



DIFFERENT

User Reaction and Efficient Differentiation of Charges and Tolls

DELIVERABLE D3.3

ECONOMIC THEORY AND METHODOLOGY ON DIFFERENTIATED INFRASTRUCTURE CHARGING

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EXECUTIVE SUMMARY

The objective of this deliverable is to develop a theoretical framework for the analysis of differentiated pricing schemes in transport markets. The scope of this deliverable is limited to the contribution of economic theory; deliverable 4.2 will focus on the behavioural theory.

The approach applied in this deliverable is to first review existing theoretical evidence. In a next step we use this framework as a base to define hypotheses, and proceed to a cross-case testing of the hypotheses.

The information that is used in this analysis is contributed by the case studies that are conducted in the DIFFERENT project. In order to collect this information in a generic way, a factsheet form was developed and completed for each case study.

As there is a large degree of heterogeneity in the case study data, a major concern in our methodological approach is to control for it. In order to allow for a consistent analysis, we introduce two indicators. A first indicator is a measure for degree of differentiation of a pricing scheme. It reflects both the number of dimensions along which prices are differentiated as well as the number of price levels within each individual dimension. This indicator will play an important role as independent variable in our cross-case analysis. A second indicator is a measure for degree of ambition, and is simply the number of aims set for the pricing scheme. This indicator will be used to control for heterogeneity where appropriate.

Economic theory provides a contribution along two main lines. The first contribution concerns the formulation of the optimal framework (the *normative* approach) for transport charges differentiation. It is reached pursuing economic efficiency, a concept derived from welfare economics, according to which transport charges (prices) should be equal to marginal social costs in order to obtain maximum social welfare. According to this theory, prices should be equal to marginal social cost (throughout the economy) to achieve this goal.

The second contribution of economics addresses various difficulties in the application of the marginal cost concept, due to technological, institutional and political reasons, leading to deviations from first-best pricing rules, i.e. towards second-best pricing approaches. This approach moves from a normative approach (how transport charges should be in order to ensure welfare maximization) towards a *positive* approach (how transport charges actually are in order to take account of several constraints).

The normative approach focuses in a first step 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). Sometimes, an aspect of welfare is considered only (e.g. the environment), but the focus can also be limited to subgroups of the users (e.g. equity).

Our cross-case analysis reveals how 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. When the implementation mechanism is a barrier for differentiation, the price setting actors tend to adopt a less differentiated scheme as a second best approach.

In a second step the normative framework focuses on behavioural responses to a differentiated pricing scheme. The point here is that the degree of 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. Taking into account this decision cost leads to an optimal degree of differentiation that is lower than what a first-best outcome suggests. Other considerations regarding behavioural responses include how acceptability may depend on misunderstandings on who is actually paying the bill as well as which exemptions exist - exemptions



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that typically have an adverse effect on the effectiveness of the price measure. Elasticities can provide indicative and useful answers to the questions about the effectiveness of a policy measure. However, policy makers must realise that the elasticity of some measure does not exist: elasticities of travel demand very much depend on the contexts.

The case study dataset confirms that there is an optimal level of price differentiation which is lower when a smaller number of aims is set as well as for car drivers compared to other infrastructure users. Furthermore, we observe how users tend to react along a behavioural dimension that directly corresponds to the domain in which price differentiation is applied. One should however take into account that a spatial dimension is involved in most real world cases resulting from the geographically confined area where the pricing scheme applies.

The positive approach describes the impact of policy makers and interest groups on the differentiated price structure. Special Interest Groups (SIGs) are interfering in the political field in order to gain as many advantages as possible for their members. Theoretical contributions in this field focus on the provision of information and campaign contributions.

Past research indicates that for the transport sector, SIGs will certainly interfere in the political process in favour of their members. Their main concern is (according to the existing research) to achieve a certain degree of regulation, which guarantees the skimming of rents. This means that most of the SIG's activities are concentrated on imposing regulation and hence a certain price level. Laffont's contribution to the modelling literature indicates that when a pricing policy is already implemented the activities of the SIGs will centre not only on the tariff level, but also on the tariff structure, that is on the type of differentiation.

Our cross-case analysis confirms the two basic axioms that were 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.
- Policy makers will react to lobbying influences and implement a kind of SIG equilibrium (like in the Stigler-Peltzman model or the Grossman/Helpman model). Infrastructure charges which correspond to such equilibrium may be termed "politically acceptable". In most times this rules out tariff-structures, which increase the welfare (as compared to the status quo ante) of only one SIG even if total welfare effects should be positive.

Case study analyses further indicate that lobby activities are generally a major explanatory variable for the tariff structure. In addition, political acceptability of a certain pricing scheme can only be achieved, if the most powerful SIGs do not object to it.

We identify how the tariff structure reflects the political power of SIGs; the more equal the distribution of political power among SIGs, the more likely is that additional price differentiations will occur.

Finally we observe in our analysis how different pricing schemes result in different manipulation possibilities by SIGs. These possibilities have however different relevance for different transport modes. Qualitative analysis showed that variabilisation is a major issue in air transport, whereas inverse Ramsey pricing is likely to play a role in city tolling systems and a more differentiated two part tariff in the shipping sector.



1 INTRODUCTION¹

DIFFERENT has a strong theoretical side. The theoretical inputs mainly come from economic and behavioural theory. These two theoretical components have been discussed in WP2 (Deliverable 2.1), together with existing charging structures and existing modelling approaches. WP 2 aimed to set the stage and provided a concise overview of the main theoretical principles related to price differentiation in transport. This deliverable, part of WP 3, has an economic perspective only. While WP 2 focused on (optimal) first-best pricing, this deliverable addresses more realistic pricing strategies by paying attention to the impact of various existing constraints.

The work presented in this deliverable is the underlying economic framework for the rest of the project. The aim is to develop a solid framework based on the economic backgrounds of differentiated transport pricing which can be used to assess the results of case studies and provides useful input to the formulation of hypotheses. We start with a discussion of several important issues of price differentiation in transport which result from our analytical framework, presented in Figure 1-1.

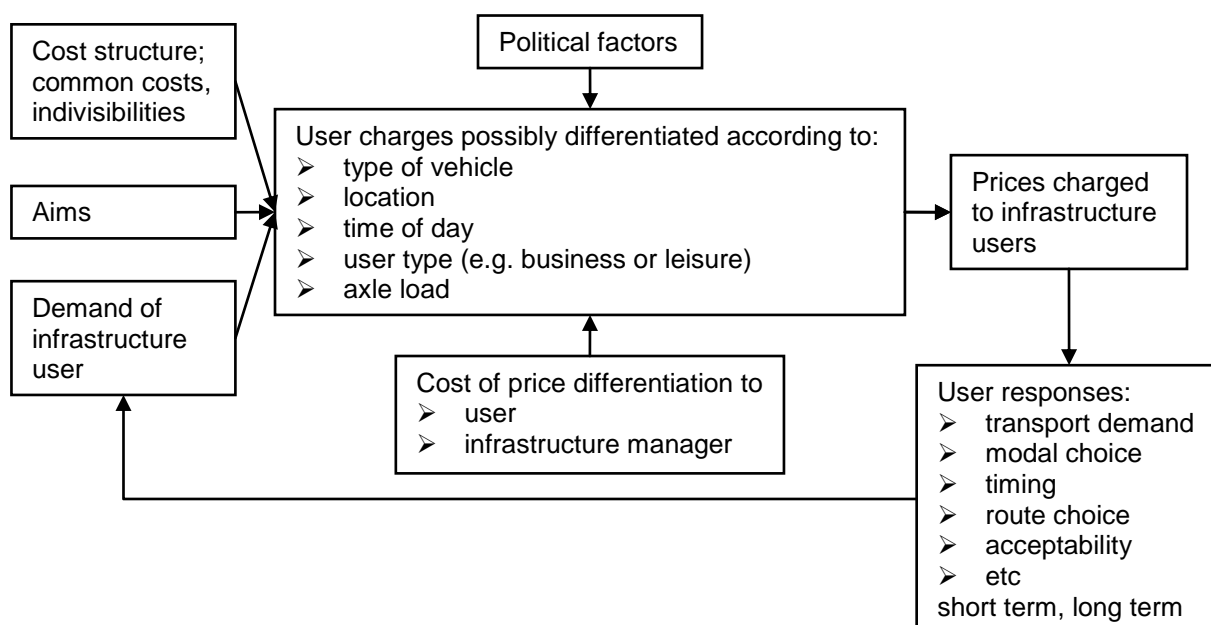


Figure 1-1 Analytical Framework

Figure 1-1 identifies five different aspects that affect price differentiation. The left-hand side of the framework gives three (normative) arguments possibly explaining differences in price setting. Objectives among infrastructure managers and operators may be different. WP 2 already mentioned many of these, with specific attention paid to economic efficiency and equity. Also the implications of the particular cost structure of the transport industry for pricing have briefly been discussed. Therefore we focus on the demand of the infrastructure user.

