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Reforming prices in urban transport
A review of research findings

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Table of contents

1 Introduction

Charging for the use of transport infrastructure is a major policy instrument to improve the efficiency of transport systems while guaranteeing their accessibility in conditions of fairness and, ultimately, increasing their quality. Starting with the Green Paper on fair and efficient transport pricing, all the way through the recent CTP revision, the EU has consistently promoted the introduction of transport pricing, particularly for what concerns urban contexts, where congestion and air quality deterioration are challenging the very survival of many cities.

Designing Urban Transport Pricing (UTP) schemes is a complex affair, which requires the pooling of a wide array of pluri-disciplinary competencies (economic theory, political science, finance, technology, etc.). Implementing UTP schemes is also complex, if only because pricing interventions are but one of the many components of urban policies and their interaction with e.g. parking schemes, access restrictions and regulation in general, land-use planning, etc. are numerous and far-reaching.

This document aims at summarising the state-of-the-art of Urban Transport Pricing (UTP) research, based on the evidence provided by research projects, demonstration experiments, as well as policy formulation and implementation experiences.

It is organised in three main sections: the first (chapter 2) highlights the most relevant conclusions of recent research and demonstration activities. It follows a straightforward sequential logic, along the five main steps illustrated in diagram D1 overleaf : i) theoretical framework, ii) valuation and other methodologies, iii) policy design, iv) policy implementation, and v) impact assessment. The following section (chapter 3) then aims at identifying unresolved issues, based on the currently available evidence, suggesting that further research is needed in a number of areas. IMPRINT is a Thematic Network, and one of its main purposes is to facilitate the transfer of research findings into policy formulation: the final section of this document (chapter 4) therefore analyses the current state of the relationship between policy and research and draws conclusions on possible improvements thereof.

This document does not attempt to be exhaustive, but rather to highlight the main outstanding issues that can be derived from the experience accrued primarily through EC funded RTD projects. Also, many theoretical and methodological issues are relevant to Transport Pricing in general, while the focus of this report is specifically on urban issues. The approach followed here is therefore to concentrate on those issues which are particularly relevant in the urban context, or/and which call for solutions that are specific to the urban context.

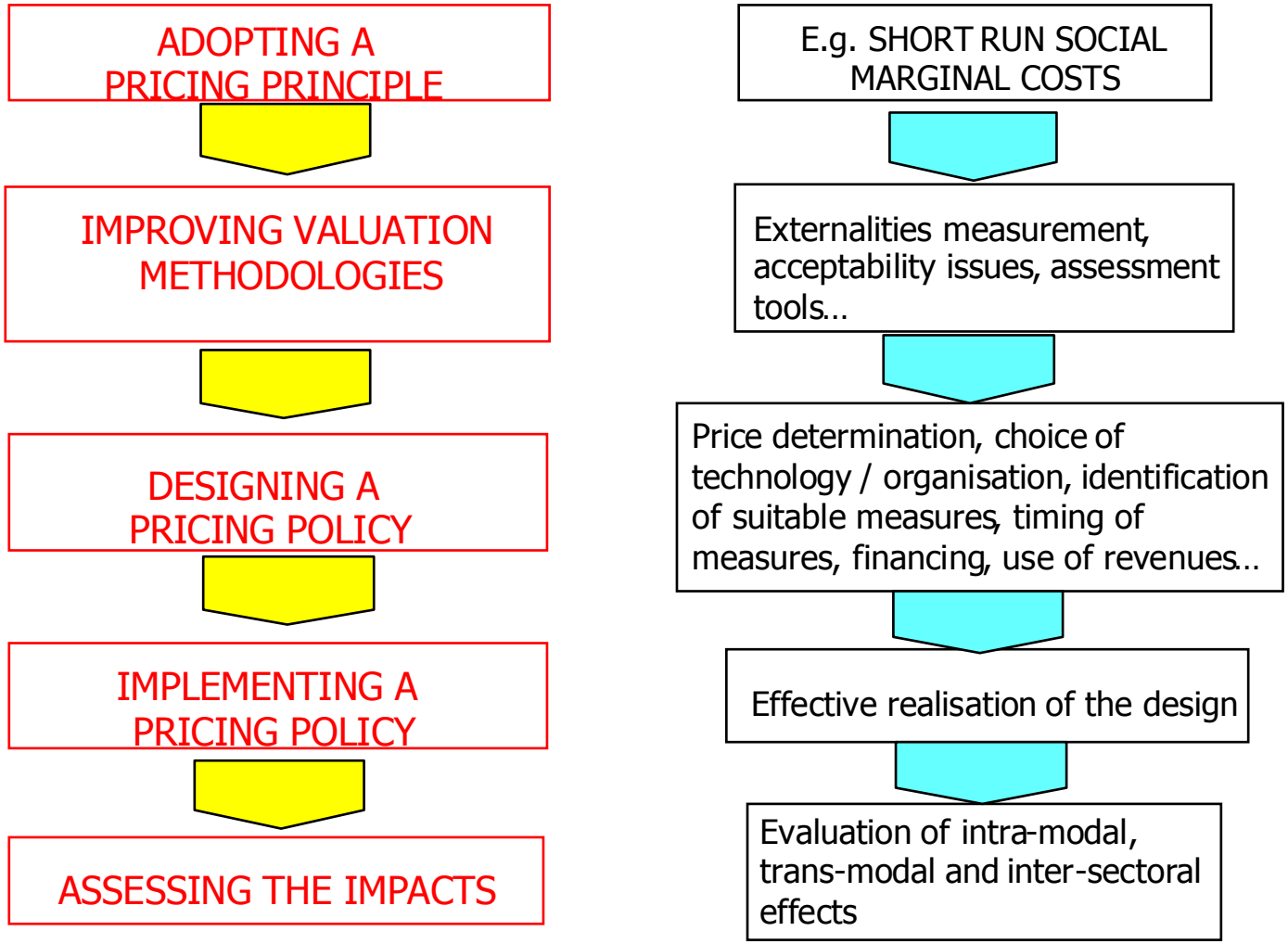
2 Urban Transport Pricing: what do we know so far?

