-term buses and light goods vehicles will have to buy a time-dependent vignette to use the German motorways. For road passengers cars a motorway vignette is in discussion. **Rail:** In 1998 a two-part tariff system of infrastructure access charges was introduced. It shows similarities to a marginal cost pricing scheme subject to a budget constraint. However, the German cartel office rejected this pricing system. A new system will have to be elaborated.
Ir	**Road:** generally uncharged. **Rail:** user tariffs have been determined over time, generally maintaining parity with bus and coach services. Infrastructure cost coverage has not been sought, nor has any specific infrastructure pricing policy been developed.

Table 3(ctd): What is the real situation of present infrastructure pricing?

Sp	**Road:** There are no developed pollution or congestion charges, and vehicles pay for the use of roads through taxes on fuel, annual licenses and other charges. **Rail:** the public railway company is in a process of transformation towards a model of separation, but it is not clear yet what are the plans for the agency that in the future will be in charge of managing infrastructure. **Seaport and Airports:** They are generally self-financed through their revenues, so for those modes users cover for infrastructure costs.
Swi	**Road:** the main pricing instruments are: fuel taxes (whose revenues are partly earmarked for the financing of road infrastructure), annual vehicle taxes (levied at the cantonal level), parking fees (levied at the local level), an annual earmarked vignette on cars for the use of the national motorways. A new Heavy Vehicle Fee will be introduced in 2001 the level of which depends on truck characteristics (weight, emission technology, etc.) and on the need to finance rail investments **Rail**: The charge should not be lower than the marginal cost incurred with the use of a "standard" part of the network. In addition, a contribution margin can be levied to contribute to cost recovery. **Inland waterways:** Relevant are only the charges levied in the Rhine harbours of Basle. They are not based on any marginal cost estimates. **Airports :** Landing charges are oriented at financial considerations and include environmental considerations (the noise emissions of the aircraft).
UK	**Road:** annual vehicle licence duty and fuel tax; there is no explicit link between these and costs although relative environmental damage estimates are used to establish differentials. **Rail:** Infrastructure charges for franchised passenger operators are based on a two-part tariff; the rail regulator has recently allowed Railtrack to increase the variable part of the tariff bringing it more into line with marginal cost, but maintaining revenue neutrality. **Airports and seaports:** there is minimal government involvement in charge setting. There is no regulation of port prices, and ports are generally under private ownership in a competitive marketplace. The Civil Aviation Authority regulates airport charges for major airports, with an emphasis on infrastructure cost recovery rather than the application of economic principles for charging.

It appears from these tables that several other principles are supported by various countries and bodies. They can be classified into two main types :

- The first one, close to the SMC, is the *Long Run Social Marginal Cost* (LRSMC), which, in its general expression, is the sum of the marginal infrastructure cost and of the marginal investment cost (the division of the marginal investment program by the marginal increase of traffic which causes it).
- The second one is the *Average Cost* (AC) ; it is more akin to private accounting procedures : it is a break-down of the expenses between the various categories of traffic through several keys which are more or less linked to the responsibility of each category in the damages and expenses.

3.2 A synthesis of the results of the survey

It is possible to summarize the answers and to classify the various positions which are expressed in the previous tables ; the classification is made according to diffrerent keys for each of the three topics :

- differences about teaching lie between basic courses in economics or engineering and advanced economics courses ; it appears that standard economic theory - ie Social Marginal Cost principle with its validity limits - is taught only in the more advanced economic programs in universities (in many countries, it is considered as mostly theoretical and difficult to apply) ; in other courses, such as engineers courses or MBA in universities, less sophisticated methods are taught, based on cost allocation procedures (this point is probably coming from the fact that, at the beginning, transport economics were developped by engineers).

- differences about current doctrines expressed by political authorities appear between countries :
    - France and the United Kingdom are the most in favour of marginal cost pricing, under the shape of Long Run Marginal Social Cost ; the French standpoint is mainly due to the fear of strategic behaviour by operators (SMC is deemed to induce low charges increasing the traffic and calling for more investments) and to equity considerations (with LRMSC, the users pay for the whole expenses, and not only for the variable expenses) ; in United Kingdom, there is some interest on road pricing.
    - In other countries, doctrines about charging stem mainly from financial considerations about the public general budget and secondly about the transport sector ; this position is expressed in Austria (environment is coped with through regulations ; charges are aimed at raising funds for general and transport budgets) and in Ireland (in this country there is no momentum towards road pricing)
    - In a third category of countries, close to the previous one, doctrines are based on financial considerations, but mainly inside transport sector and secondly inside general budget : in Germany, the charging principle is based on average cost, with an interest on Polluter Payer Principle for environment (aknowledging that environment is mainly dealt with through regulations) ; the standpoint of Switzerland is similar, with the fact that efficiency considerations, which are at the basis of SMC, do not seem to be an important issue ; in Spain there is an emerging interest in infrastructure charging, due to financial concerns and to the idea that users should pay more than presently for the use of infrastructures.

