# 3 PUBLISHABLE RESULTS

## 3.1 UNRESTRICTED DELIVERABLES

### *Deliverable 2.1: Current Status of Differentiated Charges for Transport Infrastructure Use*

Deliverable 2.1, *Current Status of Differentiated Charges for Transport Infrastructure Use*, was submitted in March 2007, and is available to download from the project website at: www.different-project.eu.

This deliverable was issued early in the project and provided background analysis of key issues to be addressed in the subsequent work of the DIFFERENT project. D2.1 focused on three areas:

- the theoretical background to differentiation in pricing for infrastructure from the point of view of economic and behavioural theory
- existing pricing differentiation practices across European countries with reference to all transport modes (road, rail, maritime and airport infrastructure)
- the availability of modelling tools that can be used to assess the potential impacts of differentiated pricing

The examination of economic theory looks at the concept of first-best pricing, where economic efficiency is achieved with marginal social cost pricing leading to maximum social welfare, and the implications of this for differentiation of prices. Alternatives to first-best pricing are then discussed in the context of economic theory, looking at issues such as economies of scale, externalities, monopolies and the type of constraints that in reality make first-best pricing in transport difficult to implement.

The discussion of behavioural theory looks at the cognitive limitations that restrict the degree of complexity that consumers can deal with and therefore the degree of complexity in pricing differentiation it is possible to implement effectively. The discussion considers what degree of pricing complexity consumers will respond to, and what psychological factors determine user reaction to price differentiation.

The discussion of existing pricing structures covers motorways, urban roads, rail, airports and ports, and for each mode gives an overview of charging practices throughout Europe. Charging practices for transport infrastructure across all these modes are then discussed and categorised according to their degree of differentiation, that is their variability according to time, location, traffic conditions etc., and their degree of harmonisation, that is the consistency of charging practice across Europe.

The review of existing modelling approaches looks at the transport models available for the relevant transport modes, and their ability to simulate effectively the differentiation of tariffs at local and strategic levels.

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## *Deliverable 5.2: Final Results and Recommendations for Differentiated Charges at Airports*

Deliverable 5.2, *Final Results and Recommendations for Differentiated Charges at Airports*, was submitted in May 2008, and is available to download from the project website at: www.different-project.eu.

This deliverable looks at the effects of differentiated airport charges with reference to five case studies:

- Gran Canaria
- Madrid-Barajas
- London Area Airports
- Hamburg Airport
- Ljubljana Airport

Different methodological approaches are utilised in each case study, depending on the data available, for example on the reaction of airport users to the differentiation of charges.

The Gran Canaria case study examines the problem of peaks in demand associated with the patterns of arrival and departure of tourist flights to the island. The case study explores whether a less peaked demand pattern, and therefore a more efficient utilisation of the airport capacity could be achieved through differentiated pricing mechanisms.

The Madrid-Barajas case study looks at how the actual level and structure of airport charges can have an influence on competition between airlines choosing among different terminals, therefore emphasising the scope of price differentiation by type of terminal. The allocation of airport slots to national airlines, and to co-operating airlines (such as the OneWorld Alliance) has an impact on the level of competition among airlines. The Madrid Barajas Airport study used a theoretical model to show that, in most cases, if airlines are allocated to separate terminals, the lack of competition in transfer flights significantly affects the ticket prices of the whole network, the competition between airlines is reduced, the ticket prices are higher and the consumer surplus and the social welfare are lower.

The London Area Airports study looks at whether price differentiation among different airports could provide incentives for airlines to choose other airports for more of their flights in order to ease congestion at Heathrow. The research established the price elasticity of market share for different passenger types in European markets originating in the London area to establish how passengers respond to lower prices and to determine how market shares change when the total price of a trip changes. The conclusions from this research are that: i) cross-elasticities of demand between airports are relatively low, indicating that there is little competition within markets; ii) there is little evidence that price elasticities for business travellers are lower (in absolute value) than price elasticities for leisure travellers; and iii) a likely effect of price differentiation is that passengers switch destinations or modes, rather than switch between peak and off-peak, or switch airport to reach the same destination.

Since the end of 2001 Hamburg Airport has differentiated its charges for airlines according to the noise emissions of individual aircraft. The case study looks at the issues surrounding the introduction of this type of charging and at the user reaction to the new charging regime based on traffic figures before and after it introduction. The case study also considers the attitudes of airport users, the airport operator, policy-makers and environmental groups to charging based on noise levels.

The case study of Ljubljana Airport, like the Gran Canaria study, examines the problem of congestion at peak periods. It is anticipated that increased demand at Ljubljana Airport will require the introduction of congestion-dependent differentiated charging schemes. This case study analyses transport demand at the Airport and has identified peak periods during the time of a day, a day in a week and a season in the year. A preliminary analysis of price elasticity of demand also indicates that by introduction of differentiated congestion pricing schemes, charter and low-cost carriers would be more affected.

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## *Deliverable 6.2: Recommendations for Differentiated Charges for Shipping*

Deliverable 6.2, *Recommendations for Differentiated Charges for Sh*ipping, was submitted in June 2008, and is available to download from the project website at: www.different-project.eu.