2.1 The theoretical framework

As just evoked, theoretical frameworks for transport pricing analysis and design are not specifically targeted to urban contexts, but equally to rural and inter-urban transport systems. Consistently, the main recommendations stemming from theoretical research projects do not substantially differ between urban and non-urban contexts. The basic findings from recent theoretical projects in this area point at marginal cost pricing as the preferred pricing principle, based on its welfare maximising properties.

A full discussion of the rationale and of the implications of such theoretical frameworks is presented in a separate IMPRINT paper.

D1: Design, implement & assess a pricing scheme



2.2 Valuation methodologies

Theoretical frameworks define the general rules and principles to be followed when planning for the introduction of pricing systems or reforms thereof. Translating such rules into practice amounts to tailoring them to the specific characteristics of the physical, social, economic, technological and political context at hand. This, in turn, requires the use of methods, tools and techniques, possibly quantitative, to calculate, estimate, or otherwise assess a varied array of policy-relevant variables and indicators, namely:

- the social costs of transport, which are the main input to pricing policy design
- the impacts of pricing schemes on the performance of the transport system and on the economy as a whole
- the level of acceptance of all parties concerned as well as other social and behavioural variables that may be affected by the implementation of pricing schemes.

In the following paragraphs, these three issues are dealt with in sequence: the currently available stock of knowledge is summarised, and the main issues characterising the urban context are highlighted.

2.2.1 Valuation of transport costs.

A comprehensive accounting framework must include both internal (resource) costs and external costs generated by transport. Research in recent years has concentrated on the design and validation of methods for the monetary valuation of external costs; the resulting body of knowledge is commonly deemed sufficient to allow for the systematic incorporation of externalities in transport accounting frameworks. Bottom-up methodologies, based on the damage cost approach, are usually preferred to top-down methods that rely on cost control accounting schemes or on other indirect estimates of real costs such as e.g. shadow prices. Despite the dramatic progress achieved in recent years in the validation of such methodologies, the level of uncertainty still affecting many of the external cost values is high, and for specific categories of externalities (e.g. ecosystem damages, community severance, etc.) the current level of knowledge is simply insufficient. These are limitations applying however to the transport costs in general, while specific issues can be identified that are particularly relevant for UTP.

2.2.1.1 High sensitivity

As opposed to rural areas, cities are characterised by a combination of high intensity of traffic (and therefore of nuisances generated therefrom) and high density of receptors (people, monuments). On the other hand, it is now well known that modest percentages of reduction in e.g. urban congestion can have dramatic, non linear effects on the level of pollutant emissions and therefore on the overall value of social costs. Time-of-the-day is also of the essence, with most cost items varying considerably between e.g. peak and off-peak periods, while most analytical tools currently in use concentrate on peak values only. Altogether, this means that external cost calculations carried out in urban contexts are particularly sensitive to the uncertainties of valuation methods.

2.2.1.2 Physical complexity

Cities are complex systems, where the physical configuration of the landscape affects the pattern of propagation of nuisances (emissions, noise) to such an extent that only highly disaggregated representations of the phenomena associated to e.g. the dispersion of pollutants can provide a reliable account of how air quality is affected. Owing to the complex behaviour

of meteorological parameters, combined with the morphological peculiarities of urban landscape, one has for instance to accept that the concentration of a given polluting substance, at a given point in time, can be found to be substantially different in two locations that are only a few centimetres apart. Clearly, this reflects heavily on the monetary valuation of the resulting external costs, considering that the presence – and the density – of receptors can also vary dramatically within small distances. Models have been developed in several projects that attempt to provide a faithful account of such complexities, through e.g. the detailed representation of street canyons, of wind patterns, etc. Even assuming that the resulting estimates of external costs are sufficiently accurate to efficiently support pricing policies, the application of such detailed calculation methods is itself a complex and demanding task, generating high transaction costs that might exceed the benefits associated to accuracy.

2.2.1.3 Urban land use.

Externality valuation has so far mainly focused on a limited set of cost categories that are deemed to cover, cumulatively, the largest part of the overall monetary value of external costs. These are: pollutant emissions, noise, accidents, congestion and global warming. Other cost categories, however, are known to exist, although it is currently difficult to carry out meaningful estimates of the corresponding values. In the urban context, the most important single cost category that is usually omitted for lack of credible valuation methods corresponds to the social costs associated to the non-optimal (or non desired) use of land: visual intrusion generated by transport infrastructure, community severance such as e.g. resulting from the protecting fences of light rail lines in certain European cities, and, more generally, undesired changes of land use patterns such as e.g. urban sprawl induced by specific transport policies, etc.

