URBAN PRICING

From theory to reality

Directorate-General
for Energy and Transport

EUROPEAN
COMMISSION

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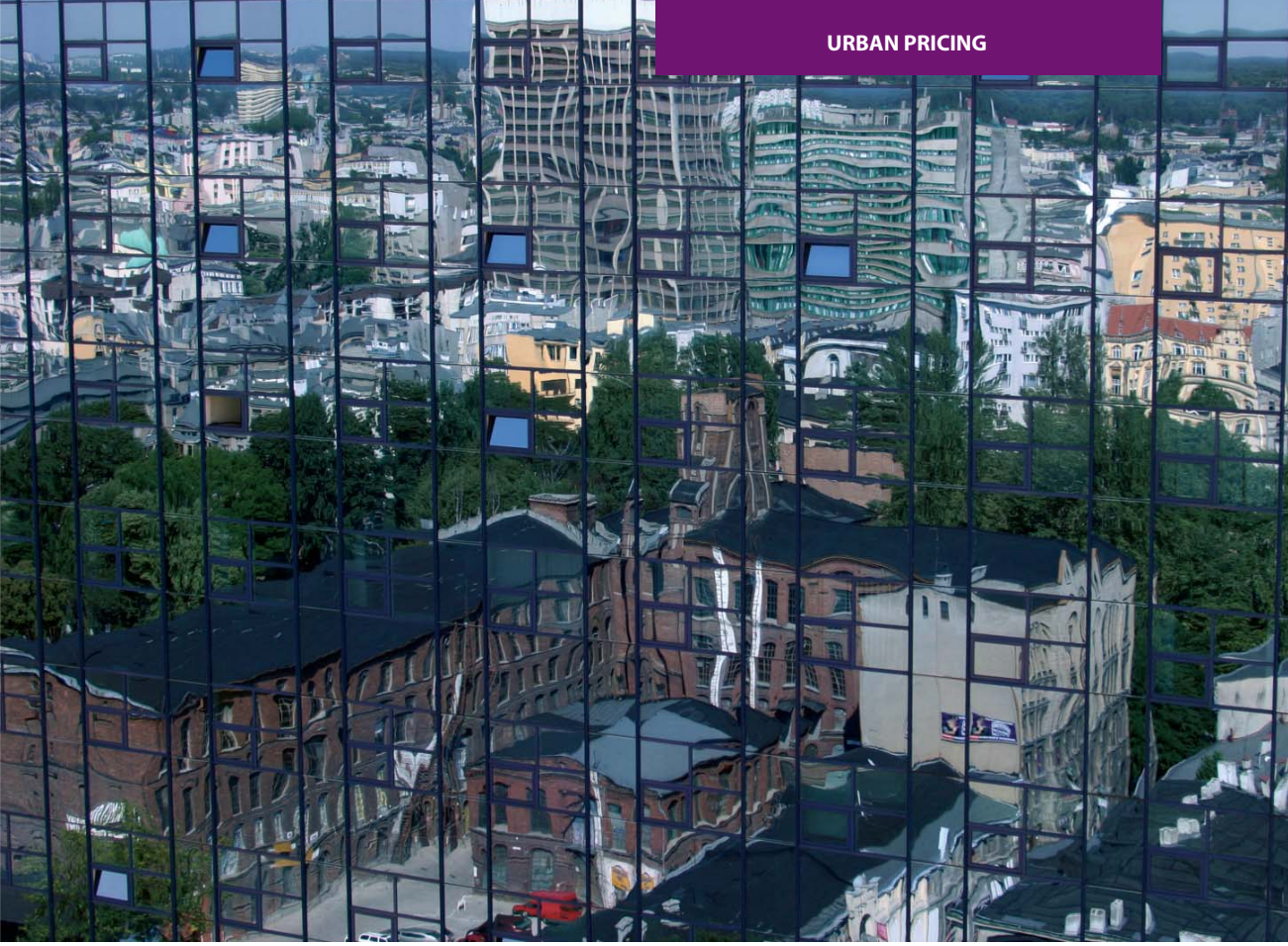

FOREWORD

The challenge to urban transport is to increase mobility while at the same time reducing its negative impacts such as congestion, pollution and accidents[1]. Supply-side solutions alone do not suffice. Demand management, including the use of price incentives, is also needed. Principles of efficiency and fairness suggest that the prices paid by travellers reflect the full social cost to society of their trips. In addition to shifting demand towards more sustainable transport modes, and cleaner and more energy efficient transport means, pricing strategies have the potential to generate funding which can be spent on the transport system.