- The main differences concerning the real situation of infrastructure pricing lie between modes : in all countries, the type of charging in the same mode are roughly the same, and the differences between modes are very important ; so the presentation is done by mode, and in each one the (generally small) differences between countries are indicated :

- Road : the most used means of road charging are parking fees annual vehicles taxes, more or less at local level ; fuel taxes (they are partly earmarked in Germany and Switzerland). There is a general tendancy towards mileage related charges, especially in Germany (first for high duty vehicles, than possibly extended to other types of vehicles) and in Austria. There are already vignettes for the access to motorways network in Austria and Germany - in these two countries, the vignettes are limited to high duty vehicles- , and in Switzeland - in this country, vignettes exist for any kind of vehicle. Vignettes and the future mileage-related charges are more or less linked to pollution and can be considered as an application of the Polluter-Payer Principle (PPP). In France and to a lesser extent Spain, the charging system relies heavily on toll motorways, the tolls being settled for financial purposes and not for efficiency purposes. In every coutry they are toll bridges and tunnels, but they are specially important in Austria and Switzeland for Alpine transit.
- Rail. The charging systems for rail are recent ; they date back only to the fragmentation reforms, about 10 years ago and there are large discrepancies between countries, concerning both–the principles and the results. Cost recovery is high in Austria, United Kingdom and Germany, and in the last two countries tariffs are two-parts tariffs with a high fixed part, which will probably be reduced in the near future - in Germany to take into account the protestations of new entrants, in United Kingdom to reflect more precisely the marginal cost ; the recovery will be reduced in United Kingdom, leaving room to some public subsidies . In France the charging system does not cover more than half the expenses and is based on parameters and relations which are similar to those which intervene in SMC. An infrastructure charging system is to be implemented in Spain and Switzerland, and should cover at least the SMC.
- Inland waterways. The charging system is fit to cover the total costs in Austria, Germany and Switzerland ; charges are very low in France and probably do not cover the SMC.
- In Air Transport, as well as in Sea Transport, the general principle is a total cost recovery, coherent with the fact that infrastructure operators of these modes are (often public) firms having to break-even. But the application of this principle can lead to many discussions as, in the majority of countries, these firms benefit from public subsidies, the fairness of which is not always assured.

4 An assessment of the results

These results can be viewed through explanations of the standpoints of decision-makers, and trying to find out the concerns behind them. They can also be analysed through a normative analysis, looking what are the teachings of economic analysis and especially whether the economic analysis has recommandations about the concerns of the decision-makers. Let us successively examine these two points.

4.1 The positive point of view : the concerns of decision-makers and the alternative charging options

Concrete charging systems are the result at a point of time of a stratification of various past decisions, taken by different non-coordinated decision-makers (for instance local authorities fix parking fees and national authorities determine fuel taxes), who are moving over time and are subject to electoral agendas and pressure from lobbies.

In this general framework, from the previous survey and also from the author's experience, it appears that decision-makers find several drawbacks to SMC :

- Politician decision-makers are not much concerned by efficiency ; they derive no benefit from a gain in efficiency, which affect the voters only to a limited extent, but they are very keen on equity, as are the voters. It appears that SMC has many drawbacks on this ground ;
- For instance congestion costs induce a very high charge during peak-hours, when the majority of trip are home-to-work ;
- Acceptability is another important political concern. This notion is close , but not exactly equivallent to equity; it is related to the bargaining power of social groups which struggle against a decision which would hurt them (unfair measures can be accepted if the social groups whichare disavantaged have no bargaining power) ; it turns out that SMC consequences have in general a low acceptability level, as is shown by the unsuccessful proposals of road pricing in several European countries.
- It is often thought that SMC leads to deficits, due to fixed costs and increasing returns to scale ; the deficit has to be funded by tax-payers, though the benefitters from the infrastructure are the users, and this point may be deemed as unfair.
- Furthermore the deficits have to be funded through an increase of taxes, a point which is seen not only as politically harmful, but also as leading to unefficiencies : decision-makers know, as well as economists, that a body which is allowed subsidies is induced to unefficient behaviours and spend relatively more time and efforts in rent-seeking than in cost abating.
- Another point, which is clear not only to the economists but also to decision-makers, is that SMC calculations are difficult and uncertain, and that a lot of expertise and audit is necessary to check their validity. In the real world, decisions are the result of bargains between several pressure groups and stakeholders, who use the uncertainty of the calculations to try to reach their private goals.

