

Phasing and Packaging of Pricing Reform

The MC-ICAM approach

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1. Introduction

Economists have for a long time propagated pricing policies as an indispensable building block for transport policies that aim at achieving more efficient and sustainable transport. The basic idea is that when individuals face prices equal to marginal social costs, they will expand consumption of mobility – and undertake other actions to reduce externalities, *e.g.* investing in cleaner cars – up to socially optimal levels where marginal benefits and marginal costs are equalized. Such pricing is therefore often referred to as marginal cost pricing – or more precisely *marginal cost based pricing*.² Over the last decade(s), sophisticated pricing policies for transport have evolved from a primarily academic, theoretical construct, to a realistic and seriously considered option for many areas – urban and non-urban – around the world. This is due to (at least) two simultaneous, interacting developments, *viz.* the steady growth in transport related problems such as congestion and CO₂ emissions on the one hand, and the development of technologies enabling automated charging on the other.

However, despite the large and growing number of plans for using pricing policies in practice, the number of actual applications has remained small. Apparently, the implementation of marginal cost based pricing in transport is not as straightforward as it may seem after calculating the net social benefits that can be realized with it, in theory enabling the government to make everybody better off with the policy than without it. Various types of barriers have been identified that may explain such difficulties in implementing marginal cost based pricing in reality, such as technological, psychological, social, political and institutional barriers (see also Section 5 below).

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² The use of the term *marginal cost based pricing* is more appropriate for instance under second-best pricing, as will become clear also in Section 4 below.

The revealed difficulties encountered in implementing marginal cost based pricing have triggered much interest in the design of *implementation paths*. If it is, apparently, not possible to introduce marginal cost-based pricing at once and throughout the entire transport sector, is it then perhaps possible to design a path along which it can be introduced? That is: can we think of a sequence of steps that each, individually, will succeed in passing the various barriers, and that together will take us to the same end result of having marginal cost based prices throughout the entire transport sector? Which should be the main principles underlying the design of such implementation paths, and are these principles related to the factors that create the apparent necessity of having an implementation path in the first place, rather than a ‘big-bang’ implementation?

The project MC-ICAM has been concerned with these and related questions, and this paper will address some of the main conceptual issues surrounding the motivation and design of such implementation paths, as they arose during this project. To that end, this paper will have the following structure. Section 2 will present the general background and structure of project MC-ICAM. Section 3 discusses some possible motivations for designing an implementation path, rather than opting for a ‘big-bang’ implementation, and provides a definition of an implementation path in the light of these considerations. Section 4 reviews the economic theory that becomes relevant for the design of implementation paths given the definition in Section 3. Section 5 discusses the translation of the conceptual ideas developed to practical policy making. Section 6 concludes.

2. Background and structure of MC-ICAM

The Commission’s white paper “Fair payment for infrastructure use” (CEC, 1998) and its predecessor the green paper “Towards fair and efficient pricing in transport” (CEC, 1995) emerged from an environment of considerable turbulence in the transport field. A range of needs at member state and European level were apparent, including the need to manage transport capacity more efficiently, to finance transport infrastructure, and the need to improve the efficiency of the transport sector by means of institutional reform involving deregulation and privatisation. The framework contained in the green and white papers represented the Commission’s endeavours to provide a comprehensive pricing principle across modes and countries that would ensure that in times of change there was an underlying scientific basis for the development of pricing in the transport market.

The core features of the white paper focused on the need to relate charges more closely to the underlying marginal social costs associated with infrastructure use, extending these costs to include external costs, and with the need to depart from prices that are

purely based on the direct costs of infrastructure use when cost coverage requirements need to be met. The need to ensure transparency, and to facilitate fair competition between modes, within modes, and across user types was emphasised. Furthermore, the contribution of transport services to the enhancement of industrial efficiency and European competitiveness was recognised.

In order to give transport users and providers time to adjust, the white paper proposed a *phased approach to the implementation* of this policy framework. Although this may sound reasonable from a political and practical perspective, on second thoughts such a proposal raises many questions that need be addressed before a well-motivated phased implementation can commence. These questions include the identification of the major *motivation(s)* for choosing a phased implementation (which will presumably affect the design of the implementation path), and of the pro's and con's of different types of implementation paths that can be imagined (see for instance Table 2 below) – which is related to the more general question towards the desired (or perhaps optimal) *design* of implementation paths.

Against this background, the goal of MC-ICAM was to develop principles and guidelines related to implementation paths, including the definition of the desired end state, by identifying and investigating a broad range of theoretical and practical issues involved. To that end, the project was designed according to the structure shown in Figure 1.