In the European Union (EU) levels and structures of port infrastructure charges vary strongly across countries and terminals. The existing charging regimes seem to be far from internalising external costs and are rarely based on efficiency principles. Differentiation of charges might be an intermediate step towards the envisaged application of marginal social cost pricing in the European Union. D6.2 presents recommendations derived from research undertaken during the course of the project.

The deliverable looks at the approaches that may be adopted by port operators towards differentiated pricing and summarises the existing structure of differentiation in infrastructure charges in selected ports: Hamburg, Gothenburg, Valencia, Amsterdam, Duisport, and Sullom Voe and Lerwick in the Shetland Islands.

The deliverable then examines different approaches to price differentiation in shipping, based for example on ship types, on practices to mitigate risk of accident or pollution, on emissions from ships, and looks at user reactions to differentiation and the possible economic efficiencies that can be achieved.

Shipping is a globalized industry and is currently functioning and competitive. In recent years there has been reduced public sector involvement in ports and greater implementation of private sector principles in ports especially port authorities. This has increased the determination of port authorities to make profits and to be efficient. In this devolution process different solutions and systems have been implemented which are adjusted to the institutional structures and environment of each port. The differences also reflect the wide range of shipping markets.

The deliverable presents forward thinking ideas how to differentiation of port infrastructure charges might be addressed in a wider policy context.

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## *Deliverable 7.2: User Reaction on Differentiated Charges in the Rail Sector*

Deliverable 7.2, *User Reaction on Differentiated Charges in the Rail Sector*, was submitted in July 2008, and is available to download from the project website at: www.different-project.eu.

This deliverable reports on the detailed analysis of the reactions to and impacts of differentiated charges in the rail sector. The results are presented, focusing first on the freight sector and then on the passenger sector. The deliverable then presents an assessment of the findings, conclusions and recommendations.

The context of charging in the rail sector is discussed, then the effects of differentiated charges in rail are presented. There are two relevant sets of charges in relation to rail: charges levied by infrastructure managers on train operators; and charges levied by train operators on 'end-users', that is on passengers or freight forwarders. The research in DIFFERENT focuses mainly on rail infrastructure charges as this area that is thought to be more directly relevant to the European Commission

The objectives of this deliverable, and of the rail sector work in DIFFERENT are:

- To develop a better understanding of how users and, to a lesser extent, end-users react to differentiated charges in the rail sector – that is how train operators react, in terms of their choices about vehicle type, route, volumes etc, to differentiated rail infrastructure charges and, to a lesser extent, how passengers react to rail passenger fares and freight forwarders react to freight forwarding charges.
- To investigate the limits to the differentiation of charges, in terms of users' capacity to react, geographical issues, equity considerations etc.
- To contribute to a methodology for determining the appropriate degree of differentiation and, specifically, to use this methodology to make recommendations as to the appropriate level of differentiation of charges in the rail sector – balancing the needs to manage traffic levels, minimise external costs and meet revenue requirements.

The deliverable presents:

- Case study work focused on the Freight market in Britain;
- Case study work focused on the freight market in France;
- Modelling work based on the freight market in Britain;
- Case study work focused on rail freight through Eurotunnel;
- Simulation modelling of the downstream market using Quinet and Meunier's techniques;
- Case study work on the role of Regional factors in Germany;
- Case study work to analyse impacts in relation to passenger fares in Germany; and
- A review of passenger fares elasticities and attitudes to different fares structures.
- Conclusions based on the above.

### *Deliverable 8.3 – 9.2: Report on Impacts of Charge Differentiation for HGV And Motorway Toll Differentiation to Combat Time Space Congestion*

Deliverable 8.3 – 9.2, *Report on Impacts of Charge Differentiation for HGV and Motorway Toll Differentiation to Combat Time Space Congestion,* was submitted in April 2008, and is available to download from the project website at: www.different-project.eu. D8.3 - D9.2 is a merged version of two deliverables that were originally planned: D8.3, Report on the Impacts of Charge Differentiation for HGV; and D9.2, Report on Motorway Toll Differentiation to Combat Time Space Congestion. The authors considered that, with extensive overlap in the content of the two deliverables, it was preferable to present the finding of this research in one merged report.

This deliverable focuses on:

- A review of implementation of the pricing legislative framework throughout Europe for heavy good vehicles and further developments to differentiate charges for infrastructure use

- Evidence from recent experiences of distance-based charges for heavy good vehicles in Germany and Switzerland, and an improved understanding of the reactions of road hauliers to road charge differentiation
- Presenting evidence from recent experiences of motorway toll differentiation in France and the US
- Presenting results of transport models, from the Brenner TEN-T corridor and the Padana Region Motorway model, to test the impacts of charges differentiation for both freight and passenger traffic

The deliverable describes the current, status of road charge differentiation in European countries, covering distance-based road charges, tolls for heavy vehicles on privately operated motorways differentiated according to environmental performance, and time-based systems for heavy vehicle charges, generally differentiated according to weight or number of axles. Possibilities for further differentiation are discussed., along with *Eurovignette Directive,* which determines the scope within Member States can influence the environmental impacts of road freight transport by designing a road toll for trucks.