2.2.2 Impact evaluation

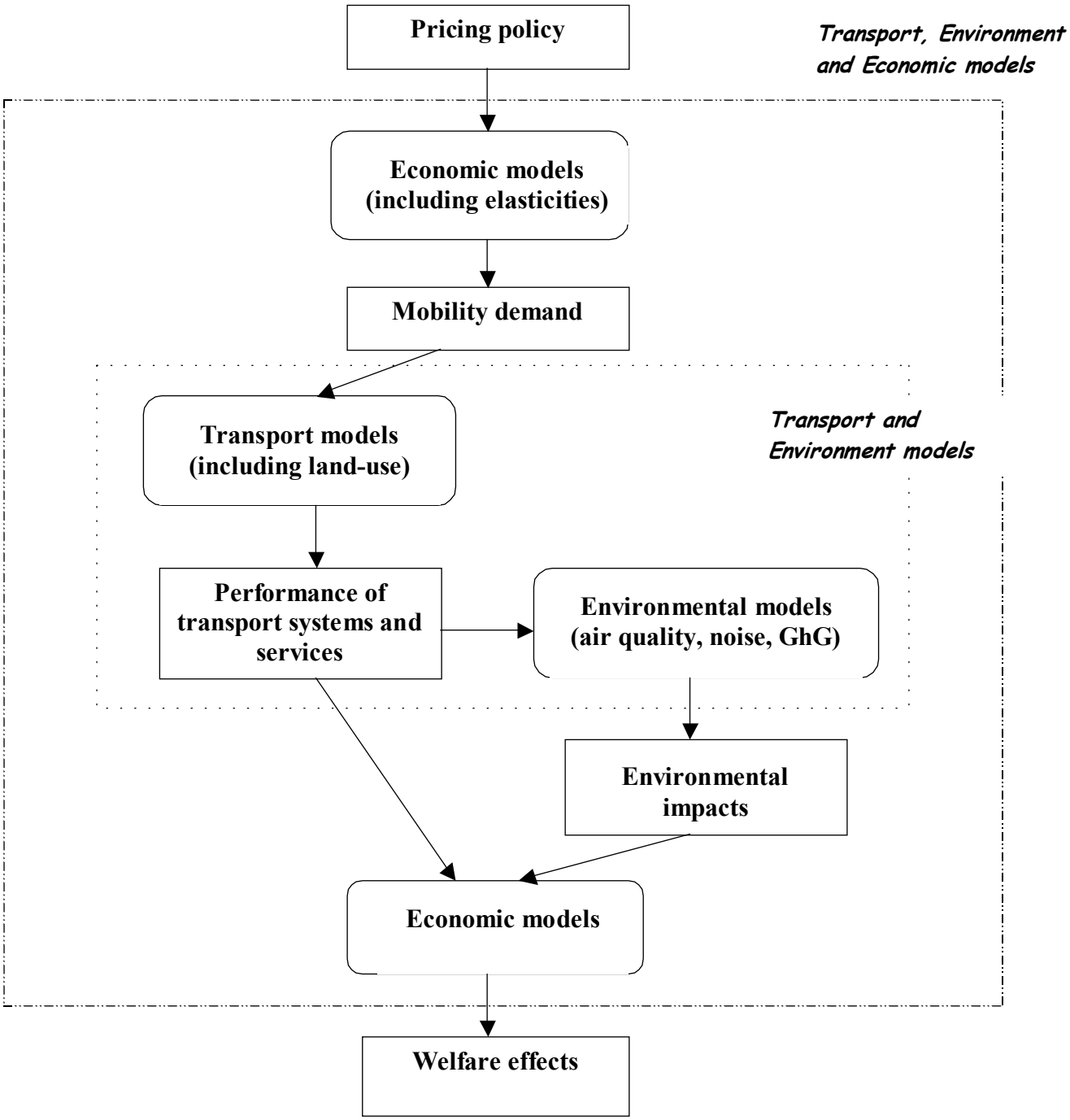
Social cost valuation is an essential input to the design of pricing policies. But policy decisions further require an evaluation of the impacts that can be expected from implementation. The scale and level of priority associated to the various impacts mainly depend on the nature of the original objectives: if pricing is introduced to e.g. reduce congestion, priority in impact evaluation will obviously be given to the measurement of congestion levels; if pricing aims primarily at increasing the patronage of public transport services, then its effectiveness will have to be assessed through the measurement of modal shares, etc.

In general, three main impact areas are considered in pricing research and experiments:

a) impacts on the transport system itself, assessed in terms of transport service performance (accessibility, speed, reliability, safety, modal split, congestion, efficiency)
b) impacts on the environment, assessed through the monitoring of air quality, noise levels, greenhouse gas emissions for which transport is responsible
c) impacts on the economy and society as a whole, which can be estimated through the assessment of income distribution effects, equity and, in general, welfare effects of pricing policies

Ideally, a comprehensive approach to impact evaluation should allow for the concurrent (and consistent) evaluation of the impacts in each of these three areas. In practice, the many research efforts in this field have usually focused on one or the other aspect, or even on specific issues within one of the main impact areas (air quality, modal split, revenue generation, etc.). The diagram D2 overleaf illustrates the role of impact assessment methods and the corresponding outputs.

D2: Impact assessment tools and methods



When it comes to urban transport systems, the application of the various methodological options and the validity of the results obtained are heavily affected by the high level of complexity of urban networks. Accurate estimations of traffic and other impacts can only be obtained through analyses at the micro level, which allow to take into account the local specificities of each network section. Even so, the dynamic interactions between the many variables involved (terms and conditions of access to the network over time; public transport supply across the network and over time; travellers choice of mode, time, destination, itinerary; etc.) are such that existing models cannot claim a high level of accuracy in predicting the effects of a given pricing policy.