But there are also other issues that are relevant for user charge differentiation. Policy makers may well affect price setting in transport. This is where the positive branch of economic theory of price differentiation comes in (at the top of Figure 1-1). The normative approach assumes that all politicians or regulators maximize welfare, but they may also pursue own goals (e.g. re-election). This kind of behaviour makes them also susceptible to the influence of interest groups. Considerations like these are of particular relevance as they may considerably affect the differentiation of user charges.

Finally also practical issues are important (in the middle of Figure 1-1). For instance, a highly differentiated first best pricing scheme may have a large implementation cost, if technically feasible at all. Such a high degree of sophistication also implies a significant decision cost for the infrastructure user. This latter issue of the cognitive burden will not be discussed in this deliverable; this is left to

¹ Chapters 2 and 3 (and the corresponding conclusions in chapter 5 as well as the executive summary) are directly based on earlier project deliverables (D2.1 and D3.1).



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workpackage 4 on the behavioural issues. We refer to the GRACE project for more information on the appropriate degree of complexity in transport charges (see e.g. Bonsall, et al., 2006). Moreover, more choices (a consequence of a higher degree of differentiation) may also lead to more search costs in an economy suggesting that less variety is sometimes better (Norwood, 2006).

The effects of price differentiation (i.e. the user responses; right-hand side of Figure 1-1) may be varied and depend on the type of differentiation and the prices charged to the final user. In between the type of differentiation and the consumers' response we should pay attention to the actual price that is charged to the user. Charges may be partially passed on to more indirect users. For instance, firms confronted with a certain type of road charge will usually apply a mark-up on the price of their products with the consequence that part of the road toll is indirectly paid by the customer. Similarly, employers may decide to (partially) compensate employees for increased commuting costs which affect behaviour. The factors determining the share paid by each actor include the competitiveness of the sector considered as well as demand and supply elasticities. With highly inelastic demand for a transported good, the infrastructure charge is likely to be passed on to the end-consumer of the good, whereas for highly elastic demand the expected outcome of the game is that the infrastructure user (transporting the good) is paying the bill.²

Based on the analytical framework presented above, chapters 2 and 3 will start with a discussion on various theoretical aspects affecting price differentiation. A subsequent chapter will discuss a methodology for classification and coherent evaluation of the case studies with respect to economic theory. The focus will be on cross-case analysis. A last chapter concludes.

² Note that this statement only addresses differences in demand elasticity for a transported good, assuming all other factors (including production functions) being constant.



2 NORMATIVE ECONOMIC THEORY OF PRICE DIFFERENTIATION

The introduction in normative economic theory of price differentiation presented here is based on deliverable 2.1 and 3.1 with minimal editing to fit the setting of this deliverable 3.3. Although it does not add to the discussion presented in earlier deliverables, we do provide an integrated overview here both for completeness as well as accessibility (deliverable 3.1 is not in the public domain).

2.1 INTRODUCTION

Transport has some characteristics that make it different from other goods. Possibly the most important characteristic of transport is that it is often not really demanded in its own right (Button, 1993). People wish, in general, to travel so that some benefit can be obtained at the final destination. Similarly, users of freight transport perceive transport as a cost in their overall production function and seek to minimise it wherever possible.

While the demand for transport has particular, if not unique, features, also certain aspects of supply are entirely peculiar to transport. More specifically part of the plant is mobile – almost by definition – and is entirely different in its characteristics to the fixed plant (for example, roads, airports etc.). The fixed component is usually extremely long-lived and expensive to replace. Further, few pieces of transport infrastructure have alternative uses.

Demand and supply work together to determine the market price in competitive markets. The price of a good or a service is what must be given in exchange for the good or service (Stiglitz and Driffill, 2000). When the forces of supply and demand operate freely, price measures scarcity. In addition, in the competitive model, the equilibrium price of an object will normally equal its cost of production (including the amount needed to pay a firm's owner to stay in business rather than seek some other form of employment). Elementary economics tells us that in the long run price will then be equated with the marginal (and average) costs of each supplier. But the transport market is different. Simple market economic theory cannot directly be applied to transport for a variety of reasons. Since journeys are unique in space and time, monopoly is likely to arise in varying degrees, especially when technological change offers an advantage to a particular mode or where economies of scale affect one mode more than another. This situation also affects the pricing of transport services. Transport prices do not simply result from the law of supply and demand.

The complexity underlying transport pricing arises if one looks at the different transport pricing objectives.

Pricing can be seen as a method to affect resource allocation. Pricing strategies permit specified aims to be achieved; there is no such thing as the right price independent of the aims pursued. The pricing policy adopted by any transport undertaking with some degree of market power depends upon its basic objectives. For example, an optimal price aimed at achieving profit maximisation may differ from that needed to maximise social welfare, or to ensure highest sales revenue. Social welfare refers to the measure used to express a society's aggregate well-being. It can be defined in many ways, most of which take individuals' utilities as a building block. Applied research often uses (weighted) sums of individual welfare measures, which is true also for "social surplus" as we will use below. There is no objective criterion for the specification of a social welfare function; i.e. economists can not define it objectively (see, for example, Atkinson and Stiglitz (1980) for further details).

In some cases there is no attempt to devise a price to maximise or minimise anything, but prices are rather set to permit lower level objectives (for example security, minimum market share) to be attained. Further, prices may be set to achieve certain objectives for the transport supplier in terms of his welfare (this is normally the case of private enterprise transport undertakings), while in other areas prices may be set to improve the welfare of consumers (as has been the case with publicly owned transport undertakings). This distinction is important, as many undertakings consider that the employment of the pricing mechanisms to achieve their objectives is automatically to the benefit of customers.



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It is clear that pricing objectives differ depending on the provision of transport services (public or private) and market conditions. The following pricing objectives can be distinguished:

- Economic efficiency³;
- Profit maximisation;
- Cost coverage;
- Environmental sustainability;
- Equity (including redistributive objectives);
- Objectives transcending the boundaries of transport markets, including macroeconomic objectives.

The objective of economic efficiency is usually important to governments, as it reflects the aim to maximise welfare of all inhabitants; this will be discussed in more detail in the following section. Profitability reflects the traditional economic assumption that firms set prices as to maximise profits. Variations on this theory suggest that many undertakings adopt prices that maximise sales revenues (Baumol, 1962) when in an expansive phase, or simply price to ensure that certain satisfactory levels of profit or market domination are achieved (Simon, 1959). A third possible objective is that of cost coverage. Most publicly owned firms are not so much focused on making profits, but rather to stay in business and recoup their costs, often induced to do so for political or fiscal reasons.

Protection of the environment has become an important objective for governments in recent years. Transport in general, and road transport in particular, are widely recognised as an important source of pollution which threatens environmental sustainability. Pricing measures have been suggested or introduced to deal with these problems. It is arguable that promoting environmental objectives is consistent with the aim of securing welfare maximisation through economic efficiency, in particular when social welfare incorporates environmental social costs and benefits.

Equity objectives and the distribution of real incomes in society are important issues to a government, reflected in the pattern of taxation and public expenditures. Whilst transfer payments, such as benefits and pensions, are a major means of redistributing income, the provision of services, such as transport at subsidised prices, is often considered to be equally important (United Nations, 2001). Moreover, tax policies (or other policies) aimed at regulating transport and the various possible allocations of tax revenues, will have distributional consequences that may or may not match more generally formulated distributional targets, and may therefore motivate adjustments in currently used (distorted) taxes, which in turn implies that indirect efficiency effects may occur elsewhere in the economy.

Finally, public bodies are concerned with macroeconomic policy objectives. Governments usually focus on four target variables: the level of unemployment; the rate of inflation, the balance of payments and the rate of growth of national output (see Stiglitz and Driffill, 2000). The level of investment in, and the pricing of, transport infrastructure and transport services both affects and is affected by macroeconomic policies.

These sorts of objectives are complex and are often not compatible. Whilst there are many transport pricing objectives, economists often focus on the pursuance of economic efficiency alone. Prices that are socially optimal are seen as the first-best benchmark, which is in most cases politically desired.