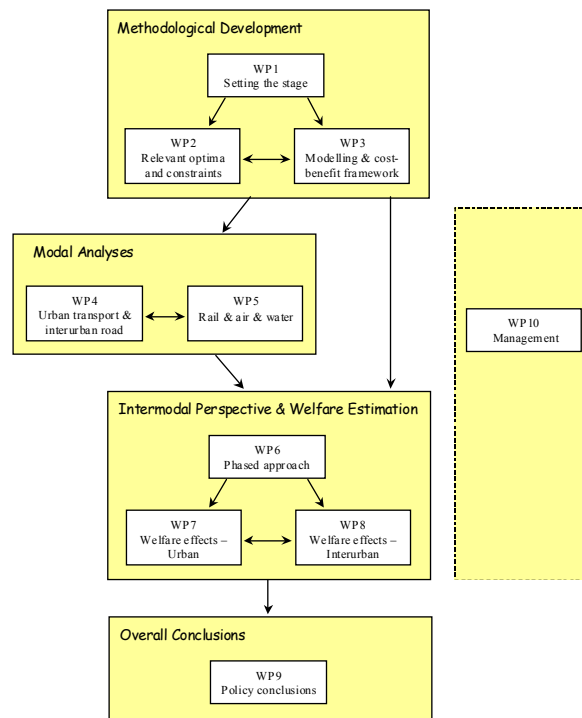


Figure 1. Structure of MC-ICAM

The first block of WP's, *Methodological Development*, sought to develop the methodological building blocks required for properly designing and evaluating implementation paths. The emphasis put on 'constrained welfare maximization' in WP2 was motivated by the insight that a major motivation for resorting to an implementation path (*IP* in the sequel), rather than opting for big-bang implementation (*BBI*), would be the existence of *barriers* and *constraints* that prevent *BBI* from being practically feasible. The emphasis put on designing a conceptually sound evaluation framework in WP3 was motivated by the desire and necessity of having a common and transparent means of judging and comparing alternative *IP*'s (within and across case-studies), firmly rooted in welfare economic principles. The emphasis on economic cost-benefit principles in this evaluation framework is a natural consequence of the object of study, marginal cost based pricing. The instrument of marginal cost based pricing – as opposed to, for instance, profit maximizing pricing or average cost pricing – implies that the objective of the policy is (at least closely related to) the maximization of welfare (see also Section 4). The evaluation framework should of course be consistent with this eventual policy objective, and an economic cost-benefit framework then offers the natural choice. Some of the key insights emerging from this block *Methodological Development* will be addressed in Section 4 below.

The second block of WP's, *Modal Analyses*, carried out in-depth modal level (urban, interurban road, rail, air, water) analyses of the current pricing and other regulatory issues, and of the current barriers to the marginal cost pricing in different modes. This has provided relevant information both for defining the starting point for any practical

IP, and for identifying the relevant constraints under which such *IP*'s can be defined. The main results of these WP's will be presented in the papers for Session II of this IMPRINT seminar.

The third block of WP's, *Intermodal Perspective and Welfare Estimation*, aims to combine the insights from the two preceding blocks in order to formulate general principles for, and actual applications and evaluations of, practical *IP*'s. WP6 focuses on the general design principles for *IP*'s and suggests ways of operationalizing these in applied work, while WP's 8 and 9 present the applications and their evaluation. These will be presented in Session III of this IMPRINT seminar.

Finally, WP9 will give information to policy-makers on the welfare gains related to the optimal steps of the phased approach, and will make suggestions for policy-making both at the strategic and more detailed levels; including formulating a recommended strategy for taking the necessary steps towards efficient (and fair) pricing based on marginal costs.

3. Why implementation paths?

In order to develop deeper insight into the question of *how* implementation paths (*IP*'s) should be designed, or which *IP* among many possible should be chosen, one should have a clear idea of *why* they should be designed in the first place. Why not simply implementing optimal pricing at once, using big-bang implementation (*BBI*), and reaping the net social benefits from optimal pricing as early as possible? Why moving towards optimal prices in a number of smaller steps? A number of possible answers have been suggested to this question (see MC-ICAM Deliverable 6 for a discussion), and it is worthwhile to consider these briefly here.

But before doing so, it should be emphasized that *BBI* of optimal pricing, as well as a possible end-state of an *IP* in which optimal pricing is achieved after a number of intermediate phases, is certainly not a state in which (optimized) prices are necessarily fixed. In other words, it is useful to distinguish between changes in prices that are due to 'phase switches' along an *IP*, and changes in pricing that would occur also under a policy-state of optimal pricing – that is, with *BBI* of optimal pricing, or alternatively in an 'optimal pricing' end-state of an *IP*.

There are two classes of reasons why optimal prices would change under a policy-state of optimal pricing. The first is related to the distinction one can make between *short-run optimal prices* and *long-run optimal prices*. The short run can, in general, be defined as the time period in which some choices cannot be adjusted – and its duration may therefore depend on the case and circumstances under consideration. These choices may

be decisions at the discretion of the transport users, such as the type of vehicle (*e.g.* clean versus dirty cars, the residential and/or work location, *etc.*), but also choices at the discretion of the infrastructure operator (*e.g.* the road capacity as set by the government). It is evident that short-run and long-run optimal prices may differ. For example, an optimal congestion tax will typically be higher as long as an optimal road capacity expansion programme has not yet been carried out, and the optimal environmental charge for a driver of a dirty car will not depend on the question of whether or not (s)he intends to replace the vehicle by a cleaner one once the current car has become obsolete – on the contrary, the higher current tax should give the optimal incentive of indeed doing so at the optimal moment. Indeed, optimal prices should in principle be based on short run marginal costs. If not, unnecessary social welfare losses would be incurred and accumulated over the period before the long-run optimum is reached. That means that also with *BBI* of optimal pricing, prices are likely to change over time after implementation and approach their long-run counterparts, as more and more actors optimally adjust more and more longer-run decisions to the new set of prices. This element of dynamic adjustments in optimal prices should, for definitional clarity, not be classified as being a part of an implementation path.

A second, more obvious reason why optimal prices may change over time after *BBI* of optimal pricing, or during a possible ‘optimal’ end-state of an *IP*, would be changes in (largely) exogenous factors, such as inflation, changes in the (real) valuation of externalities or the value of time as (real) incomes grow, *etc.* For the same reason of definitional clarity, we do not classify such changes as constituting an implementation path.

We can now rephrase the original question as follows: why not immediately move to a policy state of optimal pricing, in which short run optimal prices apply at each instant, and approach their long-run optimal levels as more long-run choices are made optimally? A number of possible motivations have been proposed, to which we will now turn.

Barriers and constraints

Probably the most important reason why *BBI* of optimal pricing is infeasible in practice concerns the existence of *barriers* and *constraints*. Within MC-ICAM, we have defined a ‘barrier’ as a – typically exogenous – factor that limits the regulator’s possibilities to perform the most desired policy. A barrier is thus relevant when it causes a ‘constraint’ on the policy options for the regulator; and therefore, in the context of transport pricing, when it prevents the regulator from being able to set all the prices it would like to set at the levels it would like to choose. Barriers and constraints are therefore no synonyms: there is a causal relation between the two. As a result, a certain barrier may cause

multiple constraints; and a certain constraint may result from multiple barriers (see also Table 3 below). We can clarify this by briefly presenting the classifications of barriers and constraints used in MC-ICAM.