Based on the recognition of the above limitations, a new breed of RTD projects has now seen the light, which focus on the experimental component of pricing research: while FP4 projects such as OPTIMA, FATIMA, PETS, TRENEN were exclusively based on modelling and simulation, and even projects such as EUROTOLL and TRANSPRICE only included a very limited original demonstration component, new endeavours such as PROGRESS and CUPID primarily rely on large scale, real life experiments to contribute to the validation – or/and to the improvement - of state-of-the-art impact assessment techniques. It is hoped (and expected) that a close monitoring of the pricing implementation process will provide useful indications, particularly as to the elasticity of users behaviour to road pricing, in terms of overall mobility demand and, even more important, for what concerns changes in travel choice (time, mode, destination, itinerary) induced by the introduction of pricing.

On the other hand, it is also now widely recognised that the impacts of the introduction of an urban road pricing scheme can hardly be isolated, in the practical context of evaluation, from the effects brought about by other, concurrent interventions on the urban transport system. Not only the respective impacts cumulate, they often produce synergies which amplify, or in some other way distort the final result.

Current research has taken these methodological difficulties on board and is addressing them through a three pronged approach:

- most pricing demonstrations face the problem of meaningfully comparing the results achieved to a reference situation, be it the so-called "Baseline", or the "Business As Usual" (BAU) scenarios, or other similar concepts. It is in fact very seldom that the data and information available at the outset in a given city readily allow to develop a full fledged *ex-post* Vs *ex-ante* analysis, whereby the same set of data and indicators are compared before and after policy implementation. The lack of such reference information reduces dramatically the validity and credibility of most impact appraisals. The most recent EU funded urban pricing projects, notably including CUPID/PROGRESS and the CIVITAS initiative have been designed - both in terms of expected duration and of methodological approach - to allow for a meaningful *before-and-after* evaluation to be carried out.
- Analytical methods, such as e.g. mathematical modelling, CBA (Cost Benefit Analysis) and the like, while theoretically preferred, are often found unable to reliably capture the complexity of urban transport systems and therefore to simulate - let alone predict - the impacts on such systems of a given pricing scheme. A practical supplement (although not an alternative altogether) to purely analytical frameworks is increasingly provided by appropriate sets of indicators, such as e.g. those identified and illustrated in CUPID for the consistent monitoring and evaluation of the PROGRESS demonstrations impacts.
- The current emphasis on empirical research paves the way to a systematic inductive approach, whereby results obtained, and impacts measured in city A would be somehow transferable to city B. Context dependency, however, heavily constrains all generalisation attempts, with empirical evidence showing how hazardous the inductive approach may

be. A step forward is likely to be achieved by recurring to statistical techniques such as e.g. cluster analysis, whereby context similarities (dimension, modal split, car ownership levels, etc.) can be factored in to explain or predict impact comparability across cities. Along the same line of thought, meta-analyses of past experiments can provide useful indications (see e.g. CANTIQUE).

2.2.3 Measuring acceptability

Acceptability is critical to the ultimate effectiveness of a pricing scheme. It is also an area where subjectivity of perception is to a large extent unavoidable, and which therefore deserves particular attention in the planning stages. Two major EU RTD projects (PATS and PRIMA) have recently investigated this area, which is reported upon in a separate IMPRINT paper.

2.3 Designing a pricing policy

2.3.1 Technology and organisation options.

Ultimately, there seems to be a wide consensus that a distance-based, satellite-controlled charging system would offer the most advantageous solution, combining fairness (the price charged incorporates all the specific features of the trip: vehicle type, distance, time, spatial context etc.) with efficiency, standardisation and interoperability (one system for all), and low operating costs. The conclusions of all recent RTD and policy work (CAPRI, HLG, etc.) point in that direction, and the development of such a system is in fact already under way, notably thanks to the GALILEO programme that will provide the communication backbone of such a generalised transport pricing application.

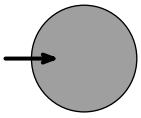
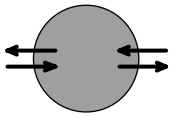
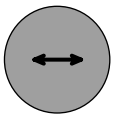
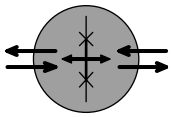
In terms of timing, however, it can be expected that many years will pass before a satellite-based system is actually in place, while urban congestion has already reached unsustainable levels, and European cities cannot afford to wait for the ultimate solution to be available on the market. The options currently practicable are varied, each in fact corresponding to the combination of a basic concept (cordon pricing, area pricing, etc) and of a technological solution to implement the concept in practice and enforce its application.

Table 1 overleaf, drawn from TRANSPRICE, summarises the basic concepts and their characteristics.

Each such concept can then be implemented through a variety of technological options, ranging from "traditional", low-tech (or no-tech) schemes (e.g. paper permits with human enforcement) to hi-tech options (based on e.g. the combined use of OCR technology, RF communication between On Board Units and off-street beacons, and IT devices for automatic fine emission). Research has confirmed that there usually is an obvious trade-off between investment costs and transaction costs, whereby capital intensive systems earn their way through low enforcement costs, while the low investment cost associated to low-tech schemes is largely offset by high operating costs and by the comparably low efficiency of the system.