Nevertheless, an expanding body of literature on transport pricing is emerging that considers pricing and revenue allocation in the context of a wider – general equilibrium – framework, in which (tax)distortions elsewhere in the economy and distributional objectives as represented in social welfare functions are considered explicitly (e.g. Mayeres and Proost, 1997 and Parry and Bento, 2002).

In this deliverable we aim to discuss some important economic principles of transport pricing. The intention is not to provide a complete overview of all economic theory on this, but to focus on relevant issues in the context of the DIFFERENT project. We distinguish two different approaches: the normative and positive economic theory of price differentiation.

³ Economic efficiency is concerned with the use of society's resources such that no mutually beneficial transactions remain possible.



In this chapter we discuss the normative approach which assumes that all actors try to maximise welfare. Pricing is efficient when welfare is maximised. The positive theory of regulation and its consequences for price differentiation are discussed in chapter 3. This approach focuses on one particular type of constraint of optimal pricing: the political dimension. Policy makers are often influenced by interest groups and it is therefore likely that prices will not be set at an efficient level.

2.2 FIRST-BEST PRICING PRINCIPLES AND IMPLICATIONS FOR DIFFERENTIATION

2.2.1 Efficiency: Social Marginal Cost Pricing

The concept of economic efficiency is derived from the theory of welfare economics, and is concerned with the allocation of resources in an economy. Welfare economics takes a rather wide view of pricing, looking upon price as a method of resource allocation which maximises social welfare rather than simply the welfare of the supplier (Button, 1993). According to this view, prices should equate with marginal social cost to maximise social welfare. What marginal cost pricing does, in effect, is to result in transport services being provided up to the point where the benefit for the marginal unit is equated with the costs of providing that unit (Button, 1993). Sometimes, private provision of the good or service may also result in maximising the social welfare. Otherwise, regulatory policies may be applied to private companies so that their pricing policy is modified to maximise social rather than private welfare. Deriving socially optimal prices needs an objective function (describing the target to be optimised, in this case social welfare). The most general form of this function is a social welfare function. Formally, a social welfare function has as its arguments the indirect utility functions of individuals (Varian, 1999). These indirect utility functions indicate the maximum utility levels of the individuals at given prices, incomes, and magnitudes of externalities such as congestion and pollution. The social welfare function inevitably incorporates welfare judgements with respect to the distribution of economic resources. These value judgements will be reflected in the policy prescriptions based on the welfare function.

An allocation is to be said first-best, if it maximises social welfare subject to the irreducible technological constraints of production (Dreze and Stern, 1987). A first-best optimum in transport is an allocation defined by quantities of goods, including passenger and freight transport volumes that maximises welfare given the prevailing technology such as vehicle fuel consumption and emissions, and the capital stock including transport infrastructure (MC-ICAM, 2002). This definition encompasses externalities if their costs are internalised in the decisions of agents who generate them and included in their utility functions. Economic efficiency then implies that the full costs of transport services are accounted for, including social and environmental costs.

We should mention that this optimal pricing rule only prevails as a market equilibrium under certain conditions, which include:

- Perfect competition;
- No distortions in other market segments;
- No externalities;
- Perfect information;
- No subsidies or indivisibilities of demand or supply.

Clearly, these assumptions will never be met in reality. This makes first-best pricing very much a theoretical result, which is often used as a benchmark for other, more realistic, pricing approaches.

2.2.2 Marginal Cost Pricing and Behavioural Dimensions

Optimal pricing of infrastructure requires that the user charge equals the marginal social costs. Marginal costs are those variable costs that reflect the cost of an additional vehicle or transport unit using the infrastructure. This implies that both user costs (e.g. fuel and time costs) and external costs determine the level of the charge. The distinction between private costs and external costs is not new. Pigou showed already in 1920 in his economic analysis of road pricing and congestion costs that



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individual users entering the road will only consider the costs they personally bear (marginal private costs), but not the external (congestion⁴) costs (marginal social cost) they impose on other road users (Pigou, 1920). This leads to over-demand and a non-optimal situation. He showed that a levy (a Pigouvian tax) equal to the marginal external congestion costs should be imposed from a social point of view. In this case only congestion costs have been included in the analysis, but the analysis holds for all types of external costs.

There has been a lot of discussion about marginal costs and their central role for pricing in the transport sector in the previous decades (see Rothengatter 2003). One of the most pressing issues is the practical application of the concept of marginal costs in the real world. A critical prerequisite for marginal cost pricing in practice is a sound estimate of relevant marginal costs (MC-ICAM, 2001). This is not evident for many external costs. It requires fundamental knowledge on the mechanisms behind the generation of these costs. This understanding, in turn, demands identification of the different types of activities in which the users of transport infrastructure are involved. These activities may be called behavioural dimensions. Various dimensions can be distinguished, depending on the marginal costs caused by the individuals, including a large variety of external effects (congestion, emissions, noise annoyance, accidents). When we look at road use, this means that optimal individual charges should at least vary according to the following dimensions (Verhoef, 2000):

- The vehicle (technology) used;
- The actual state of this vehicle;
- The number of kilometres driven;
- The time of driving;
- The place of driving;
- The actual route chosen;
- The driving style.

A similar list of dimensions can be composed for other modes of transport. It is needless to say that such a system requires very sophisticated technologies that can monitor information about the actual state with respect to these dimensions, and calculate a charge accordingly (an issue which we will discuss in the next section). This involves a wide range of various critical decisions, both short run (e.g. departure time) and more long run (i.e. car ownership) in nature, which determines charge levels. The great number of behavioural dimensions and categories of external costs to be accounted for makes the task of marginal social cost pricing in providing optimal incentives to transport users to change their behaviour extremely complex (MC-ICAM, 2001). Different dimensions may also simultaneously affect several cost categories, making it even more complicated. Table 2-1 (adopted from AFFORD, 2001) illustrates this and considers road transport as an example (a similar illustration could be given for freight transport and public transport). Car drivers can respond in various ways to hypothetical first-best pricing. When people do not change to other modes, they may choose to drive less kilometres, change departure time, choose another route, or adjust driving style. More long-term behavioural decisions include car ownership and spatial behaviour, which refers to the choice of residence and the location of other activities. This issue will receive more attention in section 2.4.

The table indicates the relevance of each dependence on a three point scale. The assigned stars are merely indicative and debatable. That is also the reason for using a three-point scale only. However, the table is illustrative in drawing explicit attention to the dependence between various externalities and behavioural dimensions (Verhoef, 2002). For instance, the way people drive affects congestion levels and accidents (risk levels increase with speed). But it has also a strong impact on noise levels and the level of air pollution. Regarding the congestion externality, Table 2-1 makes a distinction between bottleneck congestion and flow congestion. The main difference is that bottleneck congestion is caused by the existence of physical bottlenecks in the network, such as bridges or tunnels. Flow congestion refers to (limited) road capacity in general. In real networks, observed congestion is often a mixture of both types of congestion. As shown in Table 2-1, bottleneck congestion is independent of the total vehicle*kilometres driven in the network. It depends only on the

⁴ Note that congestion costs are external to the individual road user, but may be regarded as internal when the whole transport system is considered.



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question of whether a driver wants to pass the bottleneck. We will come back to bottleneck congestion in section 2.5.1.

Table 2-1 Dependence of Various External Costs of Road Transport on Behavioural Dimensions

	Car Use					Car Ownership		Spatial Behaviour (Location of Work, Residence)
	Vehicle*km	Number of Trips	Time of Driving (Peak/Off-Peak)	Place of Driving	Driving Style	Fleet Size	Vehicle Technology	
intra-sectoral externalities								
flow congestion	*	-	**	**	**	*	-	**
bottleneck congestion	-	**	**	**	-	*	-	**
infrastructure damage	**	-	-	-	-	*	*	**
accidents	*	-	*	*	**	*	*	*
inter-sectoral externalities								
noise	*	-	*	**	**	*	**	**
local emissions	**	*	*	**	**	*	**	**
global emissions	**	*	-	-	**	*	**	**
** particularly strong and direct relation; * possibly strong indirect relation, or moderately strong direct relation; - no particular strong or direct relation								

Source: Verhoef, 2002

Obviously, first-best pricing affects all behavioural dimensions. But, as will be shown in the next section, this is not very realistic in practice. We then enter the world of second-best pricing with the consequence that not all dimensions will be affected, or to a lesser extent. For instance, fuel taxes do have an impact on the number of kilometres driven, the number of trips and car ownership, but they do not affect time and place of a specific car trip.