1	Institutional barriers
1a	Organizational structures
1a1	On the 'regulatory side' (e.g. involving as yet non-existent gov't organizations)
1a2	On the 'regulatees' side' (e.g. involving market power or lobby groups of regulatees)
1b	Government levels (vertical and horizontal organization, link with tax competition etc)
1c	Political (1; see below under 3)
1d	Legal
2	Technological
3	Acceptability
3a	Public
3b	Political (2; see also above under 1)
3c	Business

Table 1. Classification of barriers to BBI of optimal pricing

Table 1 shows the main categories of barriers to *BBI* of optimal transport pricing that were considered in MC-ICAM. In-depth discussions of the empirical relevance of these barriers for various transport modes are provided in MC-ICAM Deliverables 4 and 5 and are suppressed here, but the classification is hopefully illustrative in explaining what is meant with a barrier (see also Glazer *et al.*, 2001; Harsman, 2001; Herry, 2001).

As stated, a barrier is relevant as soon as it implies a constraint on transport (pricing) policies. Also such constraints can take on different forms, and MC-ICAM distinguished constraints on:

- a. coverage or scope of the pricing system
- b. composition and level of pricing measures
- c. degree of differentiation of pricing measures
- d. rules and principles governing revenue use
- e. use of supplementary non-price measures

Table 2 (next page) illustrates these different types of constraints, within the various possible settings one could consider (a further discussion can be found in MC-ICAM Deliverable 6).

Table 3, finally, visualizes the link between barriers and constraints, and indeed shows that a certain constraint may result from different barriers (*e.g.*, the inability to differentiate prices by time of day may result from technical limitations or from social opposition), in which case it may take the removal of multiple barriers to loosen a constraint, and that the same barrier may cause multiple constraints (*e.g.*, social

acceptability may limit both the maximum toll levels that can be applied in a democracy, and the possible revenue allocations that pass the democratic test), in which case the removal of a certain barrier may loosen multiple constraints.

The existence of constraints on pricing and revenue allocation policies raise important issues for their optimal design. In a ‘world without constraints’, a welfare-maximizing government could freely choose values for the policy variables in order to realize the objective of welfare maximization. This is in fact the world assumed in standard economic expositions of marginal cost pricing, and the resulting policy rules are often referred to as ‘first-best policies’. When binding constraints exist, in contrast, we enter the world of second-best. The regulator’s problem often becomes more complicated to solve when binding constraints exist, as will become clear in Section 4 below. The challenge will be to set policy instruments such that welfare is maximized in such a way that the constraints applying are satisfied in the least distortive way possible. Such policy rules are referred to as ‘second-best’ policies.

	Setting/ coverage	Unimodal	Multimodal	Multisectoral	Multi-regulator (horizontal and/or vertical)
Type of constraint					
Constraints on the number of market segments that can be priced, i.e. on the coverage and scope		Not all links tolled Not all user groups tolled	Not all modes tolled Not all links tolled Not all user groups tolled	Existing non-optimal prices in other sectors (including labour markets for passenger transport; or polluting industrial sectors for freight transport)	Non-optimal (possibly zero) taxes by other regulators (vertically and horizontally) Tax competition and externality spill-overs
Constraints on the use of certain marginal cost based pricing measures (optimal price combinations), on their maximum levels and/or the minimum total revenues		Specific price caps Constraints on which externalities can be charged for	Specific price caps	Specific price caps	Specific price caps
Constraints on the degree of differentiation		Flat tolls (over time and space) Undifferentiated tolls over user groups	Undifferentiated tolls over modes Flat tolls (over time and space) Undifferentiated tolls over user groups	Non-differentiated congestion tolls for commuters and leisure trips i.e. not differentiated by trip purpose	Imposed equality of charges across jurisdictions
Constraints on the use of revenues		Required lowering of other taxes in that mode (for reasons of social acceptability) For example due to revenue neutrality in the case of kilometre based charge for roads	Required use of part of the revenues as subsidies in other modes (for reasons of social acceptability) or for environmental reasons: from road to rail	Impossibility to use the revenues to lower the most distortive taxes in the economy	Rules on the distribution of shares of total revenues over various governments (for reasons of institutional acceptability)
Constraints on the use of non-price supplementary measures		Fixed capacities Given network configurations Impossibility of setting local technology standards in combination with non-differentiated taxes	Fixed capacities Given network configurations	Impossibility of designing non-tax labour market policies	Impossibility of affecting locational choices of firms and households through spatial planning

Table 2. Types of constraints on pricing for various settings with some examples of implied second-best pricing schemes

Implied second-best constraints on	Coverage or scope of the pricing system	Composition and level of pricing	Degree of differentiation of pricing measures	Rules and principles governing revenue use	Use of supplementary non-price measures
Underlying barriers					
Technological and practical barriers	X	X	X	X	X
Legal and institutional barriers	X	X	X	X	X
Acceptability related barriers	X	X	X	X	X

Table 3. Possible correspondences between barriers and constraints

Implications for the definition of implementation paths

When barriers and constraints are the underlying reason why a *BBI* of optimal pricing is not feasible, a natural definition of ‘implementation paths’ (*IP*) arises, and that could be formulated as follows: an implementation path is a sequence of second-best equilibria, along which constraints on policy instruments change over time, as the underlying barriers gradually erode or are removed in discrete steps over time. A phase in an *IP* can then be defined as the time period for which the set of constraints and their ‘tightness’ does not change, while a change would mark a phase transition.

It will be clear that different types of *IP* are possible, for example as the nature of the initial constraints (the rows in Table 2) may differ across applications, and because the order in which (different types of) constraints can be released may differ, too. Furthermore, the identification of the development of constraints over time does of course not yet define unique prices within each phase. For example, even if a constraint says that no differentiation of taxes is allowed in step 1, there are still an infinite number of tax levels that satisfy this constraint. Similarly, there are countless ways of selecting a certain sub-set of a limited number of links in a network to be tolled, and next an infinite number of price levels for each of these taxes. Finding the optimal way of respecting the constraints requires solution of a second-best problem, and this is the idealized procedure followed for determining an *IP* when its existence is motivated by the existence of barriers and constraints.