A case study looks at the Swiss HVF scheme for charging heavy goods vehicles based on their gross weight, emissions category and kilometres driven, with special reference to the impacts of fee differentiation. The case study was based on a desk analysis of available statistics and a survey among stakeholders: shipping companies, haulage companies, companies of branches with high transport intensity, rail transport operators, road transport associations, truck dealers.

A second case study looks at the German Heavy Goods Vehicle charging scheme (HVF), with analysis of data published before and after its introduction. The effects of the tolling system on revenues, load factor of the vehicles, composition of the fleet, route diversion and modal shift were analysed, showing that revenues have increased and environmental aims have been partly achieved, with a long-term trend of a decreasing number of no-load trips and the increased use of environmentally friendly vehicles. There is no firm evidence of modal shift and some evidence of toll avoidance.

Some evidence from the tolled M6 motorway in the UK is presented. These tolls are differentiated according to type of vehicle (with higher charges for vehicles whose height at first axle exceeds 1.3 m). The toll for larger vehicles was originally set at £10 (5 times the toll for smaller vehicles). This ratio resulted in objections from operators of large freight vehicles and usage of the road by such vehicles was low. This fact was picked up by the toll operators who, after 9 months of operation reduced the toll for larger vehicles to £6 while increasing that for smaller vehicles from £2 to £3. This appears to be an example of toll differentiation being adjusted to reflect the demand (and therefore revenue) response.

The deliverable then considers road passenger transport, with a desk-based study of pricing differentiation in high-occupancy vehicle / toll (HOV / HOT) lanes in the US, where it appears that these lanes have, in most cases, managed to improve the utilisation of road capacity, yield revenue and provide a superior level of service for those prepared to pay for it. A weekend surcharge for congestion costs operating on the A1 (Paris-Lille) motorway is described, and differentiated tolls elsewhere on French motorways are described.

The deliverable then present modelling results from the Brenner TEN-T Corridor model and the Padana Region Motorway.

The Brenner corridor is one of the main gates for trans-Alpine traffic for both passenger and freight. Thus, a significant amount of crossing demand (with a substantial proportion of long distance HGV traffic) contributes to the traffic on the tolled motorway connecting Verona to Innsbruck and beyond. At the same time, especially in the Italian part, the road corridor is also used for (relatively) short-distance trips. Along the whole corridor, a national road runs parallel to the motorway and can be considered as an alternative route (of course especially for local trips). A major railway is also available on the corridor and a new rail tunnel is planned within the TENs projects.

The Padana Region study area comprises Lombardia, Emilia Romagna and Veneto regions and its motorway network includes : A4 Milano–Venezia, A1 Milano-Bologna, A22 Brennero-Modena, A21 Piacenza–Brescia and A13 Padova–Bologna.. The model deals with freight and passenger traffic and also includes the network of national roads developed beside the motorway network.

Testing different toll schemes on the Brenner corridor and in the Padana region leads to some interesting results, that are presented in the deliverable.

From the experiences and analyses discussed in this deliverable, the main conclusions concerning inter-urban road charges can be summarised as follows: differentiation of road tolls is effective, its application induces perceptible changes in demand behaviour; there may be a particular role for tolls which are higher during periods of heavy congestion, particularly if drivers who pay these higher tolls can be guaranteed a high level of service; Inter-urban road tolls differentiation is generally accepted and perceived as a fair measure; in the shorter term, the impact is generally low- some re-routing can be expected and the road haulage sector is encouraged to improve efficiency; in the longer term, emission-based charge differentiation is expected to lead to an accelerated fleet renewal; a consequence of the previous items is that inter-urban charge differentiation seems not an effective policy for environmental purposes in the short term, as any expected impact has only a poor positive correlation or even a negative correlation with lower transport emissions; and differentiation schemes can be designed with different objectives, but a trade-off between alternative targets most likely exists.

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## *DIFFERENT Project: Results from Urban Case Studies*

This report*, DIFFERENT Project: Results from Urban Case Studies,* was not originally planned. It is a public version of the restricted deliverable *D9.1, Results from Urban Case Studies*. It was agreed by the authors of D9.1 and by the wider consortium that the material in D9.1 is of great public interest, so that deliverable was edited and this is the resulting report.

This report covers the case studies of urban road user charging:

- the (now discontinued) Trondheim toll scheme
- the London congestion charge
- the Stockholm congestion tax
- the Milan pollution charge
- electronic road pricing in Singapore
- city centre road pricing in Rome
- the proposed (but not implemented) congestion charge for Edinburgh

It describes, as far as applicable for each case study: the history and main characteristics of the charging structure; the expected impact of the charge from ex-ante modelling; and observations made after charge implementation of the impact, for example on traffic levels and congestion, on public transport and on the city economy. For each case study there is discussion regarding the impact of differentiated pricing.