2.3 DEVIATIONS FROM FIRST-BEST PRICING IN TRANSPORT: CONSEQUENCES FOR DIFFERENTIATION

The marginal cost pricing concept has been addressed in policy documents for many years. Still three years ago, the European Commission has suggested to introduce marginal cost pricing in the transport sector as a general principle from which departures are only admitted in exceptional cases (Rothengatter, 2003). More recently, however, the Commission seems to adjust their views by introducing the concept of 'smart charging', which focuses on the financing of transport infrastructure without mentioning marginal cost pricing (CEC, 2006). As is apparent, it is not so easy to apply this first-best principle in practice. Given the optimality of marginal cost pricing, the question arises why such an evidently attractive instrument has only rarely been used in practical policy making. Apart from issues related to the limited social feasibility of pricing instruments, a different explanation for the low level of practicality may be the fact that reality is often much more complicated than the simple world assumed in theoretical textbooks. This may seriously complicate the determination and application of optimal infrastructure charges in reality.

In this section we first address the transport market. The transport market is characterised by several market imperfections which makes it very unlikely that the market, without regulation, will set transport prices equal to marginal social costs and, therefore, social welfare will not be optimised. Besides market failures, governments may also have other reasons to intervene and adjust prices. Equity is an important reason that deserves attention in the context of price differentiation. The second subsection discusses more practical constraints of first-best pricing.



2.3.1 Deviations from Marginal Cost Pricing

The previous section has shown us that equality of prices and marginal costs leads to an efficient use of resources in an otherwise ideal world. But the real world is not ideal. Actual (market) prices may deviate from marginal costs for a number of reasons. Some reasons result from market failures in the transport industry, in particular:

- Increasing returns to scale (indivisibilities of supply: fixed capacity);
- Indivisibilities of demand: peak load;
- Common and joint costs;
- Imperfect competition (e.g. monopoly);
- Externalities.

The pervasive involvement of public agencies in transportation and the failure of these agencies to apply marginal cost pricing principles is caused in part by several peculiar characteristics of the transport market (Gómez-Ibáñez, 1999). These characteristics are not unique to transport – some are found in other capital-intensive sectors (such as electricity and telephones). But they make both social marginal cost pricing and private provision seem more complex and controversial than in many other markets (e.g., for a discussion on the adoption of marginal cost pricing in ports, see Goss and Stevens (2001) and Haralambides et al. (2001)). When the principle of optimal pricing is applied to the transport sector, it is usually necessary to extend theory in order to deal with certain industry specific characteristics. We discuss some relevant issues in the context of price differentiation. Transportation facilities and services often require capital intensive infrastructure, and vehicle needs (leading to certain industry specific characteristics) may cause particular pricing problems. Specifically, the large fixed investment costs and the joint use of the facilities and services may result in necessary deviations from marginal cost pricing.

Equity is another important reason why actual prices deviate from optimal prices. Therefore we added equity to the following discussion of transport industry characteristics and their impact on price differentiation.

Economies of Scale

A characteristic of physical transport infrastructure is the considerable capital costs, which are often higher than the associated operating and maintenance costs for the infrastructure provider (especially on longer distance infrastructure), and can be very long lasting (see also Nijkamp and Rienstra, 1995). Once committed, infrastructure investment usually has few alternative uses and is normally regarded as sunk cost. This fixed component, such as roads, railways, bridges and runways normally give rise to significant economies of scale (marginal costs are below average costs). Once a rail track is laid, the marginal costs of using it falls until a certain capacity level is reached. Firms with large sunk costs and facing economies of scale have marginal costs that are lower than average costs, so that pricing at marginal costs does not generate enough revenue for the firm to be financially self-sufficient.

In the long run, however, congestion costs may show up, resulting in an increase in marginal costs. A toll should be installed which optimally should equal the external costs (Pigouvian charge). A major contribution of Mohring and Harwitz (1962) was to show that the revenues from such a congestion toll will just cover the costs of the facility provider as long as there are no economies or diseconomies of scale in facility capacity, and the facility provider is investing optimally. This holds under certain conditions and concerns optimal highway investment in a first-best world (Lindsey and Verhoef, 2000).

Budgetary problems are especially common in transportation, because transport services often exhibit economies of scale so that marginal cost pricing does not generate enough revenues to cover costs. Ramsey pricing is often suggested to be a solution in order not to deviate too much from efficient pricing. Ramsey pricing minimises the distorting effect of charging more than marginal cost by increasing prices more in those markets where demand is least sensitive to price (Nash, 2001). The basic idea is to charge those customers with the least price elastic demand the largest mark-ups necessary to cover marginal cost and thereby minimise the reduction in consumption that occurs from charging prices that are higher than marginal cost. Commuters, for instance, will be charged more than shoppers, and business travellers more than leisure passengers. It should be noted, however,



that this form of price discrimination has itself often been regarded as unfair as it exploits market power to raise the price for the captive user. If the view of equity is that all users should contribute to the cost of that facility in proportion to their use of it, then some form of average-cost pricing is the only admissible pricing policy.

Indivisibilities

Applying marginal cost pricing to transport infrastructure and services is often problematic, because capacity can only be increased in relatively large indivisible units. There are many examples to be found in the transport sector: if the capacity of a railway coach is 60 passengers, then to carry 61 persons requires another coach. Existing airports at full capacity are another example: expansion requires a new runway and terminal facilities. It is often extremely costly to make (small) additions to physical capacity. The issue is one of optimal investment timing, since, under conditions of growing demand, there will come a point at which an increase in capacity will be worthwhile. This brings us to the distinction between short-run and long-run marginal costs.

In specifying the marginal cost-pricing rule, it is important to understand the distinction between short-run and long-run marginal costs. The distinction arises because different factors of production, used in providing transport services, have varying degrees of fixedness or variability over various business planning horizons (United Nations, 2001). Airports, for example, facing increased demand may be able to increase throughput in the short term, whereas in the longer term the operator is forced to invest in new infrastructure (e.g. a terminal or runway). All costs are essentially fixed in the very short term, and, conversely, in the long run, all inputs and costs are ultimately variable (Braeutigam, 1999). Over a planning horizon, it is important to identify those costs that can be varied (variable costs) and those which cannot be varied (fixed costs). Prices should normally be set in relation to short-run marginal costs, which may be higher, lower, or equal to long-run marginal costs.

What this means for optimal pricing and optimal investment can be illustrated with an airport example (investment in a terminal). The initial marginal costs of using a terminal will be very low, so the price is low when set according to short-run marginal costs (excluding investment costs). There is no need for new investment as there is spare capacity. If the demand function shifts outwards over time, the marginal costs will (sharply) increase due to congestion effects. A new terminal might be needed now. When the price in the peak period consists of operational costs (including that of additional investment), the corresponding demand will give a clear indication of the necessity of the investment. Continuation of excess demand with these LRMC charges justifies investment in a new terminal. In the long-run optimum, $SRMC = LRMC$ may apply (Mohring-Harwitz type of equilibrium: see economies of scale).

The previous essentially implies that marginal cost pricing could produce fluctuations in price before and after capacity adjustments are made. Further, whether or not the airport makes a profit depends on whether the price lies above or below the long-run marginal cost curve. The terminal might be profit or loss making at any moment. The investment in capacity is worthwhile, when the net present value (of the benefits minus costs including investments) of the additional capacity is positive over its life time. Such fluctuations in prices and profits are likely to be undesirable, but unavoidable, because any other pricing pattern will produce welfare losses. Prices above marginal costs during times of excess capacity will cause underutilisation. If price caps are set, during periods of excess demand, non-price rationing methods will be required.

Common and Joint Costs

A related set of pricing complications occurs because transportation firms often use the same facilities, equipment and labour to produce different services: they are multi-product firms. This leads to the conceptual and practical problems of determining transport prices associated with fixed and variable costs and choosing the relevant time period because many costs may also be 'joint' or 'common' to a number of users. Pricing in these circumstances may be difficult, as it is not always clear how to allocate costs between products. Determining the marginal cost level may be difficult in such a setting. Joint costs exist when the provision of a specific service necessarily entails the output of some other service or product at little extra expense (Gómez-Ibáñez, 1999). The classic example of jointness is the return trip, where the supply of a transport service in one direction normally implies the provision of a return service (Button, 1993).



Common costs are similar to joint costs, in that they are incurred as a result of providing services to a wide range of users, but differ, in that the resources used to provide one service do not unavoidably result in the production of other services (United Nations, 2001). An airport, for example, faces considerable common costs. A terminal is used by different types of users: terminal retailers and air passengers. The same holds for runways, these are used by different types of planes. The allocation of these common costs among users poses particular practical problems, which consequently also leads to pricing problems.