The need to combat road traffic congestion and the desire to find new revenue sources for transport investments have stimulated the interest in schemes where charges for road use are introduced, such as parking fees and charges to allow vehicles to use certain roads. The theoretical advantages of charging for road use have long been discussed in economic literature. Practical experience with such schemes is more recent. Research efforts as well as the introduction of toll rings and congestion charging schemes in a few European cities in the last two decades provide considerable experience to draw from and support the translation to theoretical principles into practical policies.

1 DEFINITION OF THE SUBJECT

A key element of demand management in urban transport is the allocation of road space. As this space is a finite resource, absence of regulation can lead to overuse, which appears in the form of congestion. Reserving road space to public transport vehicles or to private vehicles with high occupancy are two ways of allocating road space. Another way is to restrict access to certain areas of the city. This latter kind of command and control measure does not make a distinction between trips of different value. Conversely, if travellers are faced with a road user charge, they will be encouraged to make their own judgement on the value of their trip.

Charging for road use, often referred to as road pricing, has long been advocated by economists on the grounds that it is socially advantageous. Roads are subject to congestion, which occurs as every additional trip made forces those vehicles already on the road to slow down. The introduction of a corrective charge will make each driver aware of the cost he imposes on other drivers. This may help reduce traffic volumes and have positive effects in terms of reduction of congestion and overall travel time on the network.

In reality, the efficiency effects of road charging policies are the consequences of both the actual behavioural responses of the travellers as well as the way the revenues from charges are spent. In addition to travel time savings, benefits include increased travel time predictability, reduced pollution and noise, reduced accidents and improved travel conditions for public transport.

The economic theory and mathematics of road pricing also dictates that the charge should to be equal to the monetary value of the additional travel time imposed by each driver on other drivers. This is the 'marginal cost pricing' principle. The principle extends into 'marginal social cost pricing' if, in addition to time, other costs, for example pollution, are considered when setting the charge. Economists have gone one to extend the welfare maximisation framework to cases where the price of public transport is set together with road charges.

The other motivation for introducing road charges is to provide financial resources for infrastructure investment programmes. Revenues from road charges can be spent as well to improve transport at large. Both demand management and fund raising make charging for road use of interest to policy makers[1]. EU policy recommends that road charges should be fair and non-discriminatory for users.

In recent years, practical experience with charging for road use has increased in Europe. Parking policies based on pricing are now commonly adopted in European cities. City-centre toll rings designed to raise revenue have been introduced in Norwegian cities. City-centre congestion charging schemes have been introduced in Durham, London and Stockholm.

2 THE NEED FOR RESEARCH

Economists have long speculated on the theoretical principle of marginal cost pricing. Progress at theoretical levels has continued with the development of models able, on the one hand, to predict the impacts of pricing schemes more accurately and to provide normative information on the attributes of ideal pricing schemes on the other. Practical experience is relatively more recent and has increasingly provided knowledge helpful to the design and implementation of road charging schemes. At the start of the Fifth Framework Programme there were seven main research questions:

How can the monetary values of intangibles be estimated?

External costs include congestion, pollution, noise, accidents. To internalise these costs with a charge it is necessary to know their monetary value. Previous research had concluded that, on average, congestion costs constitute the largest part of the overall external costs in urban areas. Research on the various methodologies for estimation of the different cost elements was a necessary step towards European harmonisation.

How should the marginal cost pricing principle be implemented?

'Which pricing instruments are most efficient in different situations?' and 'what should the right price levels be?' had been among the topics of past research. It was concluded that the price of car use should increase in peak periods. Cordon tolls and peak/off-peak differentiation can achieve significant efficiency improvements compared with the current situation. More research was needed on the implementation steps to be taken from current taxation regimes towards theoretically optimal charging solutions.

What are the real life impacts of road charging schemes?

Assessing the effectiveness of policies requires knowledge on the behavioural responses of travellers. Previous research had concluded that road charging can be effective in changing travel patterns, and that car users change timing, destination or route more readily than mode. Further research was needed using existing real world cases and demonstrations.

How can road charging be implemented in practice?

Learning from demonstrations and already operating systems is key for real life implementation of road charging schemes. This will benefit from insights on technologies (including satellite-based technologies), legal and institutional settings, and economic and financial profitability of the solutions adopted.

Is it possible to raise acceptability of road charging schemes?

Acceptability represents the main barrier to practical implementation. Past research had already suggested making road charging part of a policy package, offering alternatives to car use and using revenues for local use. Further research was needed on the methods used in real cases to tackle public and political opposition.

What is the best use of revenues from charges?

Using revenues in different ways has implications on efficiency as well as equity and acceptability. Research was needed on efficient and fair solutions for revenue use, taking also into account the investment needs of the transport system.