The report also presents the results from a conceptual model developed to investigate the comparative benefits of various charging schemes with different degrees of differentiation and to

explore the importance of correct estimates of elasticities for the outcome of these comparisons. The report then presents the findings from the Dutch 'Spitsmijden' experiment, which investigated whether car drivers can be persuaded to avoid the rush hour on a congested motorway corridor by providing them with positive stimuli through a reward scheme.

Finally this deliverable presents the rather mixed overall findings for the effects of differentiation in pricing for car drivers in urban areas.

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### *Deliverable 9.3: Recommendations for Differentiated Charges for Car Drivers*

Deliverable 9.3, Recommendations for Differentiated Charges for Car Drivers, was submitted in May 2008, and is and is available to download from the project website at: www.different-project.eu.

This deliverable draws on material presented in more detail in other project deliverables (D9.1, D8.3 - D9.2, D4.1 and D4.2) and provides recommendations on the appropriate degree of differentiation for infrastructure charges in the road passenger sector.

The deliverable first describes the theoretical justification for differentiation as this relates to economic efficiency. Different types of differentiation are then outlined, and practical issues that constrain the effectiveness of each type of price differentiation are discussed. Based on this theory, and using evidence from the case studies presented in D9.1, *Results from Urban Case Studies*, and D8.3 – D9.2, *Report on Impacts of Charge Differentiation for HGV and Motorway Toll Differentiation to Combat Time Space Congestion,* this deliverable addresses each type of price differentiation in order to reach conclusions and makes recommendations. The case studies referred to are urban road charging in London, Stockholm, Singapore and Milan, and inter-urban pricing on French motorways and the M6 toll road in the UK. The types of differentiation addressed are: by time of day; by type of road; by type of vehicle; and according to user characteristics.

The analysis concluded that the main practical constraints to differentiated charging are likely to be financial, behavioural and political rather than technical. It is noted that, although current and near-term technologies will support highly differentiated pricing regimes, the cost of introducing and running such systems may not be justified. A serious problem with highly differentiated charge regimes is likely to be the inability, or unwillingness, of individual travellers to predict the implications that the price structure would have for different journey options and the consequential likelihood that the subtleties of the price signal will be lost. It is also noted that a highly differentiated charge structure might be difficult to defend politically.

In the light of the evidence, it is concluded that the following principles should apply irrespective of the underlying reason for introducing differentiated road charges:

- when designing a differentiation scheme, account must be taken of the full range of potential effects in both the short term and the long term
- it is important to consider the nature of potential interactions between co-introduced sets of charges in different parts of the network.
- Co-operation on technical and procedural issues, and over-detailed definitional points such as common time zones for peak-load pricing, vehicle classifications and exemptions, is desirable even if the two road authorities have different objectives

- In order to achieve public acceptance of differentiated charges, it is important to explain the reason for the differentiation
- Even if every effort has been made to help people understand the charge structure, it would be unwise to expect a precise response to complex pricing signals.
- It should be recognised that people differ in terms of their ability to respond to complex pricing signals and that this may give rise to equity concerns.

Where the objective of introducing differentiated charges is to influence road users to change their behaviour in line with the price signal, the following guiding principles should be born in mind:

- Do not introduce unnecessary differentiation.
- Build gradually on existing differentiation
- Avoid types of differentiation which are particularly difficult for people to comprehend
- Provide information and advice about the price structure of the charging schemes
- Provide information which stresses the justification for the scheme
- Provide (and publicise) opportunities to change behaviour according to the differentiated charging schemes

Generally it seems likely that overall benefits (defined as minimisation of delay, accidents and other externalities while maximising the benefits to society and the economy) will be maximised by combining a charge on the urban roads with charges designed to give a degree of protection to traffic using motorways and other strategic links.

Where the objective is simply to maximise revenues then differentiation takes on a new role. Generally speaking, it becomes a mechanism for yield management and for targeting special markets. It is also noted that if the objective is to maximise revenues, advantage can be taken of the fact that, faced with a seemingly complex charge in a high, or very low, price domain, users tend to under-respond to the actual charge (i.e. they have a tendency simply to pay up and continue with their previous pattern of behaviour) – thus yielding more revenue than would have been produced if the charge had been readily understood.

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### *Deliverable 10.2: Potential Effects of Differentiated User Charges on Intermodal Chains and Modal Change*

Deliverable 10.2, *Potential Effects of Differentiated User Charges on Intermodal Chains and Modal Change*, was submitted in April 2008, and is available to download from the project website at: www.different-project.eu.

This deliverable summarises work carried out on intermodal chains and modal change aspects for freight and passenger transport. The aim of this work was to estimate the effect that differentiation of transport infrastructure user charges might have on modal split for transport of goods and people.

Part 1 of the deliverable covers freight transport and first describes a model of an intermodal transport system, then presents the results of simulation work assuming one 40' container transport on four European routes. This analysis showed that, in some parts of Europe, an intermodal solution is

cheaper than road haulage; in general intermodal haulages are attractive for companies on medium and long routes (e.g. from 500 km).