Monopoly

Firms facing the previously mentioned aspects, such as high fixed costs and economies of scale, together with significant indivisibilities in the provision of capacity, have limited competition. These circumstances, often the case in the transport industry (particularly in terms of infrastructure), give rise to monopolies. Under these conditions, and a fairly small transport market relative to the optimal size, a good or a service can only be produced at least cost if only one firm is engaged in its production and a natural monopoly is likely to emerge. Public transport companies are often claimed to be a natural monopoly, although there may be little evidence of scale economies (Gómez-Ibáñez, 1999).

Imperfect competition creates a major distortion in the market for transport services. There is every risk that the monopolist will not provide optimal transport prices, and an unregulated market will therefore not lead to the maximisation of social welfare. In such circumstances, the government may decide to intervene either by directly providing the transport services or by regulating prices.

The existence of declining average costs in the transport industry is an important reason for the emergence of natural monopolies in many sectors. The potential monopoly power and the possibility of abuse of this position may be reflected in high prices (or price discrimination) and has often led to government price regulation and public ownership. This is, for instance, the case in the airport industry. Governments are afraid of private airports setting inefficiently high prices. Therefore airports are often in public hands, or privatised airports are (price-)regulated. When governments take over, and prices are set equal to marginal costs, it is obvious that a subsidy is needed. It may also be possible to look for pricing policy options to assist cost recovery while at the same time minimising the resulting allocative efficiency losses. Two-part tariffs (consisting of a fixed charge per consumer and a variable charge per unit consumed) and Ramsey pricing have been suggested in these cases.

Externalities

The transport industry is characterised by various externalities. The essence of an externality is that it involves (i) interdependence between two or more economic agents, and (ii) failure to price that interdependence. Formally, externalities exist when the activities of one group (either consumers or producers) unintentionally affect the welfare of another group, without any payment or compensation being made (Button, 1993). Most attention in transport is paid to the negative (costs) externalities, although also positive externalities (benefits) have been identified (for a discussion on this latter issue, see Verhoef (1996)). It is quite clear from everyday experience, that there are costs associated with transport that are not directly borne by those generating them. Transport generates many negative externalities, including noise, accidents, pollution, and congestion⁵. Road travellers, for example, impose noise and vibration costs on those living adjacent to highways.

A result of the clear presence of externalities in transport is that the early neo-classical writers studying market failures frequently illustrated their viewpoints using transport examples. Dupuit was in 1844 one of the first to illustrate efficient pricing of public goods (Button and Verhoef, 1998). Coase (1960) considered the absence of property rights in relation to the existence of externalities for a railway. Another well-known example is that of a congested road, including optimal congestion charges (Pigou in 1920). They all showed that the market mechanism fails to allocate resources efficiently.

The existence of externalities has been one of the main motivations for governments to intervene in the transport industry. Economists have argued that a correction of transport prices should take precedence. The previous section has shown that optimal taxation (dealing with all types of external

⁵ Note that the congestion externality is external to the individual road user, but internal to the transport system as a whole.



costs) has as a consequence that the charge will be highly differentiated according to many behavioural dimensions. However, policy makers may decide, for instance, to focus only on congestion. Despite lower efficiency, it would considerably reduce the complexity of the pricing mechanism since location and time are the two remaining dimensions to be considered.

Equity

Finally, transportation often raises equity concerns that seem to conflict with marginal cost pricing. Marginal cost pricing clearly results in very differentiated charges with the consequence that no one transport user pays the same price which may be perceived as unfair. Equity is important in the context of the acceptability of pricing. Many stakeholders raise objections about pricing measures that they perceive to be unfair. If a pricing measure is unfair either to themselves in relation to other people or to people perceived to be less well off in society, then there could be significant acceptability problems. Transport pricing is often perceived as a form of regressive taxation, allowing only those with enough money to access a resource (e.g. infrastructure) that was once considered free. Implementation strategies are therefore discussed that allow certain sections of the community to be exempted from pricing, or compensate some groups with a lump-sum transfer. The problem of who should receive extra benefits (e.g. tax exemption) and the wider problem of making sure price measures are both equitable and perceived to be so, are important issues to be included in any successful implementation strategy. Here the concept of price discrimination shows up. In public transport, for instance, it is common that different prices are charged for the same service. The fare policy of governments may benefit particular groups of society, e.g. the elderly.

The public finance and tax literature makes a distinction between horizontal equity and vertical equity. Horizontal equity refers to the principle which states that those who are in identical or similar circumstances should pay identical or similar amounts in taxes (Stiglitz and Driffill, 2000). It requires that those with equal status - whether measured by ability or some other appropriate scale - should be treated the same. If, for instance, income were the only measure of a person, then two persons with equal incomes would be treated as equals. Vertical equity states that people who are better off should pay more taxes (Stiglitz and Driffill, 2000). This generally requires that those with less ability to pay are treated favourably relative to those with greater ability.

The role of these concepts in transport can be illustrated by describing the implementation of road pricing and the use of the revenues. Horizontal equity implies that similar users should pay identical tolls. But the question who 'deserves' the benefit (or revenues) according to this criterion is a matter of debate. It can be defined as those who actually pay the toll, or it could also include those who change their behaviour (travel pattern), thereby incurring costs in terms of inconvenience, and providing congestion reduction benefit to the toll payers. So the difficulty is that the initial users of the road have become 'unlike' after the implementation of the charge, and should be compensated. The use of road charges to fund public transport is an example. Horizontal equity is further complicated by the existence of externalities from motor vehicle use, including accident risk and environmental degradation. That vehicle use imposes costs on other people itself represents horizontal inequity. If the criterion is horizontal equity and external impacts are recognised, then revenues may be used to compensate for external costs (Litman, 1996). Funding candidates may include environmental and social programmes that mitigate the harm of motor vehicle use. However, compensation for external costs may, in turn, induce inefficient behaviour by the recipients of externalities in the sense that insufficient incentive is provided to avoid incurring the externality (Oates, 1983; Verhoef, 1994). This implies that (also) from this perspective, there may be trade-offs between efficiency and equity in the regulation of externalities.

Vertical equity is concerned with the treatment of individuals and classes that are unlike. By this principle, the distribution of costs and benefits should reflect people's needs and abilities. Progressive tax rates, and need-based services such as programmes to help the poor, seniors, and disabled people, are examples of policies reflecting vertical equity. Vertical equity is often measured with respect to income. This is an imperfect metric, since people with the same income often have very different needs and abilities. Road pricing is usually considered vertically inequitable because charges impose a relatively larger burden on the poor. For example, a €2 per day toll might be horizontally equitable (everybody pays the same amount), but vertically inequitable because it represents a larger portion of income for a lower-income driver than for a high-income driver. This fact is tempered by the observation that lower-income people drive less on average than those with higher incomes.



Another equity issue refers to spatial or geographical equity, which is concerned with the treatment of individuals located in various regions or cities. Congestion pricing could be considered as unfair from this point of view, as charges (depending on time and place) will differ among regions. Another illustration of spatial equity concerns in transport is the experience of Sydney City Council, which decided that transport availability should not depend on the geographical area in which a person lives. Transport services should be available equally to people across the Sydney metropolitan region.

2.3.2 Constraints on Marginal Cost Pricing: Second-Best Pricing

Social marginal cost pricing assumes a theoretical first-best world. Such first-best pricing is increasingly recognised as being of limited practical relevance, but it might serve as a useful theoretical benchmark. Besides the previously described reasons for market failures, various constraints and barriers may exist that prevent a regulator from charging (optimal) prices that it ideally would like. Verhoef (2002) mentions the following important constraints:

- Technological and practical constraints: first-best pricing requires charges that vary continuously over time, place, route chosen, type of vehicle, driving style etc, which might be too sophisticated and not understood by drivers or impossible to implement under available charging technologies;
- Acceptability constraints; there may be too much resistance and uncertainty (e.g. about objective and necessity of the measure) that may make it preferable to start with a few small-scale demonstration projects;
- Institutional constraints; one example is where local or regional governments cannot affect some transport charges that are set by a higher level government;
- Legal constraints; ideal prices might not be possible on the basis of legal arguments (e.g. when taxes should be predictable)
- Financial constraints; for instance the prior definition of minimum or maximum tax revenue sums to be collected;
- Market interaction constraints; transport taxes will have many consequences for other markets, among the most important is the labour market;
- Political constraints: charges may become a political issue much more than an economic question.