Other possible motivations for IP’s

The existence of barriers and constraints was the main motivation for the necessity of considering *IP*’s considered in MC-ICAM, and the implied definition of *IP*’s as given above was therefore adapted. This excluded other possible motivations for *IP*’s that were put forward during the project from being considered in greater detail.

One such other type of motivation concerns the existence of adjustment costs. Little is known about such costs. What can be said about it in a qualitative sense is that adjustment costs may, depending on the shape of the associated cost function, provide both a motivation for *BBI* of optimal pricing (when each change of behaviour involves costs associated with searching for the best response, it is beneficial to minimize the number of changes required, and hence to avoid many phases in an *IP*), and for an *IP* with many phases (when adjustment costs rise more than proportionally with the size of the adjustment, it is better to have more smaller adjustments rather than one or a few large adjustments). In other words, it cannot be said with certainty whether adjustment costs would provide a motive for designing or avoiding *IP*'s compared to *BBI*.

A second possible motivation for an *IP* that has been put forward concerns the existence of sunk costs. It is, however, not clear under which conditions this would indeed be a valid motivation for a gradual implementation of marginal cost pricing. For typical sunk costs (*i.e.* associated to the current house occupied), it could be argued that under *BBI*, individuals would immediately face the optimal incentive to trade off the costs of moving and incurring new sunk costs (while keeping the existing sunk costs by definition), and the net social benefits associated with the move (comprising their own benefits of mobility, their private costs, and the external costs they generate). In other words, also the existence of sunk costs as such is certainly not a necessary nor a sufficient condition for making an *IP* preferable to *BBI*. Very often, sunk costs and slow adjustments may of course lead to a gradual move of short-run optimal prices to their long-run optimal values, but – as explained above – such changes in optimal prices will not be referred to as an *IP*, as they would occur also under *BBI* of optimal pricing.

Partly because of the uncertainties surrounding these issues, the ‘other’ motivations discussed in this final sub-section were put aside in MC-ICAM, and attention was focussed exclusively to *IP*'s motivated by the existence of barriers and (implied) constraints.

4. Relevant economic theory

As explained above, the design and evaluation of implementation paths requires a careful consideration of at least two bodies of economic theory. The first is the theory of second-best (transport) regulation, because *IP*'s are defined as a sequence of second-best optima. The second is the theory of economic evaluation of welfare, since the focus on marginal cost based pricing naturally implies that the objective of policies is (closely related to) the maximization of social welfare. This section will summarize the key insights from the MC-ICAM deliverables 2 and 3, which dealt with these issues.

4.1 Second-best regulation

The standard economic policy prescription that, in order to reach an efficient allocation of resources, prices should be set equal to marginal costs, holds exactly only under first-best conditions and even then only when distributional considerations are ignored. In reality, however, first-best conditions are never completely met; *i.e.*, there are always constraints on the regulator's possibilities for securing that prices on all relevant sub-markets (both for the market under consideration as well as for interacting markets) will be exactly equal to marginal social costs. These additional constraints make it necessary to amend the simple rule that prices that are under direct control of the regulator should be set equal to marginal costs. The analysis of optimal policy under conditions that differ from first-best is called the analysis of second-best situations. In reality, transportation policy is always second-best policy, because there are a number of relevant constraints, both inside the transport sector and in related parts of the economy such as the labour market, that are unlikely to be removed completely (at least not in the foreseeable future).

A first important result from the literature on second-best policies is that, under second best conditions, it is usually not optimal to set prices exactly equal to marginal costs. Optimal second-best prices are usually different from marginal costs. Although optimal prices become equal to these costs when all additional constraints are removed, second-best conditions remain relevant during the *IP*. Optimal prices may therefore be said to be marginal cost *based*, rather than identical to marginal costs.

A second important result is that the difference between first-best and second-best optimal prices is highly dependent on the nature of the constraints applying. The changes that have to be made in the pricing rule are in general non-trivial consequences of the constraints analysed. Sometimes optimal prices may be close to marginal costs, and then the first-best rule provides a reasonable guide to policy implementation. However, this is not always the case, and there exist examples of second-best situations in which first best pricing would be harmful. An important finding of the work on second-best regulation is that the difference between the truly optimal second-best prices and marginal costs depends on the details of the situation under consideration. This implies that careful analysis of the important aspects of the circumstances under which the policy has to be realised is necessary to avoid the potential disappointment of erroneous expectations that were based on insights valid only under first best circumstances.

A third general result is that optimal second-best prices are such that the distortionary effects of the additional constraints (that cause the actual situation to differ from a first-best one) are partially compensated. For instance, if road traffic is priced a too low a

level in the absence of congestion tolling, optimal public transport fares should be expected to be lower than marginal cost in order to compensate for the diminished incentive automobile drivers have to use this mode. This implies that under second-best conditions optimal prices are linked to distortions elsewhere in the transport sector.

This has as a consequence, and this is a fourth general result, that the rules for optimal second-best pricing are more complicated than those valid under first-best conditions. The computation of optimal second-best prices requires more information than that of first-best prices. First-best prices are equal to marginal costs and these costs are in principle all that needs to be known to be able to set these prices if marginal cost pricing is applied consistently (although knowledge of demand and supply elasticities is helpful in predicting optimal tax levels when starting from a non-optimal equilibrium). Derivation of second-best prices requires more information, for instance the price elasticity of demand. This makes the optimal prices more difficult to derive.

The fifth general conclusion is that under second-best policies, a strong case for ‘policy packaging’ arises: creating combinations of second-best price instruments that in isolation may be prone to all sorts of efficiency losses due to unproductivity or perhaps even counterproductivity with regard to some behavioural dimensions, but that in combination may be capable of replicating the full set of incentives given by an imaginary first-best pricing scheme more accurately (see also Verhoef, 2001).