RTD projects have so far concluded with a fairly good level of consensus that, while we wait for satellite-based systems to be available, cordon pricing schemes implemented with DSRC (Dedicated Short Range Communications) offers the most balanced and attractive option. It is in this direction that the (still few) real life implementation efforts can be found, whether in Europe (e.g. Rome, and other PROGRESS cities) or abroad (upgrading of the Singapore scheme, Hong Kong trials etc.).Variants - even significant - around this basic concept are numerous, but not investigated further in this document, which does not focus on technological options as such.

Table 1: The basic urban road pricing concepts

Sites for payment			Type of pricing, based on:									
			N	A	S	R	P	V	O	T	C	E
A	Passing a point (e.g. a bridge)		♦			♦	♦	♦		♦		
B	Passing a road section		♦		♦	♦		♦		♦	♦	
C	Entrance control (licence area control)		♦	♦				♦	♦	♦	♦	♦
D	Entrance/Exit control for a zone		♦	♦				♦		♦	♦	♦
E	Zone control		♦	♦				♦		♦		♦
F	Combinations		♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
			N	A	S	R	P	V	O	T	C	E

N = National policy, A = Area/Zone, S = Section, R = Road type, P = Point

V = Vehicle type, O = Occupancy, T = Time of day, C = Congestion, E = Environment

Source: *TransPrice* Deliverable 1: Review of Options and Issues

2.3.2 Determination of tariffs.

This is certainly an area where empirical work such as is being carried out in a number of European cities will provide precious indications as to the practical applicability of the theoretical principles. Recent research (TRENEN, CAPRI) and the policy documents partly derived therefrom (HLG reports, CTP) decidedly identify SRMC (short run marginal cost) pricing as the most appropriate reference for setting and modulating charging levels. Several obstacles and constraints however make it hardly straightforward to actually set urban road prices equal to SRMC, and this is reflected in current research projects such as MC-ICAM, whose main objective may be (simplistically) stated as being "how and how far can one depart from SRMC without endangering the ultimate fairness and efficiency of the system?". Also, cities that are already in the process of designing, or in some cases implementing UTP schemes have in fact set charges which have no explicit relationship with SRMC.

There are in fact several reasons behind this discrepancy.

- Firstly, SRMC are not straightforward to estimate for urban trips. A few attempts have been made (notably TRENEN) to evaluate SRMC for selected cities, but , in general, city authorities are not appropriately equipped to carry out reliable calculations. UNITE is currently developing urban case studies that will certainly provide precious input in this area (notwithstanding the aforementioned difficulty in extrapolating from one city to the other).
- Second, urban road pricing amounts to introducing payment for a service that was previously free of charge. This is a situation that is known to generate high levels of discontent among the users, all the way to outright rejection, such as e.g. in the case of the Lyon's newly tolled ring road section. Politicians are highly sensitive to such risks, and subsequently tend to set charges based on estimated acceptability rather than on theoretical principles or even accounting evidence. For the same reason, gradual implementation is often a basic feature of UTP schemes. Whether in London, or in Rome, the initial level of planned charging is likely to be adjusted in time according to users reaction and to the level of attainment of original objectives.
- And thirdly, it is precisely the specificity of local objectives that drives the setting of the charging levels: in Rome, for instance, road pricing is designed to alleviate congestion in the historical city centre. Simulations carried out prior to the introduction of charging indicate that below a certain threshold (ca. 2.5 Euro), there is little chance to achieve a reduction of congestion, not because of standard elasticity mechanisms, but for a very specific phenomenon associated to the high number of two-wheelers, whose drivers might opt back to their private car as soon as they are permitted (although at a price) to enter the city centre at all: for cordon charges below such threshold, the number of private cars entering the city centre is therefore likely to increase with the introduction of road pricing, defeating the very purpose of the exercise. It is therefore understandable, in such cases, if policy makers do not rely on SRMC to determine optimal pricing levels.

2.3.3 Coping with distortions from pricing

Ever since the early urban pricing RTD projects (e.g. OPTIMA/FATIMA), it has been fully recognised that pricing alone cannot achieve the ultimate objective of ensuring the sustainability of urban mobility. UTP should therefore be "packaged" with other measures to enhance their respective effectiveness:

- the synergy with parking measures is particularly relevant, especially when considering that, whatever the pricing principle adopted (e.g. SRMC), road pricing (e.g. cordon charge) should be designed so as to avoid the risk of duplicating pre-existing parking charges
- research has also shown that, in general, the application of identical (or similar) pricing principles to all modes and all types of trips (i.e. both urban and rural/inter-urban) is likely to generate a surplus from private car pricing in urban areas, while non urban trips might not cover their total social costs. Cross subsidisation (as recently endorsed by the revised CTP) may contribute to correct such undesired effects.
- Other possible distortions are associated to the very nature of specific mechanisms, such as e.g. noise costs, as well as, to some extent, accident costs. As pointed out e.g. in CAPRI, the current body of knowledge suggests that the marginal cost of noise may well follow a decreasing pattern (i.e. the higher the number of vehicles, the lower the incremental noise damage associated to each new vehicle). Clearly, under such circumstances, charging the user for the marginal cost of noise will not contribute to

encouraging a reduction in traffic. Regulation is needed in such cases to supplement pricing measures.

- Also, as advocated by TRENEN, urban public transport is often found to be undercharged according to e.g. SRMC. Nevertheless, increasing the cost of public transport to the user is likely to counter act all possible strategies aimed at a more sustainable modal split, and should therefore be avoided.