Under such conditions, the regulator has to resort to second-best pricing: setting the prices that are available optimally, under the constraints applying.

This has led to some discussion on the practical relevance of marginal cost pricing. Rothengatter (2003) argues that marginal cost pricing is no longer optimal when aspects such as acceptability and institutional consequences are introduced into the analysis, and a real-world pricing system can therefore not be based on abstract economic theory. Nash (2003) replies that indeed difficulties and uncertainties remain (which should be carefully considered), but that there is no need for a totally different theoretical approach, since marginal social costs are the correct starting point in the development of any efficient pricing policy.

Given these constraints and discussions, economic research has focused on setting prices that are available optimally, under the constraints applying: second-best prices. Examples of second-best tolling include the use of toll cordons around cities instead of tolling each road in the network, and the use of step tolls instead of smoothly time-varying tolls. It is safe to state that second-best pricing will be the rule for the implementation of marginal cost-based pricing in reality. Much of the relevant literature is reviewed in Lindsey and Verhoef (2001), whereas MC-ICAM (2002) gives insight into the kind of analysis. In what follows we discuss two relevant subjects in the context of price differentiation.

Networks

First-best pricing in a network assumes that each link of a road network is efficiently priced. This is often impossible due to excessive costs, the requirement of toll-free alternatives by governments, and



the likeliness of incremental implementation. The question under study is then how second-best tolls should be set on toll roads, given un-priced congestion on un-tolled roads elsewhere in the network.

This network problem is one of the most widely studied, where the simplest version concerns a simple network in which there are two links connecting the same origin and destination. Verhoef et al. (1996) demonstrate that, if one of the links is often congested, the optimal second-best toll of the other link can be negative. This study also shows that the optimal toll depends on the relative free-flow travel times and capacities of two routes, and on the price elasticity of travel demand. Welfare gains from second-best pricing are, according to this study, a small fraction of the benefits from the first-best benchmark (only 10%). Other studies have looked at ways to enhance efficiency and have incorporated the possibility of dynamic (time varying) tolls, and sorting of drivers according to value of travel time. This does indeed yield higher absolute efficiency gains.

Most network studies assume a unimodal network. In reality, a traveller has the possibility to choose between modes. The leading example is the choice between public transport and the private car. Tabuchi (1993), for example, uses a second-best framework which is characterised by a road, subject to bottleneck congestion, that runs parallel to a railway. Assuming inelastic demand and average cost pricing of rail trips (to stay in business), it is shown that the road share of travel is highest with an optimal (time-varying) road toll, and successively lower with a step toll, a uniform toll, and no toll. Another study that reviews second-best choices in a transport network with two modes is by Arnott and Yan (2000). The main difference between second-best problems on networks and those for mode choice is that, in the former case, an assumption of perfect substitutability is often made. Although, at first sight, the two-mode problem appears to be relatively simple, it has proved to be difficult to solve (MC-ICAM, 2002). Results are very much restricted by the assumptions made (such as fixed capacity and a fixed toll) and often complicated and difficult to interpret.

Second-best studies have not only addressed the issue of the level of second-best tolls in different types of networks, but recently the toll location has also been included. Verhoef (2002) examined the selection of individual toll links, and the determination of toll levels using some sensitivity indicators. Yang and Zhang (2002) considered selection of optimal toll levels and optimal locations for achieving maximum social welfare using a bi-level programming approach with both discrete and continuous variables. And Shepherd and Sumalee (2004) explored the usefulness of solving the optimal toll problem for a medium scale network.

Heterogeneity

Travellers and road vehicles differ in a number of characteristics. Vehicles vary, for example, in the road space they occupy, and in weight and acceleration capabilities. Travellers have different values of time, desired speed, and so on. First-best pricing often makes it necessary to distinguish between different vehicle types and users (because of different marginal costs). It is important to know whether first-best congestion pricing can still be implemented, given these dimensions of heterogeneity, and if not, how second-best tolls are optimally determined. In this context a distinction is often made between anonymous tolling schemes (independent of vehicle type and driver) and non-anonymous (type-specific) tolls.

Many studies have been conducted on the implications of the problem of heterogeneity and pricing. The topics range from heterogeneity in drivers' values of time and trip-timing preferences to the heterogeneity in travel speed. Another example of a study that is of interest here is that of Verhoef and Small (2004), who consider a differentiation of tolls across parallel traffic lanes by using a static model. They show that an anonymous toll may still be optimal on each lane separately, and efficient segregation of drivers is achieved without regulation. It should be noted that the extra gains are rather small, so that a second-best single toll applied to the entire highway does not impose much of a welfare loss. Optimal anonymous tolling may entail segregation of vehicle or driver types onto separate routes.

It is obvious that the previous mentioned constraints will have various consequences for the user charges and the type of differentiation. A wide variety of dimensions can be identified for charge differentiation, ranging probably from optimal pricing which is highly differentiated (equal to marginal social costs) to a fixed charge. In reality different charging regimes are existing in transport that are somewhere in between those two extremes. The GRACE project provides an excellent overview of



existing differentiation practises for various transport modalities (Bonsall et al., 2006). We summarise the dimensions of price differentiation in Table 2-2.

Table 2-2 Dimensions of Price Differentiation

Differentiation Practise	Differentiation Criteria
first-best pricing	<ul style="list-style-type: none"> • vehicle (technology) used • actual state of this vehicle • number of kilometres driven • time of driving • place of driving • actual route chosen • driving style
existing road pricing dimensions	<ul style="list-style-type: none"> • type of vehicle (weight, number of axles, height, length, place of registration, emissions, fuel type) • time • location
existing pricing dimensions in the rail sector	<ul style="list-style-type: none"> • type of vehicle • type of track • noise and emissions • comfort • time • type of booking (internet or not)
existing pricing dimensions in air transport	<p>landing charges may vary over:</p> <ul style="list-style-type: none"> • type of plane (weight, noise, emissions) • origin or destination • time (peak/off-peak, day or night) • facilities used <p>passenger charges may vary over:</p> <ul style="list-style-type: none"> • destination • time • comfort
existing port pricing dimensions	<ul style="list-style-type: none"> • type of vessel • location of operation in port • processing time • season

Source: adjusted from Grace (information in Bonsall, et al., 2006)

2.4 USER RESPONSES TO PRICES CHARGED

People's responses to transport pricing are not straightforward. Price increases may not necessarily lead to trip suppression, it may also induce travellers to change their modal use or change their departure time, depending on the type of measure. A wide variety of transport pricing measures exists, having different consequences for travel behaviour. Price measures are considered as one of the major tools for policy-makers to influence transport development. The design of measures will generally depend on the objectives.

The response of infrastructure users will to a considerable extent depend on the exact design of the pricing scheme (e.g. a yearly tax on car ownership can be expected to affect kilometrage of a given vehicle relatively weakly, compared to a kilometre charge). Equally important, however, is the price sensitivity (often expressed as elasticities by economists) of transport users for the various relevant types of user reactions that together define transport behaviour. People have various possibilities to change transport behaviour, and can be expected to react differently to different pricing schemes. The possible outcomes (in terms of behavioural responses) of pricing can be the following:



- Trip suppression (travel frequency choice);
- Departure time choice (and scheduling of daily activities);
- Different route choice;
- Changes in modal split;
- Changes in vehicle occupancy;
- Spatial choices related to relocation;
- Change in driving style (e.g. speed choice);
- Vehicle ownership;
- Technology choice;
- Changes in destination choice;
- Class choice (for public transport).

Ubbels (2006) reviewed empirical literature on the effectiveness of pricing measures and finds the following important factors affecting price sensitivity:

- Type of price change: the different types of pricing measures can have different impacts on travel behaviour. Parking charges and road tolls may affect travel routes and destinations. A timevariable fee probably shifts some trips to other times. Fuel price increases tend to affect the type of vehicles purchased more than vehicle mileage (see also section 2.5.2).
- Type of trip and traveller: De Jong and Gunn (2001) find, for instance, that commuting and business travel is less sensitive to changes in fuel prices than travel for other purposes. In addition, travellers with higher incomes tend to be less price sensitive than lower-income travellers.
- Quality and price of alternative routes, modes, and destinations: price sensitivity tends to increase if alternative routes, modes and destinations are of good quality and affordable. For example, road users tend to be more price sensitive if there is a parallel untolled roadway.
- Time period: there is a significant difference between short-term and long-term price elasticities. Transportation elasticities tend to increase over time, as consumers have more opportunities to take prices into effect when making long-term decisions (Oum, Waters II and Yong 1992). It may take many years for the full effect of a price change to be felt. Button (1993) reports that short-term elasticities are typically one-third of long-term elasticities. 'Short run' is typically less than two years, 'medium run' is two to 15 years, and 'long run' is 15 years or more, although definitions vary. Dargay and Gately (1997) conclude that about 30% of the response to a price change takes place within 1 year, and that virtually all response takes place within 13 years.