The next part of the discussion on freight presents an analysis of the potential for changes through price differentiation, including the results of interviews with stakeholders and representatives of companies who would potentially be beneficiaries of intermodal transport of freight. This analysis confirmed that there is a perception that intermodal transport is much more expensive and less efficient than road transport.

Finally, based on evidence presented, recommendations were made for more dynamic development of intermodal haulage, for example that where local circumstances are appropriate, the local authorities should include price differentiation among the measures used to promote the use of multimodal chains. Better utilization of intermodal haulages may be increased by changes in policy of railway infrastructure access fees at European level and working out a model, which will be fair for national and private railway operators. Finally, one of the aims of intermodal haulages is to reduce congestion. However, some goods have to be distributed mainly by road – in this situation it would be more effective for the European transport system to promote co-modality, as a wider concept of intermodality.

Part 2 of the deliverable is devoted to passenger transport. A number of hypotheses were examined using a combination of evidence from previous studies, new modelling work, and logical deduction. A new model is presented, which predicts the usage of individual modes and combination modes by a representative population of travellers under different pricing scenarios to explore the impact of charges which were differentiated in terms of mode, time period and trip length, and per-unit costs of providing transport services.

The case studies and evidence referred to in this deliverable include: river and coastal ferry services in Hamburg, London, the 3-cities conurbation and in Scotland; the London, Stockholm and Singapore road user charging schemes; the abortive attempts at pricing reform by Deutsche Bahn and SNCF; pricing policy in the UK bus industry and the low cost airline industry; the UK's national road pricing feasibility study, and new evidence on travellers' response to complex pricing structures.

A number of conclusions were made following this analysis, for example; the introduction of infrastructure charges based on marginal social costs differentiated by mode, trip length and time of day, could have a significant impact on modal shares; the introduction of differentiated pricing would affect some aspects of the overall modal share more than others and the full effect might take some years to emerge; differential pricing can influence the perception of modes and, most particularly, of intermodal chains; the degree of differentiation can have an effect on modal shares over and above that of the intended price signal; a shift to environmentally sustainable modes could be achieved by imposing larger charges on the least environmentally sustainable modes and by investing the revenue to the advantage of the sustainable modes while retaining the existing subsidies to public transport; differential pricing of vehicles according to their emissions will favour the purchase and use of low emission vehicles and thus improve the environmental sustainability of the fleet but may reduce the effect that a charging scheme has on mode shares; road pricing or congestion charging can discriminate in favour of environmentally desirable modes whilst remaining commercially sustainable; differentiated charging could be designed to discriminate in favour of the most economically important trips; pricing scenarios designed to favour public transport trips will not necessarily result in increased use of multimodal chains; the main barriers to the introduction of pricing regimes which promote inter-modality are institutional rather than financial, and the use of multi-modal chains can be encouraged by appropriate presentation and packaging of prices; and the removal of modal distinctions within a pricing structure reduces the suppliers' ability to manage demand to suit capacity and to maximise income, but the resulting simplification of price structures is appreciated by users and may itself lead to an increase in demand.

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## *Deliverable 3.3: Economic Theory and Methodology on Differentiated Infrastructure Charging*

Deliverable 3.3, *Economic Theory and Methodology on Differentiated Infrastructure Charging*, was submitted in June/July 2008, and is available to download from the project website at: www.different-project.eu.

The objective of this deliverable is to present a theoretical framework for the analysis of differentiated pricing schemes in transport markets. The scope of the study is limited to the contribution of economic theory.

The approach applied in this deliverable is to first review existing theoretical evidence and then to use this framework as a base to define hypotheses, and then proceed to a cross-case testing of the hypotheses, based on the information gathered in the project case studies. The case studies are first presented in overview and then analysed in the context of the normative and positive economic theory already set out.

For example, the two main hypotheses (broken down to specific research questions) presented are:

- The degree of price differentiation adopted by a certain actor depends on factors such as the aims of actors setting the prices (infrastructure managers, transport companies, governments), demand parameters and cost structure.
- The degree of differentiation of transport prices has an effect on user responses in terms of travel behaviour (for example modal choice, trip generation, temporal choice) resulting in changes in transport flows, the efficiency of the pricing measures and the level of acceptance of the measures.

Discussion of the normative approach focuses first on how pricing schemes should be defined as a function of the price setting agents, their aims, resource cost structures and general demand properties. The aims of the agents involved can range from the very general (e.g. economic efficiency which comes down to welfare maximisation) to the very case specific (e.g. profit maximisation). Cross-case analysis reveals that there is a positive relation between the degree of differentiation and the number of aims set by the agents. Furthermore, the data show how profit maximising monopolists tend to differentiate across user groups based on willingness to pay, and how in the case of private car drivers the pricing scheme tends to favour disadvantaged users when equity is an objective.

In a second step, discussion of the normative framework focuses on behavioural responses to a differentiated pricing scheme, where differentiation may have an impact on the efficiency of the pricing scheme as well as on its acceptability. As the scheme becomes more and more complex, a significant decision-making cost is experienced by the user, leading to an optimal degree of differentiation that is lower than what a first-best outcome suggests.