These reasons and opinions are expressed by people who have to deal with the problem of transport management. Historically; engineers played an important part and they developed a corpus of ideas inspired by logic, wise spirit and sense of equity. Other categories of people interested in the field are civil servants and experts dealing with the subject, as well as professionals of the transport field, who were inspired by accounting practice. On top of that the last class of people concerned by the subject are the political decision-makers.

Among those people, there is a large consensus on concepts such as *Long Run Marginal Cost* (LRMC), *Development Cost*, *Average Cost* or *Full Cost*. Though they are generally not precisely described, they cover the idea that the users should pay for the expenses they cause to the society.

The Development Cost is a way to have a more precise definition of the idea behind the LRMC. It is the ratio between the discounted sum of the future investments and the discounted sum of the traffic increases that make them necessary.

Other advocated concepts are the concepts of Average Cost or Full Cost. A very wide panoply of calculation procedures have been developed around these concepts. Several options have been discussed about them. The first ones relate to the numerator side. Which expenses have to be distributed across the various categories of traffic: actual transport expenses, the actualised historical construction expenses, or the expenses that would be incurred if it were necessary now to build and operate a modern infrastructure?

Other kinds of considerations relate to the denominator side: how to distribute the cost between the different categories of traffic? An overview of past and current practices learns that two types of solution are often used. The first ones are accounting-type solutions, based on equivalence ratio between traffic categories for the various kinds of cost categories. For instance, pavement thickness is allocated according to the damages caused by axle load (4^{th} power of the axle load according to the AASHTO tests, based on Highway Research Board (1962)). The second ones are based more explicitly on co-operative game theory. The idea is to find an allocation which is in the core of the co-operative game of sharing the cost of the infrastructure, so that no traffic would have interest to leave the coalition to set up its own infrastructure. Procedures such as the weighted average of all possible incremental costs are an example of solutions advocated by the game-theoretic approach (CURIEN and GENSOLLEN, 1992; CASTELLANO-PARDO and GARCIA-DIAZ, 1995). These procedures were the dominant doctrine about 20 to 30 years ago in every country. They have still supporters. For instance, in the USA, cost allocation studies based on these principles are regularly published (see LINK et al. (2000)).

The ideas that support these concepts are manifold and are related to the concerns of decision-makers and to the drawbacks they see in the SMC.

A first reason for advocating concepts such as Development Cost, Average Cost or Full Cost is related to the difficulties of SMC calculations and to the possible manipulations by pressure groups and lobbies. In comparison, concepts such as average cost or development cost (this one avoiding the external costs and especially the congestion costs) seem more simple and less uncertain, and therefore less manipulable. Other considerations are based on efficiency considerations for the operator : SMC do not screen unprofitable services with high fixed costs which are not incorporated in the charge, and the operator can use this fact and the asymmetry of information to manipulate the cost, lowering the marginal cost in order to increase the patronage and gain more subsidies from the public authorities.

Average cost seems to avoid complexity and uncertainty in calculations, and also lack of finance and manipulations on fixed costs and subsidies: if fixed costs are too high, the average cost will be high too. Eventually, because of the increase of the charge, the demand will disappear, causing the closure of services whose fixed cost is too high. It solves also some equity problems in the sense that it ensures that transport costs are paid by the users and not by the taxpayers. The problem is that average cost is arbitrary, as there is no non-arbitrary way of allocating the common costs (the procedures that have been already quoted have no logical justification), except if the allocation of common costs is made according to the Ramsey rule, which is based on SMC.

The problem of manipulation of SMC for rent-seeking behaviours is real and average cost is a way to fight against it. But it is clear from the above presentation that average cost has also a lot of uncertainties, especially for the break-down of total expenses between the categories of traffics.

The LRMC seems also to be easier to calculate than SMC as it does not take into account congestion cost ; furthermore it corresponds more or less to the idea that SMC leaves aside the investments and that it is necessary to take them into account. When saying this, people are not fully aware that LRMC equals SMC in the optimal situation and does not exist in other situations, and that it does not easily take into account changes in quality of service.