2.3.4 Financial issues

The debate on the financial aspects of UTP has two main facets, deeply interrelated: on the one hand, it has to do with the raising of the funds required for the effective implementation of policy packages built upon a UTP strategy; on the other, it addresses the issue of UTP revenues and their utilisation. As clearly pointed out by e.g. TRANSPRICE, and then FISCUS, a double paradox arises:

- firstly, the timing factor: although one of the expected - and targeted - effects of implementing a UTP is precisely that of generating financial revenues, such revenues are obviously not available at the time when the UTP project requires investment funding
- secondly, economic theory advocates that revenues of transport pricing should not be earmarked for re-use within the transport system from which they are generated.

These two paradoxes have now been clearly identified as major concrete barriers to the successful implementation of UTP: on both counts, policy makers find themselves caught between the proverbial devil and the deep blue sea, i.e. trying to sell something they do not have the money to buy in the first place, without even being able to promise a direct reward.
Ways out are now being devised, as evoked below, through the design of appropriate PPP schemes, and the identification of appropriate compromise solutions on an "adequate level" of revenue earmarking.

2.4 Simulating and/or implementing a pricing policy

Many RTD projects, funded through FP4 and FP5, have looked at urban pricing issues. Most of them include either a modelling component to simulate the implementation of a UTP scheme, or/and an account of experiments carried out in real life. The two following tables contain respectively a summary of the nature and scope of the most important pricing projects, classified according to the 5-step process illustrate in diagram D1 above, and an overview of the European cities involved in case studies, simulations or demonstrations through EU funding.

Table 2: UTP research - main EU project references

Steps of the process	Research areas	Projects *
1. THEORETICAL FRAMEWORK		
Adopt a pricing principle	Methodological economic research on the most efficient pricing principle	CAPRI (D2, D4) HLG I (Final Report) FISCUS (D1, D2) MC-ICAM (D1) PETS (D2)
Adapt it to the specific mode / environment	Research on second best solutions and optimal transition phase	MC-ICAM (D2, D3) FISCUS (D1, D2) AFFORD (D1) TRENEN II CUPID PETS (D3, D4)
2. IMPROVING VALUATION METHODOLOGIES		
Evaluate the social costs of transport infrastructure use (internal + external)	Research on measurement of internal and external costs	CAPRI (D3) ExternE QUITS FISCUS (D3) UNITE (D1 to D12) HLG II PETS (D7)
Develop assessment tools (effects on income distribution, modal share, efficiency… at different levels: intra-modal, inter-modal, inter-sectoral)	Theoretical research on impact assessment	PETS TRENEN MC-ICAM (D7) AFFORD (D2a) PRIMA (D3) EUROTOLL PROGRESS (D2)
Consider acceptability	Acceptability	PATS (D1, D2, D3, D4) AFFORD (D2c) PRIMA (D1, D4) CUPID (D4) MC-ICAM (D4)
3. DESIGNING A PRICING POLICY		
Price level determination	Case studies, demonstrations, simulations	CUPID (D5) MC-ICAM (D4) PROGRESS (D3)
Timing of measures	Packaging of measures	OPTIMA FATIMA SPECTRUM MC-ICAM (D6) CUPID (D5) PROGRESS (D3)
Choice of technology / organisation	Technical specific research (engineering, …)	PATS (D4) CUPID (D5) PROGRESS (D3, D4)
Consider financing and use of revenues	Financial issues connected to implementation	FISCUS (D1, D4) PROGRESS (D3) UNITE (D1 to D12) FATIMA

4. IMPLEMENTING A PRICING POLICY		
Effective realisation of the design	Case studies, demonstrations, simulations	CUPID (D5) PROGRESS (D5) TRANSPRICE PETS CONCERT-P TRENEN-II STRAN
5. ASSESSING THE IMPACTS		
Evaluation of intra-modal, trans-modal and inter-sectoral effects	Documentation of impacts – demonstrations	CUPID (D5, D7) EUROTOLL CONCERT-P DESIRE CUPID/PROGRESS TRANSPRICE CIVITAS

* This classification is accompanied by a list of relevant deliverables (when available). This list has to be considered as an indicative guide through the main topics of each deliverable, without willing to be exhaustive.

Table 3: UTP research - main references of involved cities

Project	Cities involved	Nature of the study (case study, demonstration, simulation)
AFFORD	Edinburgh, Helsinki, Oslo Athens, Lombardy, Madrid Athens, Como, Dresden, Oslo	Simulation through strategic and tactical models Case study Survey
CONCERT-P	Trondheim, Bristol, Barcelona	Demonstration
CUPID, PROGRESS	Bristol, Copenhagen, Edinburgh, Genoa, Gothenburg, Helsinki, Rome, Trondheim	Demonstration
EUROTOLL	Stuttgart (DE), Leicester (UK)	Demonstration
MC-ICAM	Welfare assessment in Paris, Brussels, Helsinki, Oslo	Simulation through models
OPTIMA, FATIMA	Edinburgh, Merseyside, Vienna, Eisenstadt, Tromsø, Oslo, Helsinki, Torino and Salerno	Case study
PETS	Lisbon (Tagus river crossing)	Case study and simulation
PRIMA	Barcelona, Bern, Lyon, Marseille, Oslo, Rotterdam, Stockholm, Zurich	Case study
TRANSPRICE	Athens, Madrid, Como, Leeds, York, Goteborg, Helsinki, Graz	Demonstration sites and simulations through models
TRENEN-II STRAN	Amsterdam, Athens, Brussels, Dublin, Bologna and London	Simulations through models

2.5 Assessing the impacts

Methodological issues associated to impact assessment have been discussed in previous section 2.2.2. As explained above, it is hoped and expected that the new generation of pricing projects, which focus on the gathering of empirical evidence, will allow to build up a novel body of information and knowledge to feed into systematic before-and-after analyses.
As advocated by e.g. CAPRI, both modelling exercises and demonstration experiments have their intrinsic value, but it is the from their combined and compared analysis that lessons can be learnt, theories validated or challenged, and real impacts appraised.
A more extensive discussion of UTP impact assessment is carried out in a separate IMPRINT paper.