These general conclusions are not only relevant for second-best constraints from inside the transport sector, but also for constraints that originate from outside the transport sector, such as the presence of a distortionary tax on labour income. Moreover, they are equally valid for constraints that result from equity considerations (motivating, for instance, a progressive income tax) as for constraints that are present for other reasons.

Still another reason for the presence of second best constraints results from the fact that authorities at different geographical levels use their own policy instruments. The chosen values may be optimal for the people they represent (for instance a region), but may at the same time be sub-optimal for people elsewhere (in different regions) or from the broader perspective of a larger geographical unit (for instance, a country or the European Community). In such cases the values of the policy variables determined by one authority should be taken as given for policy making by different authorities implying a second best constraint.

Optimal second-best values for policy instruments, such as prices, have to be determined from the maximisation for a social welfare function subject to the inevitable technical constraints on production (that are also present under first-best circumstances)

and the relevant second best constraints. These constraints should reflect the barriers underlying their existence (see Table 3 above). If these additional constraints are binding, they imply that the maximum attainable value of the social welfare function is lower than under first best conditions. Second best policies are therefore inevitably less effective than first best policies. Research suggests that the welfare gains of second best policies are usually substantially lower than those associated with first-best pricing. Removing a constraint as soon as it is possible may therefore be much more effective than optimally adapting the transport sector to its existence.

Clearly, in reality there will not be a single instant before which it is impossible to remove a barrier and its resulting constraints, and after which it becomes possible to costlessly do so. Often, the – implicit or explicit – costs that should be made to remove the constraint(s) will be falling over time, which introduces the question towards the optimal – endogenous – timing of actions to remove constraints. It appeared impossible to study this question in the applied models used in MC-ICAM, and the question is therefore postponed to future research efforts. MC-ICAM thus treated barriers and the resulting constraints, as well as their time-path, as fully exogenous.

4.2 Evaluating the welfare impacts of implementation paths

There are two reasons why an assessment framework for second-best, marginal cost based transport pricing reforms is needed. First, different types of constraints make pure marginal cost pricing difficult to reach. The review of second-best optima above shows that there are no clear-cut results and easy formulas that can be implemented right a way. Very often there are many alternative routes and solutions that need to be compared, and this needs a careful quantitative assessment using models to compute all the different costs and benefits for the different parties involved. Second, although the principles of cost benefit analysis are well recognized, there are still large differences in the interpretation. Each transport model has already built in a selection of effects to consider and a selection of cost benefit type reporting routines. In order to use different models for the assessment of pricing reforms, we need to have a common understanding of what effects need to be measured and what cost benefit criteria to compute. Under such an assessment framework, we understand a set of rules that tell us:

1. what effects are to be taken into account
2. how to compute the effects
3. how to value these effects
4. how to aggregate the valued effects into an objective function
5. how to use the objective function to rank alternatives

This assessment framework can be seen as a rigorous definition of a cost benefit analysis that includes efficiency and equity objectives.

There are four requirements for such an assessment framework:

1. it has to be capable of assessing second best pricing reforms proposed by the theory
2. it has to include efficiency as well as equity concerns
3. it has to be implementable for the models that will be used in the case studies of MC-ICAM
4. it has to be able to assess implementation paths

MC-ICAM Deliverable 3 constructed such an assessment framework using five steps:

1. We first tried to learn from previous experiences. Different research consortia have computed second best pricing reforms. How did they define and compute second best optima and implementation paths? What definitions did they use for efficiency and equity effects?
2. Next we surveyed the models that are used in MC-ICAM. What are their capabilities in computing effects and designing optimal pricing reforms?
3. Most transport policy analysts have a sense of what the costs and benefits of a pricing reform are, but when it comes to actually defining all relevant effects there is no unanimity. In the third step we list all the components that an ideal assessment framework would have, and check whether the MC-ICAM models that will be used include these effects.
4. The following step is to value all the individual effects. What conventions and methodologies do we propose to use to value market effects, travel time savings, and effects on environment and safety that arise when we reform prices?
5. The final step is to aggregate the different effects into an objective function that takes into account efficiency and equity objectives. Here we propose solutions for issues like intergenerational effects and the valuation of government revenue effects.

It would take too far to discuss the resulting assessment framework in great detail here; see MC-ICAM Deliverable 3 for full details. It is, however, useful, to briefly discuss the main principles underlying the use of this framework, the effects of pricing reform to be included, and the issue of aggregation of welfare effects.

Principles

The following principles or ‘rules’ were identified for the use of the assessment framework developed:

1. Define the time horizon and geographic scope of alternative pricing proposals
2. Construct a reference and an alternative pricing equilibrium that are feasible
3. Construct an optimal pricing alternative (first-best benchmark)
4. Test the reliability of the conclusions of the assessment

Effects to be included

Given that one wants ultimately to check efficiency and equity, the best option is to compute effects at the individual level where possible. In general one uses the following categories of effects; obviously we are interested in the changes of these effects with respect to a reference equilibrium:

1. User benefits for the travellers (and households) for passenger and freight operators or consumers, calculated using the consumer surplus to users ("rule of a half" or logsum formulae) and including the benefits from land use changes where such benefits can be appropriately calculated.
2. Producer surpluses, defined by annual revenue minus cost incl. taxes for all transport-related firms, operators and entrepreneurs.
3. Value of transport-related public revenues, defined as annual government tax revenue minus expenses for local and national governments taken together.
4. External costs, defined as accident cost plus noise and air pollution cost and possibly other external effects if they can be identified as an external effect.
5. Effects on other markets, especially when these markets are distorted, this means large differences between prices and marginal social costs.
6. Investment and implementation costs, if not included within the 'producer surplus' components, are often of particular interest to develop an implementation path.