The development cost relies on the same reasons. It looks smart and it is attractive because it seems to combine several nice features (the word marginal is avoided, the reference to investment, the relation to the expenses). It avoids the objection not to be defined when the situation is not optimal, but it has no real justification.

In conclusion, it appears that many of the concerns of the decision-makers about SMC are quite valid. But in order to deal with these concerns, they suggest alternative solutions which do not really solve the problems they intend to solve and which have several drawbacks.

4.2 The normative point of view : an assessment by the economists

Economists have other views on SMC charging, someof them rejoining the concerns of the decision-makers. They relate to efficiency, equity and information and institutional issues.

4.2.1 Efficiency considerations

The virtues of smc on the grounds of efficiency are well established in a "perfect" world. But real world differs from this perfect world. Let us first recall the case of a "perfecr" world, then analyze the maindepartures from this case.

4.2.1.1 First best situation

The efficiency of SMC is rigourously demonstrated in the first best situations,ie in a perfect world where markets are competitive (firms act as price-takers), there is no public good (then no tax), no externalities (except, in transport, the congestion externality), cost functions show no increasing return to scale and there is no information problem.

In that case, the result is that the optimal charge p is :
$p=MEC+MECC$

Where :
p is the optimal charge
MEC is the marginal cost of the infrastructure operator

MECC is the marginal congestion cost (due to the increase of time caused by an extra-user to the other users)[2]
It is clear that *p* is the translation to the case of transport of the general SMC principle.

Furthermore, when the infrastructure cost function exhibits constant returns to scale, the revenue from optimal charges just equals the expenses.

The real world departs from this paradigm on two points : first, it is not possible to implement the diversified charges recommended by the theory ; second, the hypotheses of the first best solution are not fulfilled. Let us explore these points.

4.2.1.2 Practical considerations about the implementation of SMC

SMC is dramatically changing over time and location, a fact which entails several problems :

- concrete translations scheme requires first an adequate delineation of time frames. Sets of definitions (concerning ultra short run, short run, medium run and long run) may differ for different kinds of infrastructure. There is also a problem of adequate delineation of space frame.

- if such variable charging system were implemented, should users be able to respond to so subtle incentives, implemented in complicated charges? It appears that in many sectors, price differenciation is widely used by private firms, but not to such an extent as SMC requires. In air transport, deregulation has induced a lot of differenciation, but after a few years, differenciation decreased. Differentiation may be better accepted in wholesale markets where transaction cost of finding and agreeing on a satisfying contract are no deterrent given the large volume of the sales.
- In general, we have not the proper instruments to charge the right SMC ; for instance the pollution cost varies according to the maintenance of the car, and is higher during the first km of the trip.There is no practical tool to replicate such a sophisticated charging framework, though in the next future, telematics may procure the proper devices for that.
- As a consequence of the two previous points it is necessary to average the charges, for instance to set up a unique congestion charge for the whole day ; this congestion charge is then an average between very low cost for off-peak periods and very high costs for peak periods, and in bothperiod there is a loss of efficiency. Is not this loss too important to make useless the implementation of SMC?

4.2.1.3 Cost of public funds

It is often thought that infrastructure cost functions have increasing returns to scale, and consequently SMC leads to deficit which must be funded by taxes.

First, this belief can be challenged : due to external costs - and specially congestion costs - there are many cases were smc revenues would be higher than costs. For instance a recent

[2] As regards the value of time only the travel time is introduced. The influence of *rescheduling* is however important as well, and should be taken into consideration in more elaborate models.

study made for France, Germany and the UK (REVENUE, 2000) has shown that deficits appears in rail and intercity road transport, but they are superseeded by excedents in urban road transport.
Let us nevertheless consider the case of increasing return to scale and deficits which have to be funded by taxes.

The first best situation assumes that taxes are optimal, or equivalently that public funds can be raised without loss of efficiency. In the real world, it is not the case : optimal (ie : lump-sum) taxes do not exist, and real taxes entails losses of efficiency (for instance taxes on labour generally induce a lower employment rate…). Let us drop this assumption and consider that public funds are raised through taxes which are imperfect, i.e. lead to a departure from the optimum.