Elasticities can provide indicative and useful answers to the questions about the effectiveness of policy measures. However, policy makers must realise that the elasticity of some measure does not exist. Elasticities of travel demand will vary with circumstances and very much depend on the contexts. Relevant contexts include geographical scale of the study, the short-term or long-term, existing price levels and alternatives, and the composition of the population. The types of change in travel times and costs might also be relevant (e.g. small or big change, increase or decrease, and gradual or drastic change). This makes it difficult to compare and interpret different elasticities. Comparison of elasticities only makes sense when there is a clear description of the dependent and independent variables (which price changes and what kind of demand are affected).

2.5 EXAMPLES OF PRICE DIFFERENTIATION

In this section we present some examples of price differentiation measures and discuss their impact on transport activity demand and the corresponding social cost assessed using a modelling framework.



2.5.1 Differentiation: Time Dependent Congestion-Charges

A common framework used to analyse a time differentiated congestion tax is the bottleneck model (Arnott, de Palma and Lindsey 1990). In the model, traffic can flow through the bottleneck at a fixed rate of s vehicles per hour. If the arrival rate at the bottleneck exceeds the bottleneck capacity, a queue arises.

The model assumes that travellers have a desired arrival time. In order to arrive in time, the travellers choose their departure time. However, only s vehicles per hour can arrive at the destination which is behind the bottleneck. This means that if too much travellers leave at the same time in order to arrive at their preferred arrival time, some of them will arrive too late at the destination. At the other hand, some travellers may anticipate the queue by leaving earlier but then they arrive too early at their destination. And still others do not like queues at all and will choose not to travel (or to use a different transport mode that is not affected by the bottleneck).

The cost of a trip through the bottleneck with departure time t is described as

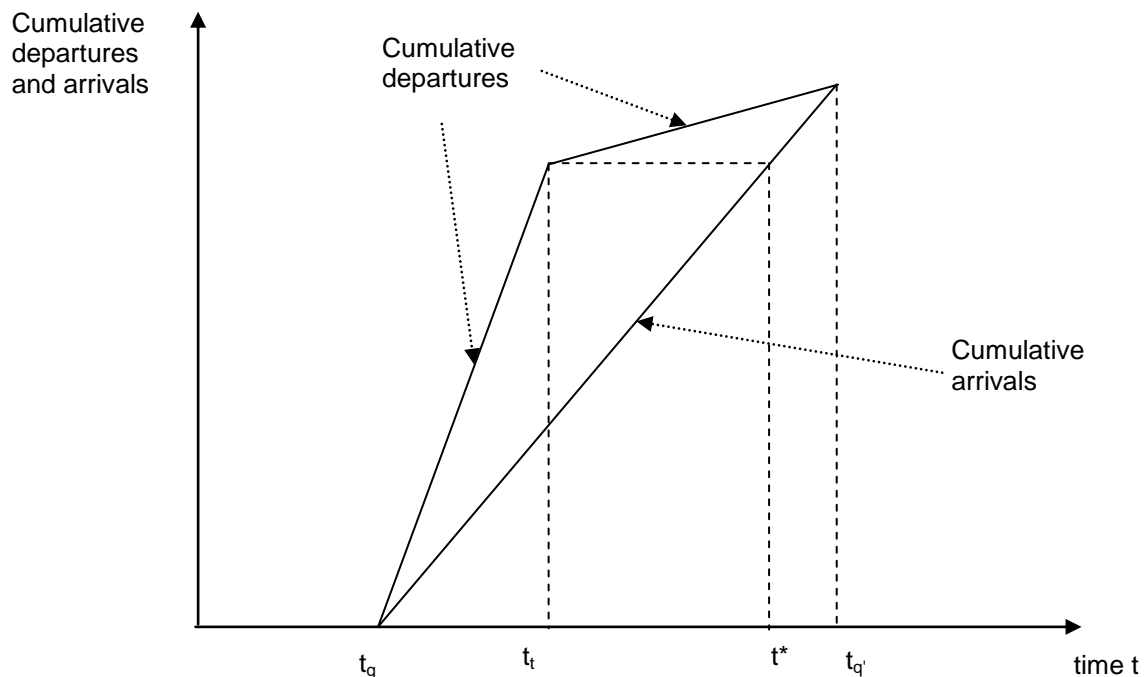
$$C(t) = \alpha T + \beta (\text{time early}) + \gamma (\text{time late})$$

where T is the travel time, α the value of time coefficient for travelling time (including waiting in the queue), β the value of time coefficient for early arrival and γ the value of time coefficient for late arrival. In the analysis the travel time T is set to reflect waiting time only, hence assuming travellers arrive at the bottleneck immediately after leaving their origin (this simplifies the analysis without affecting the results).

The first term αT of trip cost $C(t)$ reflects the user costs related to travelling time, this is the in-vehicle time. If the queue is longer, a longer waiting time results and the first term reflects this cost in the overall trip cost. The second and the third term contributing to the trip cost reflect the discomfort of not arriving at the preferred time. The larger the deviation from the preferred arrival time, the larger the corresponding cost. Different coefficients apply for arriving early or late, as for a given time deviation arriving late is usually considered a less preferred option compared to arriving early.

In the bottleneck model, the desired arrival time is defined to be equal for all travellers. An equilibrium arises when no traveller can change the cost of a trip by leaving earlier or later. The corresponding situation is described by Source: based on Arnott et al. 1990

Figure 2-1.



Source: based on Arnott et al. 1990

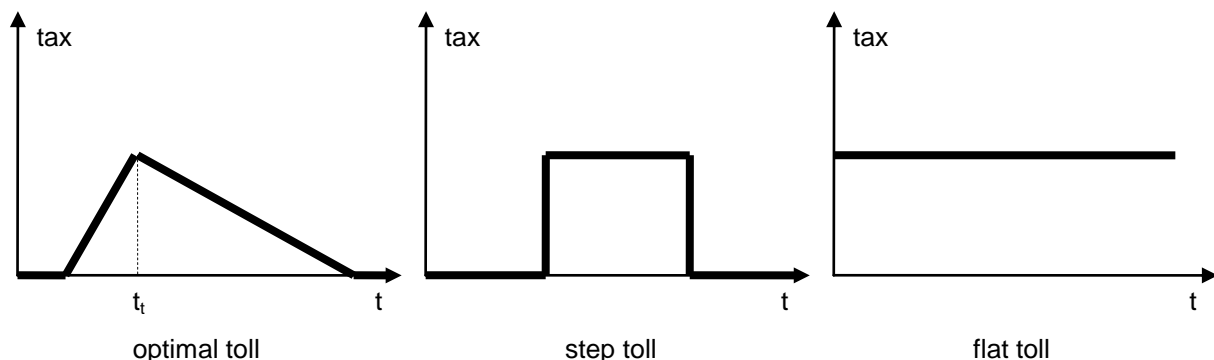
Figure 2-1 The No-Toll Equilibrium in the Bottleneck Model

The traveller leaving at t_q faces no queue and hence no waiting cost. Total travel costs are $C(t_q) = \beta(t^* - t_q)$. Before t_q no travellers leave, as they could easily lower their travel cost by shifting their departure time to t_q . After t_q , the queue grows until t_t . The traveller leaving at t_t faces the longest queue, but no schedule delay costs by arriving exactly at the preferred time t^* with a travel cost $C(t_t) = \alpha(t^* - t_t)$. After t_t , the queue becomes shorter to disappear from $t_{q'}$ on. The last traveller leaves at $t_{q'}$, faces no queue and has a travel cost $C(t_{q'}) = \gamma(t_{q'} - t^*)$.

Arnott et al. (1990) demonstrate with this modelling framework the impact of a toll under a static demand (constant number of trips), where different tolling schemes result in a rescheduling of departure times. Arnott, de Palma and Lindsey (1993) extend the model by allowing for elastic trip demand. This means that the traveller has two choices to change his travelling behaviour: or to change change his departure time, or not to travel at all. Three scenarios of pricing are simulated (

Source: Arnott et al. 1993

Figure 2-2).