How can pricing measures be integrated with other measures?

Policies need to be implemented in packages because of mutual reinforcement, compensation of adverse impacts, mutual financing or public acceptability. Research was needed to identify balanced policy packages that include pricing.

3 RESEARCH PROGRAMMES

Urban pricing has been addressed in a number of research projects within the Fifth Framework Programme.

Within the Key Action 'Sustainable Mobility and Intermodality,' a few projects dealt with the implementation of the marginal cost pricing principle in transport with the aim of supporting the development of an integrated approach to implementing the pricing reform proposed by the EU. Urban and inter-urban transport, road and other modes were addressed. One project[5] investigated how efficient pricing can be implemented in cities in the short, medium and long term given the current inefficient situation. It provided an assessment of the extent to which the intermediate steps capture the benefits of full marginal social cost pricing. Another project[12] has developed methodologies and case studies for the measurement of marginal social costs of urban transport. Research into revenue use8 has provided an assessment of the revenue use proposed in urban case studies.
A thematic network[4] has facilitated the transfer of knowledge between research and policy communities.

The same Key Action has also included research on demonstrations of road charging schemes in cities[7]. This has produced insights into issues such as user responses and acceptance, institutional settings, privacy and technical aspects linked with infrastructure and equipment. Another thematic network[3] has provided an evaluation of impacts and implementation issues for both demonstrations and real world systems and a further one on policies for urban freight traffic[2] has provided a review of the impacts of pricing

on freight transport markets. The potential benefits and synergies of the implementation of pricing in package with other measures was studied in a project[9] using simulation.

The **CIVITAS** (City – VITAlity – Sustainability) initiative focused on the introduction of integrated sustainable urban transport strategies with the aim of achieving in particular a significant change of modal split. Demand management and revenue raising based on integrated pricing schemes are among the policy areas addressed. The four projects[6,10,11,13] funded within the Fifth Framework Programme included several pilot demonstrations.
Parking pricing policies to promote cleaner vehicles and innovative payment systems to promote public transport use and intermodality were tested.

4 RESEARCH RESULTS

Theoretical implementation paths

Hypothetical implementation paths for urban pricing reform were studied by modelling work[5] in four European cities: Paris, Brussels, Helsinki and Oslo. Paths were identified taking into account constraints stemming from technological, institutional and acceptability barriers.

It was found that it is certainly worth implementing simple pricing structures, if this is the only way to get started. Greater efficiency gains derive from measures that are more differentiated with respect to mode of transport, location and time of day (Paris and Brussels case studies). Implementation paths may not progress monotonically and this may lead to big fluctuations in price (Brussels case study). As an example, the price of public transport should first fall when car use is under-priced and then rise when road charging is introduced. Such changes may create financial and other administrative difficulties.

Land use impacts are an important and under-researched concern. It was found that location and land use effects may be important and differ significantly between cordons and differentiated link charges, resulting in much less urban sprawl in the latter case (Oslo case study). Also, the level of government which should be responsible is an important issue since local government may ignore costs and benefits to citizens outside its own area (Brussels case study). The estimated annual per capita welfare gain in the long term scenarios of the four case studies range from roughly € 170 - 400 or about 0.5 - 1% of annual per capita GDP.

Measuring marginal costs

Case studies[12] have produced estimates of marginal costs and differences between them have shown that there is no unique state-of-the-art approach to measuring. Road congestion has been extensively investigated and it was found that the type of model used heavily influences the results. For accidents, a new methodology has been developed which correctly distinguishes between external and internal cost components. The impact pathway approach is recommended for environmental costs.

The quantitative results suggest that the dominant issue for car traffic is congestion; however, this varies greatly between case studies, in the range of € 0.05 - 0.25 per vehicle kilometre. Such variability leads to the conclusion that values are not transferable from one city to another. All of these values are lower than values from modelling work in the Fourth Framework Programme, which might have overestimated congestion costs as simpler network models had been used. Accident costs are also comparatively large, in the range of € 0.04 per vehicle kilometre. Noise is an important factor, particularly at night, when the cost is in the range of € 0.004 - 0.05 per vehicle kilometre, and air pollution is also significant, especially for diesel cars. Areas of high traffic speed and density report lower marginal noise costs, as an additional car has less impact in conditions of higher background noise. Noise costs are found to be the dominant item for heavy goods vehicle traffic, in the range of € 0.2 - 0.8 per vehicle kilometre at night.