The positive approach describes the impact of policy makers and interest groups on the differentiated price structure. It may be said that Special Interest Groups (SIGs) are interfering in the political field in order to gain as many advantages as possible for their members. Cross-case analysis confirmed the two basic axioms that where formulated based on the theoretical framework: the setting of Infrastructure-tariffs will always be subjected to a strong political element. The positive theory aspect of setting infrastructure charges is therefore highly relevant. Lobbying activities will be a major explanatory variable for the tariff structure that will finally be implemented; and policy makers will react to lobbying influences and implement a kind of SIG equilibrium. Infrastructure charges which correspond to such equilibrium may be termed "politically acceptable".

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## *Deliverable 4.2: Psychological Constraints of User Reactions towards Differentiated Charging; Evaluation and Recommendations*

Deliverable 4.2, *Psychological Constraints of User Reactions towards Differentiated Charging; Evaluation and Recommendations*, was submitted in April 2008, and is available to download from the project website at: www.different-project.eu.

The aim of this deliverable is to investigate empirically the question: to what degree of complexity are users able and willing to understand, and respond to, differentiated transport charging structures. In the transport sector differentiated pricing is increasingly used to influence behaviour in order to manage users' demand for infrastructure capacity.

Research in cognitive psychology already provides knowledge about the cognitive limits of users faced with a differentiated charging scheme. Whether people can understand a pricing system and its communication depends on their prior knowledge and experience with principles of differentiated charging in various domains of life. Furthermore there is always the question on psychological costs of behavioural adaptation. The higher these costs are, the less likely a change in travel behaviour as a reaction to differentiated charging becomes (cognitive comfort). If the differentiation becomes too complex for individuals to understand, they tend to base their behaviour on a simplified mental model of the price structure.

Even if a differentiated charging system is easy to understand, users may not be willing to do so. A central motivational factor that might influence user reaction toward differentiated pricing is acceptability. Several factors have been identified, which contribute to the acceptability of transport pricing measure, such as personal goals, problem perception, perceived effectiveness, and perceived fairness. There are other motivational factors, which may have an impact on consumer decision, for example disengagement or personal involvement. Inter-individual differences in the ability and willingness of people to deal with extensive information are due in part to cognitive abilities and motivation, but there are also some personal factors, such as user's age, gender, education and income, and situational factors, such as time pressure and trip purpose, that have to be taken into account when analysing consumer reaction to differentiated prices.

To test these theoretical assumptions data from surveys and questionnaires on the user responses to price differentiation from a wide range of case studies has been analysed.

The case studies and data sources consulted and described in some detail in this deliverable are:

For car drivers:

- The AKTA Road Pricing Experiment in Copenhagen
- Newcastle Survey on Attitudes and Responses to Road Charges
- Proposed Congestion Charging in Edinburgh
- Evidence from Analysis of GRACE / DfT Questionnaire Surveys

In addition laboratory experiments on user responses to differentiated charges undertaken in Dresden and Newcastle are described and used as sources.

For freight operators:

- Surveys conducted by TRT and ILiM, focussing on toll differentiation in road haulage.
- Surveys conducted by SINTEF that and considered the effects of road freight tolls on attitudes and behavioural responses in urban areas

For ferry and rail passenger:

- The Forth Hovercraft Trial of summer 2007
- Yield management in passenger rail in France and Germany

Results from field experiments and surveys indicate, for example that people have more difficulties in dealing with differentiated prices if schemes contain distance-based elements and have fewer problems if differentiation elements are built on already existing cognitive structures and/or on elements people are familiar with. The results provide evidence that effectiveness of pricing schemes depends on personal price thresholds: a low price level associated with high complexity indicates a low likelihood of behavioural changes.

Findings from the case studies suggest that motivational factors, particularly acceptability of pricing measures, affect people's likelihood and willingness to respond towards differentiated charges. The interrelation of acceptability and user responses seems to be moderated by situational factors and users perception of these factors. The effectiveness of charges will strongly depend on whether people perceive that they are able to adapt their behaviour and whether they will perceive a supportive situation. Otherwise, if users perceive that the charging schemes restrict their travel behaviour and / or freedom of action, individuals might experience psychological reactance.

Negative impacts deriving from highly differentiated pricing systems are more likely in the personal travel sector than within transport companies. In contrast to the personal travel sector, logistics and freight operators seem to act more rationally. Dealing with differentiated charging schemes belongs obviously to business routines and is allocated as a necessary task to specific organisational structures within transport companies.

Finally from the findings of this report, and in the interest of achieving an effective introduction of differentiated pricing, a number of recommendations were derived: do not introduce unnecessary differentiation; build gradually on existing differentiation; avoid differentiation elements which are not in line with an easy human information processing; do not expect precise calculation of charges that were designed to provide complex pricing signals; make pricing schemes familiar to users by assistance and helpful advice; provide adequate information and advice about the price structure of the charging schemes; provide information to stress the justification for the scheme; provide (and publicise) opportunities to change behaviour according to the differentiated charging schemes.

The lead authors of D4.2 are: Lars Rössger, Jens Schade, Denise Obst, Tina Gehlert and Bernhard Schlag from Technische Universität Dresden; and Peter Bonsall and Bill Lythgoe from ITS, University of Leeds.