Then the welfare cost of raising a tax revenue of one is equal to :

$$(1+l)$$

in term of private income.
In that case, it can be shown that the optimal charge is :

$$p=[(MECC+MC)/(1+l)]-[(l/(1+l)*(q/e_{qq})]$$

Where :
q and p are vectors, the components of which are : q_i, p_i
q is the traffic flow
e_{qq} is the direct elasticity of traffic to price

This charge has two roles :
- to correct for congestion. This role is fulfilled by the first term
- to raise revenue ; this role is fulfilled by the second term.
-

It is clear that the charge is higher than SMC, the charge being increased in order to lower the negative effect of the tax.

4.2.1.4 Budget constraint of the transport producer

This situation is very close to the previous, and happens when, in order to avoid the drawbacks of deficits, a constraint is imposed on the infrastructure manager : it has to balance expenses and revenues ; this situation has been extensively studied (for instance RAMSEY 1927 and BOITEUX 1956). The hypothesis is that the transport producer is a public monopoly which has both to achieve the maximization of social welfare and to break even.

The government no more intervenes; his optimization task is taken by the transport producer. In that case, it can be shown that, under commonly made assumptions (which can be enlarged to the price of a more complicated result), the optimal charge is :

$$p=MC+[MECC/(1+l)]-[m/(1+m)][q/(1+e_{qq})]$$

where m is the multiplier associated to the budget constraint and q and p have the same meaning as in the previous case .

The formula is just a bit different from the previous one : the higher the budget constraint, the lower the influence of the MECC on charging. In that case too, the charge is higher than SMC, the mark-up being higher for unelastic traffic.

4.2.1.5 Externalities

Coming back to the model with cost of public fund, we now complicate this model a step further by introducing externalities of an environmental type : in addition to the previous costs, the collectivity (the neighbours of the road) bears a cost which is increasing with the trafic. Here too, economic analysis provides precise answers.

With some currently made assumptions (which can be enlarged to the price of a more complicated result), it appears that, if :

$ECN(Nx)$

Is the environmental cost of traffic and MECN it marginal cost,then the optimal charge is :

$p=[MECN+MECC-(p-MC)]/[(1+l)]-[l/(1+l)(q/e_{qq})]$

As previously the tax has to fulfill three goals : to correct for external costs, to correct for imperfect pricing of the transport producer, and to raise funds. The first two objectives are balanced with the third one with the coefficient *l*.

4.2.1.6 Imperfect pricing of substitute or complementary goods

Let us come back to the situation where there are no cost of public funds nor, for sake of simplicity, external effect ; and let us assume that there are two transport modes, named by the subscripts 1 and 2 ; let us assume that, for some reason, the price of mode 2 is hold different from the first best solution, namely that the real charge P_2 is not equal to the optimal one p_2

$$P_2 \neq p_2$$

Then it is obvious that P_1 should be different from p_1 in the (second best) optimal situation.

It can be shown (QUINET 1998) that

$$q_1(p_1 - P_1) = -(e_{12}/e_{22}) q_2 (p_2 - P_2)$$

where : e_{22} is the own elasticity of mode 2

e_{12} is the cross elasticity of mode 1 *vis-à-vis* the price of mode 2.

The intuitive result is that charge is lower than SMC when the substitute mode's charge is lower than its SMC. This practical problem happens within the European Community under the principle of fair competition within markets. If the train system receives somehow a subsidy (e.g. the network owner, trickling down to train operators), express bus line companies for example could file a complaint about unfair competition.

4.2.2 Equity problems

Economic analysis gives also results when there are equity concerns, when for instance some agents are given a priority vis-à-vis the other ones. This priority is traduced by a specific form of the Social Welfare function, giving a special weight to the prioritized agents ; the result for infrastructure charges are given by complicated formulas which are a generalization of the SMC principle, and are not reproduced here (see for instance : BALLARD, FULLERON,

SHOVEN and WHALLEY, 1985, or BOVENBERG and DE MOOIJ,1998, or also MAYERES 1999, or MAYERES and PROOST 2001).

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4.2.3 Problems of uncertainty, information and institutions.

It then appears that, on the grounds of efficiency and equity, SMC - or formulas deduced from it in situations of "imperfect" world - provides valid answers and leads to better situations than ~~the~~ other concepts such as Average Cost or Long Run Marginal Cost. Let us now turn to more realistic situations of asymmetric information (for instance the infrastructure manager has a better knowledge of costs and demand than the regulator), conflicting objectives between institutions (the regulator aims at welfare maximizing, and firms aim at profit maximizing), and where furthermore there is uncertainty (so that it is not possible afterwards to know whether good result on costs is due to the efforts of productivity of a firm or to chance).