3 UTP: issues requiring further research

Drawing from the above review, one can conclude that the current state of knowledge in urban transport pricing, while sufficient to initiate and proceed with real-life implementation, still requires supplements, improvements and enhancements in various areas, where further research is likely to be beneficial.
Some of these areas are already being explored through on-going or forthcoming projects, notably within the last phases of the EU FP5. Others are still largely untouched, and decisive steps towards their analysis are recommended.

3.1 Equity

The equity implications of UTP are manifold and potentially dramatic. They range from pure distributive effects to the threat that access restrictions impose on the freedom of movement, but also to the need to ensure the equal treatment of modes and of the various categories of users, whereby UTP may affect the quality of service of specific urban transport services more than others.
To a large extent, equity is one of the facets of the broader acceptability issue, and in that respect it has been tackled in projects such as PATS, PRIMA and AFFORD. On the other hand, the current experiments carried out within PROGRESS and CUPID have highlighted equity as one of the critical impact areas to be monitored. First lessons can be learned from these projects concerning:

- the perception of end-users (transport service users), which, according to surveys carried out within e.g. PATS (but also in certain PROGRESS cities), is more balanced than usually expected: it would seem that equity concerns are not overwhelmingly constraining users expectations and reactions to the introduction of UTP, and that policy makers tend to over-rate the potentially adverse reaction of citizens in this regard
- equity measurement, which poses problems so far unresolved, both theoretical and practical. Forthcoming RTD projects such as e.g. SPECTRUM should contribute decisively to the advancement of methodology in this area, by e.g. pointing at balanced mixes of: i) analytical tools (for ex-ante modelling and equity impact simulation) and ii) monitoring techniques, based on appropriate equity indicators, to allow for ex-post assessment and policy validation.

3.2 Use of revenues

As previously highlighted, optimal use of the financial proceeds from UTP systems is a subject of heated controversy. On the one hand, economic theory suggests that welfare is maximised when revenues are not earmarked, but rather used to e.g. lower general income taxes. On the other hand, urban policy makers are convinced that re-injecting the revenues

from UTP into the urban transport system improvement, through e.g. the enhancement of public transport services, or the provision of new infrastructure, is essential to ensure both fairness and users acceptance. The current orientation seems to point at a compromise solution, whereby the basic rule of welfare economics can be bent on two accounts:

- firstly, it can be accepted that part of the UTP proceeds are earmarked for transport system improvements, with the remaining part being used for general fiscal purposes
- second, earmarking should in any instance be devised within reasonably flexible rules, e.g. allowing for cross subsidisation of modes.

Future research is expected to explore the feasibility of these concepts, and help determine the most appropriate level of compromise, i.e., to put it crudely, provide answers to two basic questions:

- what is the maximum share of UTP proceeds that can be earmarked and re-injected within that same urban transport system?
- which are the boundaries of the economic system (modal, territorial) within which earmarking is acceptable?

The last wave of FP5 projects will at least partly address these issues.

3.3 Institutional and legislative aspects

As previously mentioned, the design, implementation and enforcement of UTP require the involvement of institutions and decision makers at several levels (national, sub-national and supra-national). Particularly in the case of UTP, the range of involved institutions and the scope for potential conflicts (or, at least, lack of co-ordination) are very wide: cities are usually constrained in their policy making by legal and institutional rules that are issued at the national level, e.g. in the area of basic taxation (including fuel), but also for what concerns the protection of citizens privacy (an issue that has already been raised in several cases where advanced ICT solutions for UTP enforcement were perceived as a threat to basic privacy rights). Furthermore, within the urban institutional framework itself, conflicts of competence are emerging between e.g. mobility agencies, budget departments, infrastructure departments etc. in relation to UTP design, realisation and exploitation. These aspects are largely unexplored so far, and future research is bound to address them systematically, also considering the current evolutionary trend towards privatisation, the liberalisation of public transport and the increasing role of the private sector in transport infrastructure funding. As several EU RTD projects have pointed out, de-regulation does not amount to the abolishment of rules, but rather to the re-definition of the legal and institutional framework. New rules are needed to enable the transport market reforms, and UTP can play a major role in such reforms. Research in this area will need to answer basic questions such as:

- what forms of PPP are the most effective for UTP funding?
- what are the areas where inter-departmental co-operation (within the city administration) is mandatory to ensure smooth implementation of UTP systems?
- what should be the limits of local authority powers in devising and implementing UTP systems?
- is it possible to define a paradigm of institutional setting that could serve as the best practice reference for cities intending to introduce a UTP system?

Here again, the last wave of FP5 projects should at least partly address these issues.