Aggregation of welfare effects

The basic idea is that a transport pricing reform project leads to a variation in the utilities of current and future generations that ought to be assessed. In order to assess this sum of changes in utilities, we need a social welfare function. The social welfare function is the objective function used for the ranking of alternative pricing policies by the decision maker. This function is an increasing function of all individual utility functions and can contain different degrees of inequality aversion or equity considerations. Projects are then assessed by the expression that sums the weighted welfare changes for currently living individuals and future generations, owing to the implementation of the policy.

The net benefit of a pricing reform for a given individual of the current generation is the sum of all effects expressed in monetary terms. Computing all effects is in general impossible. What effects are crucial to compute? When only efficiency counts, Deliverable 3 suggested to compute the effects listed in Table 4. This list of effects replaces the traditional computation where one uses the sum of consumer and producer surpluses on only one transport market to which one adds the change in government revenues valued via a marginal cost of public funds parameter.

MARKET AFFECTED	WHAT EFFECTS	HOW TO COMPUTE
Primary transport market	Loss of consumer surplus + Loss of producer surplus + Gain in Tax revenue – Change in External costs	Computed with transport model
Effect on other transport markets if they are distorted (where user price is different from social marginal cost)	[User price - Marginal social cost] x change in volume	Computed with transport model or added by back of the envelope computations if the model does not cover all transport modes
Direct and indirect effect on labour market	Labour Tax rate x change in labour supply induced by tax interaction effect and by commuting cost effect	Computed via back of the envelope computations or via general equilibrium model
Effect on other directly affected markets that are distorted say Housing markets	[User price - Marginal social cost] x change in volume	Computed with transport model or added by back of the envelope computations if the model does not cover the housing market

Table 4. List of Effects to be computed for an increase of a charge on a transport market that is recycled via a decrease of the labour tax rate

One issue deserves some emphasis here. As can be seen from Table 4, there is in general a preference *not* to aggregate all effects on non-transport markets into one marginal cost of public funds parameter. This is so for two reasons. Firstly, the value of the marginal cost of funds will depend on how the funds will be used. This important caveat tends to disappear when one value for the marginal cost of funds is used. Secondly, the rest of the economy (labour market) is not only influenced via the change of tax revenue and the associated decrease in labour taxes but also in a direct way via cross price effects and via reduced or increased costs of commuting.

5. Towards practical policy making

The foregoing has outlined the general principles used in MC-ICAM for the motivation, design and evaluation of implementation paths. Figure 1 summarizes these insights for an imaginary *IP* that goes through 3 intermediate phases before the (assumed) optimal end state is achieved.

In each phase, a specific set of *barriers* exists (see Table 1), that creates specific *constraints* on the pricing and revenue use policies that can be implemented (see Table 2). Typically, the barriers and constraints will be removed over time. During each stage, the regulator seeks to perform optimal second-best policies that respect the exogenous constraints (see Section 4.1), implying a certain equilibrium with an associated social welfare level (see Section 4.2) which can be interpreted by comparing it to the welfare that would apply in absence of the policy (BaU: Business as Usual) and the welfare that would apply under (imaginary?) first-best policies during that phase.

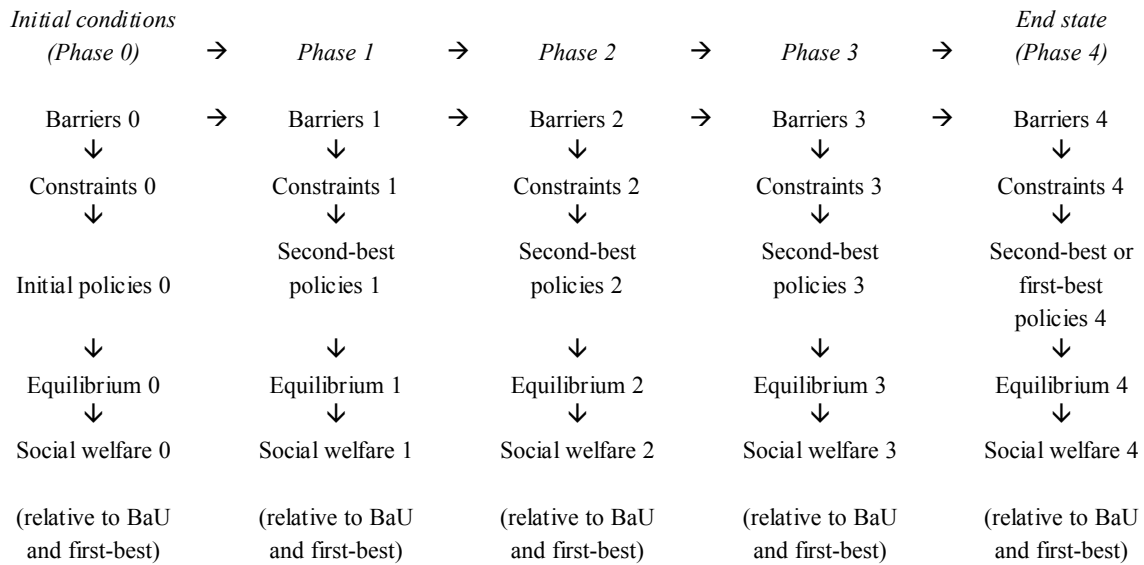


Figure 1. Schematic representation of IP's in MC-ICAM

An important aspect of the optimal design of an *IP* thus concerns the determination, for each phase, of the best among many possible policies that would satisfy the constraints applying during that phase. This may be hard to determine formally in practice, if anything due to the large dimensionality of transport network regulation. For the large network models used in MC-ICAM, this indeed turned out to be the case, and model implementation paths were developed both for urban and inter-urban transport, that were based on the thoughts developed earlier in this paper, but that did not aim to find the true second-best equilibrium for intermediate phases during an *IP*. By means of illustration, Tables 5 and 6 in the appendix summarize these *IP*'s. More detailed definitions and the evaluation of these paths will be presented in MC-ICAM Deliverables 7 and 8, and in Session III of this IMPRINT meeting.