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## *Deliverable 11.1: Synthesis and Conclusions*

Deliverable 11.1, *Synthesis and Conclusions*, was submitted in June 2008, and is available to download from the project website at: www.different-project.eu. Deliverable 11.1 summarises the main results of the DIFFERENT project.

In the European Union, transport infrastructure charges vary strongly across transport modes and countries. Some degree of convergence exists on the intention to apply the principle of marginal cost pricing but, in the presence of unsolved difficulties in funding transport investment and other concerns about marginal social cost pricing in several countries, any such convergence is slow. More differentiation in pricing would increase the efficiency of pricing structures. This leads to questions such as: how differentiated should these price structures be in order to lead to efficiency gains? how do users react? what are the effects on equity and revenues?.

These questions, with a strong focus on user reactions, were studied both from the theoretical and from the empirical perspective in DIFFERENT. The theoretical study covered both the *normative* and the *positive* theory of economics. In addition, DIFFERENT made use of behavioural theories, taken from psychology, to study reaction of users to differentiated infrastructure pricing. Among the many results that emerged from this exercise the most important are (1) that pricing-schemes are rarely implemented in pure text-book forms but rather reflect a compromise between various aspects and approaches, (2) that there is an optimal degree of differentiation beyond which further differentiation is counterproductive, and (3) that a political influence on pricing structures is always discernible and therefore should not be disregarded in the design of pricing-structures.

D11.1 recaps the economic and psychological theory that has underpinned the work of the DIFFERENT project and then, in this context, summarises the empirical results from all project case studies: in air, shipping and rail transport, interurban and urban road transport, and for intermodal chains. These results show that the effects of price differentiation depend very much on the particular mode under investigation and the particular circumstances.

The effects of price changes are discussed in the following paragraphs:

In the case of interurban road transport the evidence shows quite clearly that price changes led to changes in transport demand. In Germany the introduction of the HGV-toll led to reactions with respect to route choice, the effective tonnage chosen, and logistics. In Italy modelling work showed substantial effects for the Brenner corridor and also important effects in the Padana region. In Switzerland too the introduction of a toll on HGVs brought quite noticeable effects with it.

The case for railways is unclear, mainly due to severe data limitations, a consequence of the regulatory upheaval that the railway sector is currently running through. The most reliable evidence gathered with respect to railways was on the effects of the so-called “regional factors” in Germany, which are part of the German network operator’s (DB Netz) pricing policy. Here the “user reaction”, was from the public transport authorities, which in Germany are responsible for putting out urban transit services for tender. The evidence shows that the public transport authorities reacted quite strongly to the introduction of the regional factors by closing lines.

Air transport seems to belong to the exceptions with respect to effects of pricing. This is not to say that differentiation could not work in the future. The results we obtained only reflect pricing policies up to recently. Taking this proviso into account, in all cases investigated the effects of changes in starting and landing fees on the behaviour of airlines were rather limited. The London and Gran Canaria case studies showed certain effects of starting and landing fees but these effects were limited. A closer

look at the case studies reveals that the cost-share of airport-fees in the total costs of airlines is rather small. It comes as no surprise therefore that airlines react rather inelastic to these fees.

The many case studies on ports leave no clear picture. It seems, however, that the case of ports is quite similar to the case of airports. The share of port dues in total costs of shipping companies is, particularly for long distance and container shipping, too small to induce substantial reactions.

The effects of price differentiation are discussed in the following paragraphs:

In interurban road transport the differentiation of the German and Swiss HGV toll according to axle weight and emission classes showed clear effects. In Germany, for instance, a trend towards smaller and cleaner trucks was observed. In fact, the move to smaller trucks (which are exempt from the toll) has become so pronounced that there is discussion about extending the toll to vehicles under 12t. Similar observations were found in Switzerland.

For urban car traffic, the introduction of the highly differentiated charging scheme in Stockholm led to strong driver reaction; however, since the strongest traffic reductions were found in the hours with the lowest charge, further research is needed to explain this phenomenon. The London scheme at first sight seems not to be differentiated at all. Upon reflection it is clear that the difference between day-times were the charge applies and where it does not apply, amounts to differentiation. The evidence shows, that many car drivers adjust their behaviour accordingly (e.g. by postponing trips into the night-time). Strong effects of differentiation can also be observed in the cases of the HOT Lanes in the USA and in the case of Singapore.

The scarcity of data makes it very difficult to derive clear conclusions in the case of rail. The case of the regional factors in Germany may again deliver the most reliable evidence. The case study showed a clear correlation between differentiation and the behaviour of the public transport authorities. Simulation results based on a German engineering cost calculation model showed that varying the components of a two-part tariff for pricing network access resulted in substantial changes in demand of the freight transport operators.

The Spanish airport case studies (Madrid Barajas, Gran Canaria) delivered evidence on substantial possible welfare effects of peak-load pricing. The Spanish case studies also made also clear that institutional constraints currently prevent this welfare gains from being exploited. The case of London has led the conclusion that there is relatively little competition between airports (at least among the London airports). Therefore, price differentiation doesn't seem to be a competitive parameter of airports.