It is clear that institutions are important for the analyze of these situations ; for instance the information asymetry between infrastructure management and operations is much lower when both are included in the same organization than when they are run by two different organizations. We assume that, in the line of the reforms of the European Union (and according to the real situation in most modes of transport), there is a separation between infrastructure management and the operators, and that the third actor is the regulator. The objectives of the operators - which are generally private firms - is to make profit ; the objective of the infrastructure manager is a mix of profit, bureaucratic goals (maximizing the turn-over,…) and welfare maximization, according to its status (rarely private firm, most often public firm or public service) ; the objective of the regulator is to achieve some kind of welfare. In this framework, two types of relations and information situations are to analyze from the point of view of infrastructure charges : downstream, between the infrastructure manager and the operators, and upstream between the infrastructure manager and the regulator.

4.2.3.1 Relations between the infrastructure manager and the operators

In this case the important change visneither the infrastructure manager nor the regulator know well the private value or social costs of the services to be run on the infrastructure. The challenge is then to induce efficiency in the downstream market of the operators. This open the case for quantity regulation instead of price - and charges - regulation, and for the use of auctions instead of charges to select the efficient services. Let us see these points more in detail.

4.2.3.1.1 Prices or quantities regulations

On the side of costs, the uncertainty is large for environmental damages ; nobody knows well the effects of car traffic in a specific situation on air pollution. In this situation, charges are very uncertain and the welfare gain is hazardous ; quantity regulation may have more predictable and reliable effects (WEITZMAN, 1974) : according to the slopes of these two functions, and to the dispersions of the uncertainty on demand and on costs, it is better to

achieve the allocation through prices or through quantities. In this last case, there is no charging, or the charging is made according to other goals than efficiency (for instance according to the objective of revenue collecting), and efficiency goals are achieved through quantity regulation. Furthermore, a correct charging system would need a lot of information and implies too high transaction costs to be valuable. This fact provides another argument in favour of quantity regulation.

4.2.3.1.2 The use of auctions

The efficiency of charges is that it is a mechanism for selecting the efficient services : ; this mechanism works well when the values of the operators are simple and n ot related to each others ; it is the case in road transport : the individual users the value of which is higher than the charge are selected, the other are rejected, and the total value is maximized. This may not be the case in some modes such as rail and air transport for instance, and more gerally when there is to allocate scarce resources ; in rail for instance, the value of a service for an operator depends on whether competitors has got another service close to the first one, or whether the first operator has got another service on a complementary line : the values of services are not independent and it can be easily shown that in such case charging cannot select the most efficient operator, and charging must be replaced by auctions.

4.2.3.1.3 How to induce efficiency in operations ?

Another problem which is related to charging is to induce efficiency in operations. The solution depends on how the downstream market operates ; if the downstream market is competitive, efficiency is implemented by competition itself, the infrastructure manager has not to deal with it, and the regulator has "just" to ensure that competition works well.

If the downstream market is not competitive, a possibility to achieve the goal of productivity or effort incentives to the users is to offer to the users a menu of tariffs (LAFFONT and TIROLE 1994), the simplest expression of them being often used two-parts tariffs : a high quantity of transport is associated with a low unit price, close to the marginal cost, and will be choosed by efficient users, and at the other end, a low quantity associated to a high unitary price will be choosen by relatively inefficient users . The problem is that this situation may hamper new entrants which are small users, vis à vis the incumbent firms which are generally large users.This can be applied to any regulated transport production consumed by a segmented demand: travellers and freight on railroads or HDV and private cars on highways, or more simply high and low users of an infrastructure. The social surplus maximization leads to the following best incentive to the regulated operator: high consumption should not be distorted (ie price should equal marginal cost), but low consumption is lowed than the one when the operator has perfect information about users preferences.

Well deviced tariffs can achieve this goal over time : when uncertainty is low, the charge is close to the « price-cap » type, which has a strong incentive effect and do not leave too much information rent ; when uncertainty is high, charging is close to the type « cost plus » : incentive must be lowered in order not to imply a too high information rent.

4.2.3.2 Relations between the infrastructure manager and the regulator

The task to which charging can contribute is then for the regulator to induce efficiency in the infrastructure manager's behaviour. Efficiency must be taken in a very wide meaning : first to minimize the cost of infrastructure provision, then to ensure static efficiency (the infrastructure manager does not misuse its monopoly power), and also to achieve dynamic efficiency (mainly to induce a correct infrastructure investment).