Schemes in operation

Research into existing road charging schemes could provide useful insights[3,7]. Toll ring systems are in operation in Norwegian cities including Bergen (introduction in 1986), Oslo (1990) and Trondheim (1991). Bergen was the world's second urban road pricing scheme after the Singapore Area Licencing Scheme opened in 1975. Urban toll rings were introduced in Norway for financing purposes. When passing a toll station to enter a central area, vehicles pay a distance-independent charge. Toll revenues pay part of the road investment programmes.

There is no guarantee that the driver will benefit from driving on any new road funded with the scheme in his trip, though Norwegian cities managed to get the necessary political and public acceptance. Reasons for the success of toll rings include: agreements among major political parties, low charge levels, part of the revenues allocated to public transport, extra state funds granted to road investment, no queues in the toll stations in rush hours, and collection of tolls limited to approximately 15 years. Only recently, national legislation endorsed road pricing as a means to manage transport demand. Principles set by the Norwegian Traffic Act allow, in particular, revenues to be earmarked to local transport, indefinite duration of schemes, and exclusion of possibility to apply congestion pricing and toll financing simultaneously in the same area.

The main impact of the toll ring in Oslo is linked with the new road infrastructure, mainly tunnels on the primary network, which could be realised sooner than it would have been with state funds only. Part of the road network could be devoted to local use; bans on motorised traffic could be introduced. The Oslo toll ring, like Bergen's, has had little impact on traffic levels. This is despite the fact that the funds raised have been used to finance public transport developments. In Trondheim, a charge in the range of € 1.7 led to a traffic reduction of approximately 10%. Modal split was not influenced significantly. Travellers have continued to use their car, but outside the charging period and the charged area.

At the start of the Fifth Framework Programme, there were no congestion charging schemes in operation in Europe. In mid 2006, there were schemes in Durham, London and Stockholm. London introduced a congestion charging scheme in February 2003. A flat daily charge of £ 5 is levied for moving a vehicle within a 21 km^2 area around the city centre.

The charge was raised to £ 8 in 2005. Residents of the charging zone receive a 90%

discount. Vehicles are detected by Automatic Number Plate Recognition technology. System operating costs are high, in the range of £ 90 million annually. Revenues from charges are in the range of £ 120 million, additional revenues from enforcement £ 70 million. Traffic entering the charging zone has been reduced by 18%, and traffic delays have been reduced by 30%.

Impacts from planned schemes

Road charging experiments were carried out in a number of European cities[7]. Trials have provided insights into travel behaviour. Modelling studies assessed impacts under different charging schemes.

The most basic scheme is a cordon where vehicles are charged per trip or per day for crossing the cordon line. This can be further developed into a zone system where vehicles pay when crossing each zone border. The charges may vary across different times of day and different types of vehicles or user groups. An alternative scheme is to charge users by distance travelled in the charge area. Charge can again be differentiated by time, vehicle and user group, as well as by zone.

Copenhagen tested a distance-based scheme in a field trial with 500 vehicles. It was found that road user charging does affect behaviour. But the pricing level needed to be high, in the range of € 0.6 per kilometre in the peak. Increased occupancy of the test cars were among the behavioural changes recorded.

Genoa demonstrated a cordon charging scheme in its inner-city area with a sample of 150 volunteers. A budget in Euro was assigned to each of them. Since the value of the charge the user perceives is higher when it represents a loss (as in the real case) than when it represents a missing income (as in the demonstration case) it was estimated that real money equivalent of the charge per entry was in the range of € 0.5-1. On this basis, it was found that the mean reduction of entries to the charging area was in the range of 32 - 44%.

In Gothenburg, distance-based charging scenarios were tested. A reduction of car trips of 10% per day was found in a scenario where charges are levied 24 hours a day. In a scenario where a charge is levied only in the morning peak, it was found that car traffic was reduced by about 15% and drivers avoided the charges by travelling at a different time. Simulation showed that the introduction of road pricing would mainly compensate for the traffic increase which is expected in the future due to economic growth, but would not bring traffic volumes to lower levels than today.

Technological developments

Different technologies are available for road charging. A series of trials have provided an assessment of available solutions[7].

Electronic Fee Collection (EFC) systems based on **DSRC** (Dedicated Short Range Communications) are in operation in Norwegian toll rings in parallel with manual payment. Vehicles are equipped with tags attached to the windscreen. In addition, a video camera takes pictures of the front licence plate. A standard technical specification for EFC named **AutoPASS** was introduced in 1999. Contractual interoperability, giving a vehicle legal access to any AutoPASS lane in Norway, was introduced in 2003. Tag-based DSRC are also used for access control in the limited traffic zone covering the historic centre in Rome. The system is based on the **TELEPASS** technology in use on Italian motorways.