It was said already, that port-dues amount only to a small share in shipping companies' expenses. Accordingly, the effects of differentiation in the case studies were low.

D11.1 concludes with conclusions and recommendations for each transport mode studied.

The lead authors of D11.1 are: Christos Evangelinos, Bernhard Wieland, Lars Rößger, Denise Obst and Jens Schade from Technische Universität Dresden.

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There were contributions to D11.1 from all other project partners.

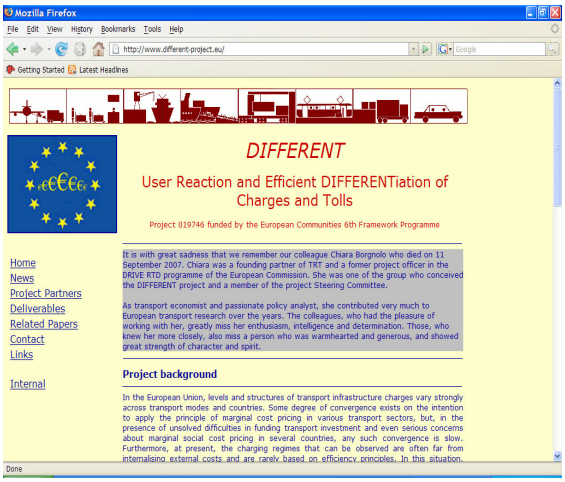
## 3.2 OTHER DISSEMINATION

The principal channels of dissemination exploited by the project consortium are:

- The project website, which contains information about the project's aims and objectives, project partners and contacts and, most importantly, contains all the project's public deliverables available for public download
- The DIFFERENT Leaflet, which provides basic information about the project, the consortium, project main goals, the technical approach, and the expected achievements
- Publications in refereed academic journals, in other technical and non-technical journals and industry publications
- Attendance and presentation of papers at national and international conferences
- Presentation of project results at diverse workshops and seminars, aimed at researchers, students, politicians and decision-makers

## *DIFFERENT Project Website*

The DIFFERENT project website was set up in the first months of the project and has been constantly updated throughout the project. The website contains pages on the project aims and objectives, news, partners, project contacts and deliverables. The full text of all project's public deliverables are available for download on the website; in addition, the executive summaries of restricted deliverables can be downloaded. A password-protected "members-only" area has been used to post the non-public deliverables and other information internal to the project.
An example of screenshots from the website is shown below.





## *DIFFERENT Project Leaflet*

The project leaflet is an A4 sheet, printed double-sided, and to be folded into three columns. The two sides of the leaflet are shown below, and it is downloadable from the project website.

Hardcopies of the leaflet were sent to the Commission on their special request for distribution within the Commission Services. Further hardcopies have been distributed by all partners to appropriate contacts. The leaflet has, for example, been distributed at conferences attended by members of the project consortium and has served as a "business card" for the project, being sent to stakeholders in preparation for interviews carried out within the project.


## *Publications in Journals and Industry Publications*

As the work of the project is now complete, papers have been submitted for publication in:

- Transportation Research Part E
- The Logistics and Transportation Review
- Transport Policy
- Transportmetrica
- The Journal of Air Transport Management
- The Review of Industrial Organization;
- The Scottish Transport Review.

There are immediate plans to submit papers based on the work of the project to:

- The Journal of Transport Economics and Policy
- Transportation Research Part C: Emerging Technologies
- Transport Policy
- Transportation Research Part A: Policy and Practice.
- Journal of Transport Geography

There are discussions within the consortoim regarding proposals for special issues, based on the DIFFERENT project, of:

- European Transport/Trasporti Europei
- Transport Policy

## *Papers at National and International Conferences*

Papers based on the work of the project have been presented at:

- the 11th World Conference on Transport Research, Berkeley, CA, June 24-28, 2007
- the Air Transport Research Society 2007 World Conference, University of California, Berkeley, July 21-23, 2007
- AET European Transport Conference, Leiden, Netherlands, October 17-19, 2007
- TRA Transport Research Arena Europe, Ljubljana, Slovenia April 21-24, 2008.
- the Third International Conference on Funding Transport Infrastructure and the Tenth "Journée Transport", Paris, June 19-20, 2008

and papers accepted for:

- the 12th Air Transport Research Society World Conference, Athens, Greece, July 6-10, 2008.
- 4th International Conference on Traffic & Transport Psychology, Washington, DC, August 31–September 4, 2008.
- 35th Conference of the European Association for Research in Industrial Economics, Toulouse, France, September 4-6, 2008.
- AET European Transport Conference, Nioordwijk, Netherlands, October 6-8, 2008.
- XXIX International Congress of Psychology, Berlin, July 20-25, 2008.

In addition papers have been presented at a number of seminars and workshops attended by politicians, decision-makers, researchers and students.

The project website has a page for “related papers” and this will be updated to include all the relevant output of the project, and will be kept updated as dissemination continues after the end of the project.