The solutions -and their problems of implementation - are classical : regulation on infrastructure charges to avoid monopolistic behaviour, price-caps for cost-minimization. A specific case of transport infrastructure is that they are supposed to have large return to scale and fixed costs and may lead to rent-seeking on behalf of infrastructure managers whose objectives are more bureaucratic than welfare maximizing : using the uncertainty on costs, they advocate for low marginal costs, then low charges ; they get large subsidies to cover fixed costs and large investment to cope for the demand which is artificially increased by the low charge, at the expense of the tax-payer. The argument is advocated by the pros of average cost. The solution of economic theory is to propose a menu of charges to the infrastructure manager, and it appears that the charges is higher - and closer to the average cost - , the incertainty and information asymetry is high.

Another argument advocated by the pros of Average Cost is that without a link between expenses and revenues, and a punishment if expenses exceed revenues, there is a risk of overinvestment due to the uncertainty of investment appraisal and strategic behaviour by infrastructure managers who are guided by bureaucratic goals of extension in size of their business.The criterium of Average Cost ensures that the investment is profitable, but it leads to reject other investments which are also profitable but do not satisfy this criterium. Let us also assume that the main idea underlying this question is to put a link between expenses and revenues, but this link may not be just an equality ; a well deviced lum-sum subsidy may both achieve this goal and allow for a SMC charging. Anyway this situation advocates for an improvement in the expertise in project appraisal.

The problem of implementation of this kind of solution is the risk of regulatory capture : as the time goes, there are more and more renegociations of the contract between regulator and infrastructure manager, the regulation becomes more and more discretionary , and the risk of regulatory capture increaeses. This argument advocates for a deeper attention to institutionnal arrangements. In that line, a solution could be that the infrastructure manager has to break-even its budget - if it is a public firm- or to maximize its profit under price regulation - if it is a private firm - with lump-sum subsidies linked to fixed costs estimates. Another point which implies institutional arrangements is the situation when there are specific investments : then a strong partnership or a merger of infrastructure managers and operators is to be recommended. in this situation, the infrastructure charging problem vanishes.

A specific attention has to be given to the fine-tuning of the financial arrangements. For instance, a private infrastructure manager whose ~~goal~~ objective is profit should not be directly given the revenues from congestion costs as this would ~~it~~ induce ~~him~~ it to underinvest in capacity infrastructure ; these revenues should better go to him through lump-sum subsidies.

4.2.3.3 Problems of jurisdictions

Institutional arrangements should take into consideration problems of jurisdictions, which have consequences on infrastructure charging. These problems arise for instance in the case of international traffic. Such a situation has been analyzed for instance in the case of international traffic between two countries, this traffic being charged in both countries for the part of the trip it makes in each of them (COURCELLE and alii, 1998 ; BASSANINI and POUYET 2000).

The charges in each country have effects on the tax revenue and on the externalities in the other country. The pricing policy depends on the degree of cooperation or competition between the two countries, and on the technical and legal possibility to discriminate between domestic and foreign traffic ; it depends also on the hierarchy of environmental goals and budget constraints.

Another point which is addressed by economic analysis is the effect of the hierarchy of jurisdictions. Reasons in favor of such hierarchy are the cost of information transmission and processing, incompleteness of contracts between the center and the periphery, and a better effort incentive (CAILLAUD, JULLIEN, PICARD 1996) ; on the other side, taxes by inferior jurisdictions are subjects to several drawbacks, especially in the case of source based taxation : tax exportation, competitive tax spill over, NIMBY and beggar-my-neighbour tax competition induces inefficiencies in state taxes ; this point leads to recommend to use resident based taxes by the central government in order to correct these failures (INMAN and RUBINFELD 1996).

4.2.3.4 Conclusion

what can be concluded from this long list ?

- First, if problems of information and uncertainty are not taken into consideration, economic tneory has precise answers to the problems arising from tne vaeious imperfections of the real world vis à vis the hypotheses of an ideal (first-best) economic world. These solutions are based on SMC, and depart from it through well known formulas.
- when information and uncertainty problems are taken into account, things are more complicated. In some cases, the solution do not rely on charges, but on regulations or on some revelation mechanism such as auctions. In almost all these situations, the charging priniple must be set up in accordance with- and closely linked to- institutional arrangements.
- The decision to take depends on how large are the fixed costs and the information asymetries :

    - Are fixed costs high ? Eeconometric analyses show that fixed costs are not that high and that they have been often overestimated in the past. Often, fixed costs are due to the fact that infrastructures are overdimensionned, either because they have been done for public obligation purposes (rural roads) or because traffic forecasts were wrong. In the first case the charging problem is mainly a matter of political choice and equity ; in the second one the solution is to close the infrastructure, and is not a charging problem, except if some kind of charging may induce this closure and do not entails too many drawbacks on other grounds.