3.4 Impact assessment

In qualitative terms, UTP trials or/and simulations have confirmed that urban road pricing does have a meaningful potential in reducing traffic (and therefore congestion and the

environmental nuisances associated to urban mobility), and, possibly, in modifying the users pattern of behaviour (trip choice, modal choice, etc.).
But, as repeatedly mentioned, the current body of knowledge in this area is mainly constrained by the lack of mature experimentations allowing to draw robust conclusions for what concerns both the impacts of UTP themselves and the appropriateness of the tools and techniques to assess those impacts.
Real life, full scale demonstration projects such as PROGRESS and, prospectively, those carried out within the CIVITAS initiative will undoubtedly allow for precious advancements in this area, particularly for what concerns the causal relationships between the existence (and the characteristics) of a UTP system and users behaviours, where standard economic theory, based on elasticities and utility functions, is proving to be not fully adequate to capture the complexity and subjectivity of urban travellers decision processes.
Another fundamental issue is that of generalisation and transferability (of good UTP practice). As previously mentioned, no straightforward extrapolation can be carried out from one city to the other. This calls for a supplement of research aiming at the establishment of a full fledged generalisation and transferability framework, possibly combining statistical techniques (so as to make the best of the input gathered from real life experiments) with economic and transport modelling. Until and unless such a framework is available, results from individual UTP experiments will hardly allow to formulate policy conclusions as to the impact of UTP *per se*.

3.5 Harmonisation

The issue of harmonisation is in fact another facet of the institutional theme. It is now clear that a lack of harmonisation of pricing principles and structures across Member States and among modes is a major impediment to the implementation of generalised UTP policies. But harmonisation (or lack of it) may also play a very important role in modifying the relative competitivity of cities within the same nation, or region. The recent CTP revision fully recognises the importance of these matters and announces a new directive in this area.
It is however felt that the implications of harmonisation issues are insufficiently explored at this time. Projects such as MC-ICAM (that aims at defining a "Phased approach" to smooth implementation of generalised SRMC pricing, including UTP), and the forthcoming SPECTRUM (that will attempt to devise the optimal transition paths to move from a heavily regulated transport system to increasingly market driven scenarios, where UTP plays a major role) undoubtedly point in the right direction, but additional investigations of the complex issue of harmonisation and the implications thereof are also needed.

3.6 Urban freight movement.

Freight movement is responsible for a large share of the sustainability problems currently faced by European cities, but UTP research has so far concentrated primarily on passengers traffic. Future research and demonstration programmes must indeed integrate goods distribution vehicles in UTP schemes, if only for intra-modal consistency and equity purposes.

3.7 Long term implications and scenarios

Urban sub-systems evolve over time with different speeds: while transport structures and activities can be modified, even radically, in relatively short periods of time (a few years, sometimes less), other sub-systems, and in particular land-use related patterns and the activities thereto, evolve at a much lower pace.
The sustainability of modern cities is, in fact, both a matter for urgent deliberation and immediate interventions and one that should be analysed in the perspective of long term

scenarios. The incorporation of UTP in such long-term scenarios, along with other major long term factors (e.g. ICT diffusion, e-life, etc.) then becomes mandatory and should be promoted through adequate RTD endeavours, so far hardly visible.

4 Making UTP happen: from research to policy

In previous sections of this report, we have repeatedly affirmed that the current state of RTD is sufficient to proceed with UTP implementation: viable technological solutions are available; the basic implications of economic theory are understood; the major impact areas of UTP have been identified and are being explored; tools and techniques to measure, valuate and assess are reasonably well mastered. Although further research and demonstration activities are needed, the first priority is therefore to "make UTP happen", which amounts to ensuring that the body of knowledge outlined above is made concretely usable by policy and decision makers. "Making UTP happen" then requires a comprehensive communication strategy, of which IMPRINT-EUROPE is an instrument. This last section points at the main areas that such a communication strategy should cover.

There are in fact four main categories of players involved: the research community, policy and decision makers, and the end-users (urban travellers and citizens at large), industry and operators (including private financing institutions). The main communication flows that could facilitate the successful uptake of UTP systems are summarised in Table 4 below.

Table 4: from research to policy

To ▸ / *From* ▾	**RTD**	**Policy makers**	**Users**	**Industry/operators**
RTD		⇨ RTD results ⇨ Clarifications ⇨ Problem solving		UTP requirements (technological, organisational)
Policy makers	UTP functional requirements		⇨ Commitment ⇨ Cost/benefits of UTP	Requirements (functional, financial)
Users		⇨ Acceptance ⇨ Social constraints and expectations		
Industry/operators	Requirements (scientific and technological)	Constraints (financial, technical, institutional)		

It is here assumed that users mainly communicate with policy makers (and hardly interact directly with the other players).

Communication from the RTD community to policy makers concentrates on:

- ⇨ the presentation of research results, in plain, jargon-free language;
- ⇨ the supply of clarifications on conflictual issues such as, in particular, how to reconcile economic theory with pragmatic constraints

It takes the form of written summaries of RTD results, debates, and specific, problem-solving answers to clarification requests

It should happen within a context-specific frame, as much as possible, in order to facilitate immediate acknowledgement and uptake. Hence the need for generalisation and transferability tools as advocated above.

Researchers are also responsible for the issuance of technological and organisational specifications of the desired UTP systems, directed at the concerned industry and operators.

Communication between policy makers and users is the other critical component of the communication strategy. Although it does happen that users voice their expectations and concerns in a direct and explicit way, most of the communication between citizens and policy makers goes through implicit channels, i.e. the revealed preferences behind their choices and behaviours.
Policy makers, in turn, usually reach citizens through collective and rhetoric channels, with little or no effectiveness on specific issues such as the development of a UTP scheme. Much can and should be done to reinforce this component.