Camera based systems with **Automatic Number Plate Recognition** (ANPR) are suitable for enforcement. The data collected can be used to check against database of valid vehicle records and generate enforcement reports. ANPR was tested in Genoa, Bristol, Edinburgh and Rome.

Results are indicating that lane straddling can be a problem for recognition and that front- and rear-facing cameras have a higher success rate in capturing vehicles than front-only camera configurations.

Vehicle Positioning Systems (VPS) make distance-based charging possible. VPS systems with GPS were tested in Bristol, Copenhagen and Gothenburg. Results indicate that, although GPS technology works in principle, improvements are needed, particularly advances in accuracy and systems able to compensate for the loss of signals. In Gothenburg participants in the trial stated that VPS would not add to privacy concerns as mobile phones and street cameras make surveillance on the streets already high.

Research has also outlined the likely future developments of road charging schemes[5]. In the short term, area-based charges will probably be introduced in central areas and on weekdays, equal for all vehicles, using DSRC and ANPR technologies. In the medium term, distance-based charges using satellite-based technology will probably be in place. This would be facilitated as vehicles should become increasingly equipped with satellite technology as a standard feature. Multiple services would be enabled using the European satellite system, Galileo, for example for EFC, guidance and security. In the longer term, distance-based charging would cover all of the urban network at all times. Parking pricing would use technology integrated with the satellite-based road charging system.

The acceptability problem

Research helped recognise the factors affecting acceptance of road charging measures[3,7].

The policy needs to be perceived as fair, in particular with respect to personal cost-benefit relation. The role of revenues plays an important role. Citizens wish to see earmarking of revenues and this must result in guaranteeing a desired level of mobility for all.

The successful Norwegian experience supports the idea that implementation of pricing is more acceptable when new investments are paid by new charges put in place. Basically, people expect to be charged for things they wish to acquire, not the things they wish to avoid (congestion as an example).

Findings indicate that particularly the general perception of environmental problems caused by traffic positively influences acceptability.

Opinions based upon fear and avoidance of change may lead to ambivalent attitudes towards an innovation. Negative aspects of an innovation may become more and more important in the public perception the closer the implementation of the innovation comes. This was found in the case of Edinburgh, where support decreased the closer the planned pricing scheme came to implementation.

Acceptability was found to increase after implementation in most cases. In the Trondheim case, however, unstable attitudes were found. Support increased after implementation initially, and decreased later. This is attributed to major adjustments to the design scheme. It has been argued that this occurred because rules of credibility and transparency were violated.

Acceptability can only be expected if citizens have confidence in the effectiveness of the measures, the use of the revenues, the fairness and anonymity of the system and the possibility to participate in the decision process in some form. Confidence is supported by transparency of the intended measures. Citizens can more easily commit themselves to new ideas if effective communication processes are put in place early. The Oslo experience shows that introducing pricing for a limited period and giving the chance to examine it again enhances acceptability.

Acceptability may be higher where an existing access restriction scheme is developed towards a road charging scheme, as planned for the limited traffic zone scheme in Rome. This is likely to occur, in particular, in other Southern European cities. Instead of using road charging as a stick, such "hybrid" schemes would use the flexibility of pricing to mitigate the impacts of existing demand management measures of the command and control type on car users. A similar approach has been adopted in the United States, where tolls were introduced to allow any vehicle to use existing High Occupancy Vehicle lanes, which would have been otherwise underused.

The use of revenues

The use of revenues is a crucial issue, both in terms of its link with public and political acceptability and in terms of its impacts on the welfare effects of pricing reforms. Modelling work[5] in the Helsinki case study found that investing in additional road infrastructure is less justifiable on efficiency grounds than investment in public transport. Other modelling work[8] in the Oslo case study found that marginal cost pricing for cars with earmarking of revenues for public transport improvements would allow maximisation of welfare while keeping the subsidy to public transport at the current level. This would be obtained for a charge of € 4 in the peaks, which is approximately 200% higher than the level in the existing toll ring scheme.

Acceptability surveys carried out in the Oslo case study[8] found that public attitudes are more positive if revenues are earmarked for public transport. This is the main reason for accepting an extension of the toll ring scheme. Research in the case study of Edinburgh[8] looked at the planned cordon charging scheme in terms of who should set the charges and how revenues should be used. It was suggested that prices should be set at an optimal level considering the welfare of the residents of the whole region. The proposed revenue sharing arrangement with the neighbouring authorities was judged positively in terms of its potential to lead to efficient and equitable solutions.