- If fixed costs are high, the infrastructure is then more akin to a pure public good. The solution is not to be found in charging but in the institution which allow for the better decisions of doing or not doing ; clearly, this situation advocates for public management, ie intregation between the infrastructure manager and the regulator. The same happens when public service obligations and external effects are very important.
- Is information asymetry high ? The answer is highly depending on specific situations. If it is the case, a budget balance solution is necessary, but it does not prevent from a generalized SMC charging solution, of th e Ramsey type.
- In some specific case, charging must be replaced by regulations or by auctions.

5 Conclusion : how to reconcile?

On the whole, it appears that there are large discrepencies about charging doctrines, on the fields of academic teaching (advanced courses teach smc principle and its limits, other teach accounting based procedures), of official doctrines (some states support average cost principle, other ones are closer to smc principle), and of practical implementation (in most modes, real charging systems more or less tend to achieve break-even).

These results can be viewed through a positive analysis, looking at the behaviours of decision-makers , or through a normative analysis, looking whether the economic analysis has answers to their concerns.

It appears that politician decision-makers are more interested in acceptability and equity than in efficiency, and SMC often implies unfavourable consequences on these grounds. Furthermore SMC is a complicated concept, its estimates are uncertain and this uncertainty leads to strategic behaviours by the operators, the result being increases of deficits, subsidies and costs.

Alternative concepts are suggested by decision-makers in order to overcome these drawbacks. They are average cost, long run marginal cost or development cost. What are the assesments of economic analysis on these questions ?

Economic analysis put more emphasis on efficiency. On this ground a first limitation of SMC arises from the fact that there is no practical tool to implement thevery diversified charges of the SMC, and proxies imply loss of efficiency. A second limitation comes from the fact that the assumptions of the first best world are not fulfilled : apart from information problems, there are market imperfections (non-competitive markets, cost of public funds, externalities). Economic analysis provide answers to these situations. It provides also formulas to solve equity problems. Those formulas are derived from SMC, they include informations on demand (mainly elasticities). Without information and uncertainty, these formulas are superior to the alternative doctrines such as average cost or development cost.

Things change a lot with uncertainty and information asymmetry. It appears then that charging may not be the proper way to achieve efficiency : in some cases, regulations or auctions should be preferred. Furthermore, alternative doctrines gain in interest, as they prevent from strategic behaviours such as rent-seeking and they induce more incentives for cost minimization.

The issue is : how large are fixed costs and information asymmetries :

- Recent econometric analyses show that fixed costs have been often overestimated in the past and are not that high . Often, fixed costs are due to the fact that infrastructures are overdimensionned. In this case the charging problem is mainly a matter of political choice and equity the solution is to close the infrastructure, and is not a charging problem, except if some kind of charging may induce this closure and do not entails too many drawbacks on other grounds.
- If fixed costs are high, the infrastructure is then more akin to a pure public good. The solution is not to be found in charging but in the institution which allow for the better decisions of doing or not doing ; clearly, this situation advocates for public management, ie intregation between the infrastructure manager and the regulator. The same happens when public service obligations and external effects are very important.
- Is information asymetry high ? The answer is highly depending on specific situations. If it is the case, a budget balance solution is necessary, but it does not prevent from a generalized SMC charging solution, of the Ramsey type.

- Anyway, whatever the charging solution is, its implementation needs to know the cost function of the infrastructure, an approximation of which is given by the knowledge of the SMC. Furthermore, in almost all situations, the charging priniple must be set up in accordance with- and closely linked to- institutional arrangements.

It is then important to assess, in each specific situation, how far are we from the hypotheses of first best, how large are uncertainty and information asymmetry, and how large are fixed costs. The opinion of the author is that, on those matters, we are in general not far from first best hypotheses, that fixed costs are not that high,and that consequently there is a large scope for SMC.

Anyway, the quest for marginal cost pricing is not necessarily neutral in its impacts. Some aspects can be easier taken into account in the SMC pricing scheme than other ones and institutional structures may have surprising effects on pricing structures. Furthermore, the lessons from market reform in various public infrastructure systems indicate that the force of the self-propelling dynamics of the transformation process should not be underestimated. But up to now, in transport, this last problem is (unfortunately…) not really dramatic.

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