When an *IP* is evaluated according to the approach sketched in Figure 1, one not only obtains insight into the associated welfare effects *per se*, but the progress of social welfare – compared to BaU and optimal welfare – along the *IP* may also provide important insights into the question of which constraints are particularly harmful to social welfare. This would give an indication of the barriers that are the most attractive candidates for earlier removal, and hence might be an – admittedly *ad hoc* – first step into the direction of endogenizing the time profile of barriers and resulting constraints (an important issue that, as stated, was postponed to future research).

6. Conclusion

The implementation of marginal cost based policies in transport has proven to be a difficult matter. Full-scale overnight implementation probably only exists in the minds of modellers, but apparently so strongly that the questions of how implementation paths should be designed, and what the consequences are, have received hardly any attention in the relevant literature. MC-ICAM's ambition was to shed some light on this issue, from a solid scientific perspective.

This paper described the background to the MC-ICAM project, its overall structure and approach, identified its key elements and their interrelation, and explained the key findings of the theoretical part.

The issue of designing and evaluating implementation paths has not yet been settled. Nevertheless, we believe that the project has taken us further on these matters, by offering a structured approach to these matters, and testing the implications in empirical transport models.

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 - Modelling and Cost Benefit Framework (MC-ICAM Deliverable 3) by Stef Proost, Nicole Adler, Bruno De Borger, Edward Calthrop, Andre De Palma, Dirk Henstra, Robin Lindsey, Farideh Ramjerdi, Simon Shepherd and Arild Vold
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Appendix. Example Implementation Paths

Phases	Phase 0 (current situation)	Phase 1 (short term, -3 years)	Phase 2 (medium term, 3-10 years)	Phase 3 (long term, 10- years)
Key dimensions & second-best constraints				
Coverage or scope of the pricing system	<p>General lack of integration of external and infrastructure costs in prices.</p> <p>Great national and local variation in the integration of these costs.</p>	<p>Step tolls on selected links.</p> <p>Area-based charges (incl. cordon tolls) in central urban areas and on weekdays.</p>	<p>Distance based electronic road pricing (ERP) road pricing for private cars and heavy good vehicles (HGVs) replaces area-based charges.</p> <p>Charges include infrastructure damage and emissions.</p> <p>Pricing still restricted to central area and weekdays.</p>	<p>Distance and GPS based ERP on all urban links and at all times for all vehicles and targeted at all major externalities, including congestion (road and parking), emissions, accidents and noise.</p>
Composition (mix) and level of pricing measures	<p>Generally three-part tariff comprising: vehicle tax, annual license fee, and fuel tax.</p> <p>Parking charges, also as substitute to road charging.</p> <p>Direct road user charges, i.e. road tolls, area licences and the like only in a few cases.</p> <p>Very different pricing systems across countries.</p>	<p>Step tolls, Area based charges, Cordon tolls, Parking fees, Fuel taxes</p> <p>Fare structures with minor changes to existing ones.</p> <p>Publicly controlled parking fees increased where necessary to cover induced costs.</p> <p>In public transport fare structures and subsidies adjusted to be in line with area-based charges for cars.</p> <p>Fuel taxes affected by intermodal considerations.</p>	<p>Area based charges, Cordon tolls, Parking fees, Fuel taxes, Electronic distance based road pricing using GPS Global position System).</p> <p>Integrated fixed & variable usage charging schemes (two-part tariffs)</p> <p>Pay-As-You-Drive Vehicle Insurance</p> <p>Public transport fare second-best and integrated with the road pricing system.</p> <p>Further adjustment in public transport fares and in public transport subsidies as distance-based ERP phased in. Charges gradually moving towards pricing relevant marginal social costs.</p>	<p>Electronic distance based road pricing using GPS</p> <p>Road pricing and fares broadly first-best.</p> <p>Public transport fares integrated with the road pricing system</p> <p>Public transport fares and subsidies fully adjusted (levels) and smart card technology integrated with concurrent GPS-based ERP road pricing system.</p>
Degree of differentiation of pricing measures & charging technology	<p>Practically no differentiation in time and space and by vehicle type.</p> <p>Users pay irrespective of the infrastructure damage, congestion and pollution they cause.</p> <p>In public transport, fares differentiated by journey length, mode and operator where a commercial decision.</p> <p>In most cases simple flat or zonal fares.</p> <p>Also travel cards giving unlimited travel for</p>	<p>Cordon tolls static.</p> <p>Cordon tolls and step tolls anonymous and based on PCEs (Passenger Car Equivalents).</p> <p>Publicly controlled parking fees by location and time (also by duration), and increased where necessary to cover induced costs.</p> <p>Simple technology used but ensured that it is compatible with plans for more sophisticated technology in the future.</p> <p>In public transport minor</p>	<p>Cordon tolls dynamic.</p> <p>Distance based electronic road charges ERP anonymous, GPS-based and based on PCEs and/or vehicle type</p> <p>User charges for emissions differentiated by vehicle type.</p> <p>Integrated fixed & variable usage charge schemes (two-part tariffs).</p> <p>Pricing partially integrated with ATIS (Advanced Travel Information Systems).</p>	<p>Distance based road pricing non-anonymous and based on vehicle type & condition and, possibly, driver characteristics.</p> <p>Road pricing fully integrated with GPS and ATIS.</p> <p>Publicly controlled parking fees fully disaggregated by location and time.</p> <p>Same for private parking when possible.</p> <p>Parking charging technology ultimately integrated with the GPS-based ERP system.</p>

	certain period of time.	changes to existing fare structures (fare cards, peak/off-peak differentials, reductions for selected groups). Application of smart card technology.	Publicly controlled parking fees more disaggregated by location and time. Smart card technology for public transport integrated with (technologically) concurrent road pricing system.	based ERP system. Ultimately non-anonymous charges according to full marginal social cost based differentiation. Public transport fares and subsidies fully adjusted (levels) and smart card technology integrated with concurrent GPS-based ERP road pricing system.
Rules and principles governing revenue use	Vehicle purchase taxes, annual license fees and fuel taxes to state budget. Road user charges earmarked where collected. Public transport fares to cover cost of service production.	More hypothecation.	More hypothecation.	How much hypothecation also a political choice.
Use of supplementary non-price measures	Infrastructure investments common to alleviate congestion problems.	Infrastructure given Complementary public transport measures. Alternative work schedules (e.g. staggered work hours, flextime, compressed work weeks, telecommuting), complementary public transport measures (Dial-a-Ride, minibuses, taxi service improvement, etc.).	Infrastructure partially adjusted: investment in public transport and road infrastructure. Increased public control of private parking (fees and other conditions). Alternative work schedules...	Infrastructure fully adjusted to optimum. Information systems indicating fare structures for passengers in public transport. Alternative work schedules...