Integrated policies

Research into the impacts of policies[9] provided useful insights for the definition of a combination of measures. In the Leeds case study, modelling work found that a combination of distance-based road charging of € 1.5 per kilometre and the introduction of bus lanes leads to higher welfare benefits when evaluated over a 30-year time horizon than a combination of distance-based road charging of € 1 per kilometre and 150% increase in public transport frequency. The combination of distance-based road charging and bus lanes has high synergetic effects compared with introducing these measures alone, the total benefits being 40% higher than the sum of the total benefits from each individual measure.

CIVITAS achievements

A broad range of measures in urban transport were implemented in the cities of the four CIVITAS projects[6,10,11,13] that were funded jointly by the Transport and Energy parts of the Fifth Framework Programme. Measures included integrated pricing strategies for demand management and revenue raising.

One group of measures dealt with parking pricing. A project aimed at the introduction of a parking strategy with reduced fees to promote clean vehicles in Stockholm[11] has led to an agreement at local level on the definition of a clean vehicle. A campaign to advertise the strategy has resulted in increased interest in clean vehicles by the general public. The awareness raised among journalists has acted as a multiplier. Today, many in Stockholm intend to buy a clean vehicle in the future.

In Winchester[6] a charging scheme for parking has been introduced where discounted season permits are offered to vehicles with low emissions of CO_2 based on current UK tax band classification. Free season permits are offered to electric or hybrid vehicles. Although the impacts have been minimal due to the low number of vehicles concerned, the scheme has been successful in so far as the public generally agreed with it and there was some indication that it would encourage the purchase of clean vehicles in the future.

In Graz[11] the parking fee was decreased by 20% for low emission vehicles and increased by 20% for the rest. Eligible clean vehicles were provided with a special coin for payment. The Graz experience made clear that a common standard is needed for the environmental characteristics of vehicles. Also, partnerships with car dealers should be established to give the scheme better promotion.

Another group of measures dealt with innovative technical solutions to improve parking and public transport payment. Systems for payment of on-street parking using mobile phones have been introduced in Berlin[10] and Cork[6]. Smart cards for public transport payment have been successfully introduced in Bremen[13]. Paying for public transport tickets by mobile phone is today possible in Rome[6] using SMS.

Freight traffic

Insights into road charging from the freight traffic perspective have been provided[2]. It was found that the impacts of pricing schemes on urban freight traffic are still a matter that requires further analyses. Impacts should be investigated in terms of both transport decision responses and effects on competition and logistics patterns. Freight vehicles will benefit from lower travel time and higher reliability and punctuality. If they have to pay a charge, this may be passed onto the customers. Some freight operators fear that the result might be a shrinking transport market with increased competition and lower margins. Innovative transport operators have a comparative advantage as higher transport prices will put storage, logistics and vehicle capacity utilisation back into the spot-light of economic considerations.

Modelling work[10] found that a distance-based charging scheme for heavy duty vehicles in Berlin, with charges differentiated by time of day in the range between € 0.30-0.60 per kilometre, could lead to a reduction in social costs in the range of € 25 million annually.

Benefits from research

Research in the Fifth Framework Programme has provided contributions to the economic analysis of pricing policies with considerable experience of applied modelling work using large-scale empirical models and taking into account city-specific and country-specific barriers and constraints. New evidence on values of marginal costs are a significant input for theoretical analysis of optimal charges.

Decision makers in cities will be able to learn from new insights provided on road charging schemes including schemes already operating and field trials. Knowledge useful to progress in the implementation of congestion charging schemes has been provided in particular on user responses, performance of technologies, and successful approaches to deal with acceptability issues. First evidence of the potential for innovative parking schemes to promote clean vehicles has also been provided.

5 EUROPEAN **POLICY IMPLICATIONS**

Research provides recommendations on the pricing structure based on ideal models. Setting the pricing policy according to the marginal social cost principle is predicated on the grounds that it maximises welfare. Insights on practical pricing policies suggest that starting with simple pricing schemes is often the only viable solution. Evidence from modelling work finds that it is certainly worth implementing simple pricing structures, if this is the only way to get started. But further differentiation to take into account the location and the time of day is usually worthwhile. Hence, while knowledge of marginal social costs may not be the most important factor in setting prices in the first instance, it is useful to know these costs to estimate future policy directions. This requires case-based estimates, because marginal social costs are found to be significantly variable between urban areas.

Research provides empirical evidence to validate the expectations created by theoretical speculations and models. Empirical evidence confirms that charging for road use can reduce congestion and change travel behaviour as well as provide revenues which can be re-invested in transport. The experience of Norwegian toll rings indicates that setting low fares can be suitable for financing purposes but produces only minor traffic reductions. If charging for road use is to be used as a demand management tool, higher fares need to be set such as in the congestion charge in London where significant effects in terms of traffic impacts could be achieved.