Table 5. Phasing-in of measures in urban transport

Phases	Phase 0 (current situation)	Phase 1 (short term, -3 years)	Phase 2 (medium term, 3-10 years)	Phase 3 (long term, 10- years)
Key dimensions & second-best constraints				
Coverage or scope of the pricing system	<p>Road: 3 Europes: Eurovignette, free roads, toll roads</p> <p>All have fuel taxes and annual licence duty</p> <p>All countries required to have charges for rail infrastructure use</p> <p>Generally (? There is in fact a wide variety, and each case study will have its own starting point - Chris) consists of a MC-based, two part (or multi-part) tariff with fixed element based on unavoidable costs and an allocation of joint costs and a variable element based on wear and tear and electric traction costs.</p> <p>Air: Airport pricing includes landing fees according to maximum take-off weight of aircraft, transfer and non-transfer passenger departing fees, air traffic control tariffs, parking fees, freight loading / unloading charges, security and control charges for passengers and freight and at certain airports, night charges, noise fees and peak fees. Separate concessions and gate fees are collected for landside operations.</p>	<p>Road: some countries will implement HGV kilometre based charges ahead of EC legislation</p> <p>No changes currently to allow other modes to reach MCP schemes already in place for rail transport.</p> <p>Initiate use of peak-off peak, congestion and noise pricing mechanisms at large, hub airports</p> <p>Gradual implementation of existing directive</p> <p>Water: Introduce route or distance based charge with differentiation according to vessel type and emission factor to account for marginal infrastructure costs and emissions of local pollutants. (is this a short term measure? Chris)</p>	<p>Road: HGVs generally charged per km (Euro legislation).</p> <p>Tolls on specific roads (congested or expensive new construction) more common</p> <p>Rail and air: msp excluding scarcity and congestion</p> <p>Air: Initiate use of peak-off peak, congestion and noise pricing mechanism at all airports, in a neutral manner. Introduce fuel taxes to account for NOx and CO₂ emissions, on at least an E.U. wide basis. Encourage discussion on a worldwide basis to prevent airlines from refuelling at tax-free refuges.</p> <p>Rail and water: full marginal social cost pricing including wear and tear and environmental costs but not scarcity and congestion or accidents.</p> <p>In a slower variant (for all three modes): km charges covering wear and tear only.</p>	<p>Road: full GPS based (ERP) marginal social cost pricing for HGVs on all roads</p> <p>Rail and water: full marginal social cost pricing (including scarcity, congestion and accidents.</p> <p>Air: Use MCP mechanism without constraints. Introduce scarcity charges through market-based slot allocation mechanism. Introduce accident charges.</p>
Composition (mix) and level of pricing measures	<p>Road: mix of VED, fuel tax, tolls, vignette</p> <p>Rail, air and water: some countries under charging, others over charging relative to marginal social cost.</p> <p>(Actually this is true for rail but is it true of water?. Chris)</p> <p>Water: Port fee based on vessel type and destination, location of operations in the port, total processing time at port and season. Inland waterways: Harbour and lock dues</p>	<p>Road: mix of Vehicle Excise Duty, fuel tax, specific tolls, vignette for heavy vehicles, kilometre based charges</p> <p>Reduce fuel taxes as other charges introduced.</p>	<p>Road: km charge with other taxes reduced to compensate.</p> <p>Tolls more common; charges revenue neutral.</p> <p>Reduce fuel taxes as ERP with MCS pricing is phased in.</p> <p>Rail and water: full marginal cost of operations and environmental cost but not scarcity and congestion.</p> <p>Second best adjustments for under pricing on roads (if relevant)</p> <p>Rail and air: marginal social cost pricing (msp) (A,B); optimal second-best adjustments for under pricing</p>	<p>Road: fuel tax reduced to cover CO₂ costs only. Vehicle Excise Duty abolished. Reduce vehicle licences ultimately to zero, as ERP with MSC pricing is phased in</p> <p>Within the above, two alternative scenarios: remaining revenue neutral; full marginal social cost pricing.</p> <p>Road, rail and water: full marginal social cost pricing.</p>

			on roads (if relevant) (A)	
Degree of differentiation of pricing measures & charging technology	Varies; for road, in some countries supplementary charges for motorways For rail, some charges highly differentiated in time and space; others not.	Road: no differentiation within country by time or space Rail – differentiated by location	Road: tolls more differentiated by time of day Rail – differentiated by location	Full differentiation on all modes by time and location
Rules and principles governing revenue use	Road – vignette price must not exceed infrastructure cost Rail – all receipts generally devoted to rail infrastructure	Road: cross-subsidisation between modes	-	-
Use of supplementary non-price measures	Rail: EC directives, vertical separation. Investment, including investment in rail to relieve road congestion and environmental cost. In some cases, schemes include penalty payments/bonuses based on performance criteria, accident charges, congestion charges and information charges.	Rail: Agree amongst EU countries on removal of organisational constraints. Air: Harmonise state legislation according to EU legislation, define delay legally and set-up EU-wide database for all airports.	-	-

Table 6. Phasing-in of measures in interurban transport: road, rail, air and water