Even if implementation costs can be high in reality, congestion charging schemes will generally still create significant net revenue.

Distance-based charging schemes are theoretically superior, but practically not yet feasible as the GPS technology is not mature enough for real world applications. If a congestion charging scheme is to be implemented in the near future, a cordon or area charging scheme using more mature technologies such as DSCR and/or ANPR should be the priority. ANPR may be cheaper and easier to implement than DSRC since it requires no in-vehicle equipment, but is probably more expensive to operate.

Addressing equity concerns is a key issue for decision makers. One of the major criticisms of road charging policies is that they can be unfair to certain groups in society, in particular low-income drivers who cannot afford the charges. There is some evidence from the Norwegian experience that spending revenues from road charges on public transport increases acceptability of the charging scheme. Investing in public transport improvements can be an effective way to avoid adverse impacts on low-income individuals.

Another concern is for the population living within the charged area, who would be forced to bear a disproportionate share of the charges simply because of where they live. Discounts and exemptions are ways to deal with the adverse impacts on these groups. The impacts on the residents living outside the charged area can also raise concerns, if the charge is levied on commuting trips. Both efficiency and equity considerations call for a wider view on the impact on all potentially affected population groups when deciding all aspects of the charging scheme.

Gaining public and political acceptability is a major issue to resolve for cities deciding to implement road charging schemes. As users are prepared to pay for new services more than for services that were previously free, road charging is more acceptable when it is limited to new links and when new investments are paid by the revenues from the charges.

Acceptability of road charging schemes tends to be higher where problems are particularly acute and demonstrable, where revenue use is transparent and earmarked, and where there is an identified package of complementary measures. Evidence shows that acceptability increases after implementation, though not in all cases, and is higher where initial price changes are simple and modest. Acceptability is expected to be higher when road charging is integrated with existing access restriction schemes, because in such cases charging is perceived as a way to increase mobility opportunities, not as a disincentive to use the car.

Early and highly effective communication is required to make clear to the public how revenues from the charges will be spent and what the citizens will get from it. Consultation with the retail sector should emphasise the appeal of a better quality environment for the customers of the shops located in the charged area. Generally, a strong political champion and clear methods to deal with the media are a big help in increasing the acceptance of a scheme. Instability of attitudes over time suggests the need for maintaining continuing surveys of public opinion.

The first European experiences show that parking pricing strategies that promote clean vehicles can have significant impacts in terms of raising awareness about the existence and benefits of clean vehicles. There is also evidence that such schemes can influence vehicle purchase decisions. Common standards for the definition of clean vehicles will facilitate the introduction of these schemes and will help car dealers promote clean vehicles.

6 OUTLOOK ON RESEARCH

Fifth Framework Programme projects[2,3,4] have recommended the following areas for future research:

- The extent to which the full complexity of variation in marginal social costs should be reflected in prices is a topic for analysis.
- More knowledge should be collected on how to estimate costs for particular circumstances from available evidence, especially for congestion and local environmental impacts.
- The question of how to assess impacts of congestion on reliability of travel on the different modes deserves more attention.
- Further evidence is needed on relocation and economic impacts, which are difficult to measure and predict.
- The distribution of the impacts on different groups within society needs more empirical evidence.
- Empirical evidence should be collected on the impacts on travel patterns of discounts and on the loss of benefits resulting from exemptions and discounts.
- Optimal combination of road charging with other measures needs further research. Analysis of the implications of different solutions for re-allocation of road space would be valuable.
- Acceptability should be further investigated in relation to techniques for involvement of stakeholders and to fairness of the implementation process.
- Research is needed to deepen the understanding of the behavioural responses to pricing and other policies of the stakeholders in the freight transport and logistics markets.

In the Sixth Framework Programme the objective of one task was the investigation of the costs of transport infrastructure use. Specific objectives were refinement and harmonisation of estimation methods, particularly for road congestion, and evaluation of socio-economic impacts. The objectives of another task focused on user reactions and differentiation of charges. The ongoing **CIVITAS** initiative has continued to include integrated pricing strategies among the policy areas for demonstrations and tests. These include road charging, possibly in combination with innovative pricing of parking and public transport.

One project[16] is currently dealing with estimation of the costs of infrastructure use. One co-ordination action[17] aims to provide a discussion platform for successful implementation of new pricing regimes. Another project[15] aims to investigate the success potential of charge differentiation from a theoretical and empirical perspective. The emphasis is on learning about user reactions from real world cases and suggesting how differentiated charging schemes should be implemented to maximise welfare given practical constraints.
The **CIVITAS** projects include among integrated area access control and road charging (in Genoa[14]), parking pricing policies to promote cleaner vehicles (in Norwich[19]), contact-less ticketing and multi-service card, for public transport users (in Toulouse[18]), and integrated multi-operator public transport ticketing (in Preston[20]).

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[10] TELLUS, Transport and Environment Alliance for Urban Sustainability, 2002-2006, CIVITAS Initiative, *http://www.tellus-cities.net*

[11] TRENDSETTER, Setting Trends for Sustainable Urban Mobility, 2002-2006, CIVITAS Initiative, *http://www.trendsetter-europe.org*

[12] UNITE, Unification of Accounts and Marginal Costs for Transport Efficiency, 2000-2002, *http://www.its.leeds.ac.uk/projects/unite*

[13] VIVALDI, Visionary and Vibrant Actions through Local Transport Demonstration Initiatives, 2002-2006, CIVITAS Initiative, *http://www.vivaldiproject.org*

6th Framework Programme projects

[14] CARAVEL, 2005-2009, CIVITAS Initiative, *http://www.civitas-caravel.org*

[15] DIFFERENT, User Reaction and Efficient DIFFERENTiation of Charges and Tolls.

[16] GRACE, Generalisation of Research on Accounts and Cost estimation, 2005-2008, *http://www.grace-eu.org*

[17] IMPRINT-NET, Implementing Pricing Reforms in Transport Networking, 2005-2008, *http://www.imprint-net.org*

[18] MOBILIS, 2005-2009, CIVITAS Initiative, *http://www.civitas-mobilis.org*

[19] SMILE, towards Sustainable Mobility for peopLe in urban areas, 2005-2009, CIVITAS Initiative, *http://www.civitas-initiative.org/project_sheet?lan=en&id=1*

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LIST OF **ACRONYMS** AND **GLOSSARY** OF TERMS

ANPR	Automatic Number Plate Recognition
AUTOPASS	Norwegian standard for toll collection systems based on DSRC
CONGESTION CHARGING	Pricing of car use, with the main aim of reducing traffic especially in peak periods and in central areas. It contributes to behavioural changes of travellers as well as to raising funds.
CONGESTION COSTS	Value of time spent travelling by all travellers
CORDON CHARGING	The most basic scheme, where vehicles are charged per trip or per day for crossing the cordon line, usually around a central area.
DISTANCE-BASED CHARGING	Pricing scheme where vehicles pay based on distance travelled
DSRC	Dedicated Short Range Communications
EFC	Electronic Fee Collection
EXTERNAL COSTS	Costs related to infrastructure use, but not included in the cost on which decisions of travellers are based. Include delays to other travellers, negative impacts on environment such as air pollution and noise, uninsured accident costs.
GPS	Global Positioning System
MARGINAL COSTS	Usually used to mean change in congestion costs due to an additional vehicle
MARGINAL SOCIAL COSTS	Change in social costs due to an additional vehicle. Includes all social costs in addition to congestion (e.g. air pollution and noise costs, costs of accidents).
MARGINAL COST PRICING	According to this principle, prices paid by travellers are set equal to the marginal costs arising from the use of transport facilities. For road users it requires internalisation of external costs of congestion by a charge.
MARGINAL SOCIAL COST PRICING	Marginal cost pricing principle extended to all social costs in addition to congestion costs
TAG	On-board unit communicating with road-side equipment at check points in EFC systems based on DSRC technology
TOLL RING	Scheme introduced in Norwegian cities to finance transport investment programmes. A charge is paid when passing a toll station to enter the central area.
VPS	Vehicle Positioning System
ZONE-BASED CHARGING	Evolution of cordon charging, where vehicles pay when crossingeach zone border. Depending on the zone pattern, borders can intercept orbital or radial trips. Multi-cordon charging is a particular case of zone-based charging where zones are concentric.

The issue of urban transport sets a challenge to increase mobility while simultaneously reducing its negative impacts, such as congestion, pollution and accidents. Urban pricing has been addressed by a number of European research projects in the EC's Fourth Framework Programme.

Research continued in the Fifth Framework Programme and this brochure reports on the main results achieved in the recently completed projects of this Programme. Results useful for designing a phased approach to the implementation of a pricing reform have been produced, and new evidence on values of marginal costs has been collected. A number of projects have taken as their primary focus road user charging schemes. New evidence on travel behaviour collected in trials has supported modelling work in feasibility studies of new charging schemes and has provided further insights into the impacts on traffic that can be expected from the schemes. The brochure also provides some idea of the real impacts of those charging schemes already in operation.