Source: Arnott et al. 1993

Figure 2-2 Tolling Schemes Simulated by Bottleneck Model



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A first scenario describes an optimal toll. This toll is at any time t equal to the time cost corresponding to queuing in the untaxed base scenario (αT). As such, no cost is involved for the traveller: queuing costs are substituted for taxes. For society the toll revenues, which are equal to the waiting costs in the untaxed scenario, are a net benefit. Considering that no net cost is involved for the traveller, total demand remains stable. In a second scenario a coarse toll is simulated. The setting is a step toll collected during peak time. The rationale for this toll scheme is to simplify the optimal setting in order to limit technical implementation requirements as well as cognitive efforts by the user. A last scenario is an undifferentiated, flat toll. Under such a scenario, no rescheduling of trips occurs but overall demand diminishes.

The quantitative impact of the three schemes is presented in Table 2-3 for different values of the demand elasticity of trips and an arbitrary value for the model parameters (see Arnott et al. 1993).

Table 2-3 Impact of Different Tolling Schemes on Bottleneck Performance

Variable	Demand Elasticity	No Toll	Flat Toll	Step Toll	Optimal Toll
normalised number of trips	0	1	1	1	1
	0,2	1	0,8909	0,9390	1
	1	1	0,7071	0,8280	1
travel cost $C(t)$ (USD/trip)	0	6,063	12,125	8,842	6,063
	0,2	6,063	10,802	8,304	6,063
	1	6,063	8,574	7,322	6,063
welfare loss compared to optimal tax setting (USD/trip)	0	3,031	3,031	1,390	0
	0,2	3,031	2,671	1,302	0
	1	3,031	2,101	1,144	0

Source: Arnott et al. 1993

We will limit the discussion of the result to the simulations corresponding to an elasticity value of 0,2 which is a best-guess value (for the long term). This means that a traveller has two options to avoid (part of) the queue: or to reschedule his trip, or not to travel through the bottleneck at all (possibly by choosing a different transport mode).

As discussed, under the optimal tax no change in user cost occurs and hence no change in demand for trips. The efficiency gain (welfare gain) amounts to USD 3,031 per trip (on average). An optimised uniform toll has an important impact on the user cost but can realise only a small welfare gain. A coarse step-toll however has a smaller impact on user cost and allows to realise over 50% of the welfare gain of the optimal toll.

Note that the efficiency gain resulting from applying the (optimised) coarse toll is about five times as high as the scenario with the uniform toll. This indicates that the welfare impact of rescheduling trips is much larger than from a demand reduction.

It is interesting to note that differentiation has a cost for users, both compared to the untaxed and the optimally taxed scenario. The rationale for a coarse scheme may be a reduction of complexity for the user. For this simplification the user pays a price. So from a user point of view there is a trade off between both objectives.

An implementation of the bottleneck model in a network topology can be found in de Palma and Lindsey (2006). Peak hour congestion in the greater Paris area (Île-de-France) is modelled using the METROPOLIS model. Apart from trip demand and trip rescheduling this model also allows for rerouting. An implementation path for a cordon toll is simulated, starting from a uniform toll on one (ring road) link, extending it to a selection of links (ring road and arterials), next converting it to a stepwise cordon toll around the city centre and in a last step extending the cordon by including the whole Paris intra-muros area (inside of Blv. Périphérique).

The findings of the simulations with the METROPOLIS model indicate that the possibility of trip diversion (rerouting) puts a limit on the level of the toll. The welfare gain of the (flat) link based tolls



are modest, for the cordon based (step) toll somewhat higher. But as these scenarios only affect a minor share of all trips, the obtainable welfare gain is still far from the optimal case where all links are tolled.

The gain for the user (in terms of schedule delay and travel time cost) is about 65–85% of toll revenues. This means that if about one third of toll revenues flow back to the travellers in some way, the operation is about neutral for the average user.

The implementation of a time differentiated congestion charge is still limited. Some examples include Singapore and the SR 91 express lanes in Orange County (California).

2.5.2 Differentiation of Environmental Levies

User cost differentiation following an environmentally motivated scheme has been studied by Knockaert (2006,2007). The impact assessment is based on simulations using a customised version of the TREMOVE modelling framework covering the entire Belgian transport activity demand (excluding airplanes and merchant fleet).

The TREMOVE model is a partial equilibrium representation of the transport markets originally developed for the EU Commission under the Auto-Oil II Program. The model (see Figure 2-3) represents all the transport markets (passenger and freight), all modes (4 types of cars, metro, public bus, rail etc.) and contains a crude representation of congestion and a detailed emission module (TRE-part). The model tracks the evolution of the car stock per vehicle type (MOVE stock-part). The model computes the effects and welfare costs of alternative measures to reduce emissions in the transport sector. These measures include taxation and regulation packages ranging from subsidies to public transport and electronic road pricing to the obligation of installing catalytic converters.

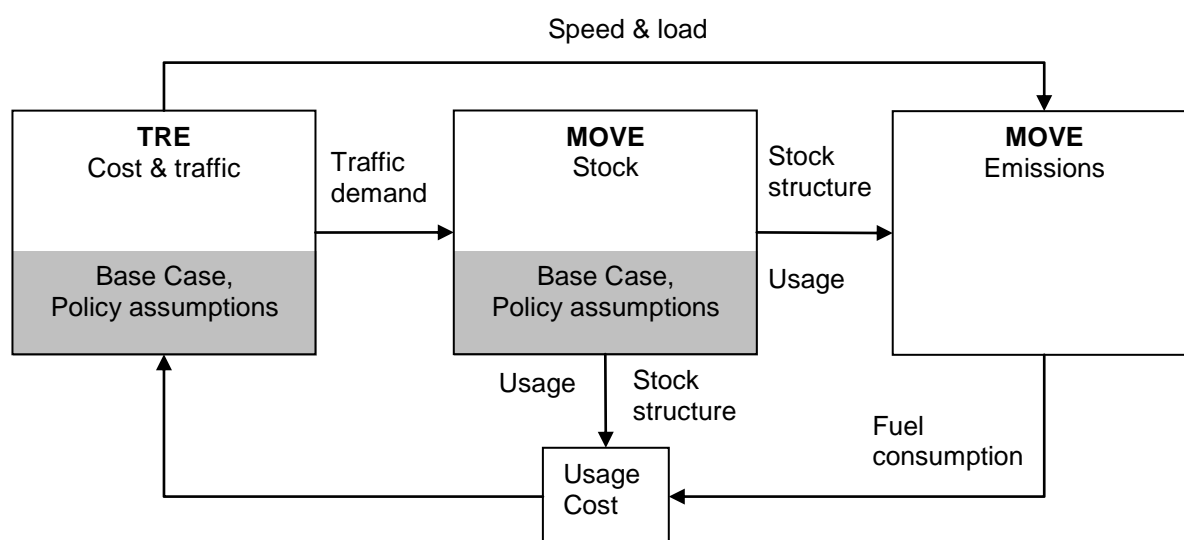


Figure 2-3 The TREMOVE 1.3a Modelling Framework

The model version for Auto-Oil II covered the 1990–2020 period for 9 EU countries (not including Belgium).⁶ Existing transport flow forecast data are used to calibrate the model for every year. For a more in-depth discussion of the TREMOVE 1.3 model we refer to The European Commission, Standard & Poor's DRI and K.U. Leuven (1999). An updated and extended version of the model (version 2 and beyond) has been released in 2005, covers a wider geographical area, and is discussed in De Ceuster et al. (2005).

The customised version for Belgium by Knockaert (2006,2007) was developed in parallel with this upgrade and hence is based on the original model updated with some features from TREMOVE 2 and some custom extensions to allow a more advanced simulation of environmental taxes.

⁶ The geographical scope of the different versions of the TREMOVE model is mainly defined by the baseline dataset.



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The exercise discussed in Knockaert (2006) focuses on an environmental tax that is imposed on all transport activity in Belgium (all modes/vehicles). The tax is levied as a per kilometre charge and its level is equal to the external environmental damage from emissions (including electricity production for electrical vehicles). The charge is differentiated for area's (urban, non-urban motorway and non-urban other road), time periods (peak/off-peak), and vehicle technologies (fuels, emission standards, engine technologies, emission standards e.g. EURO IV). A broad range of alternative vehicle technologies is introduced in the vehicle choice model for private cars (e.g. compressed natural gas, battery cars, hydrogen fuel cell).

Some details of simulated damage by emissions are presented in Figure 2-4 and Figure 2-5, which represent baseline figures for Belgium (the baseline scenario serves as a reference scenario for policy simulations in the TREMOVE model, hence the baseline is a no-toll scenario).

External emission cost in urban areas (2020)

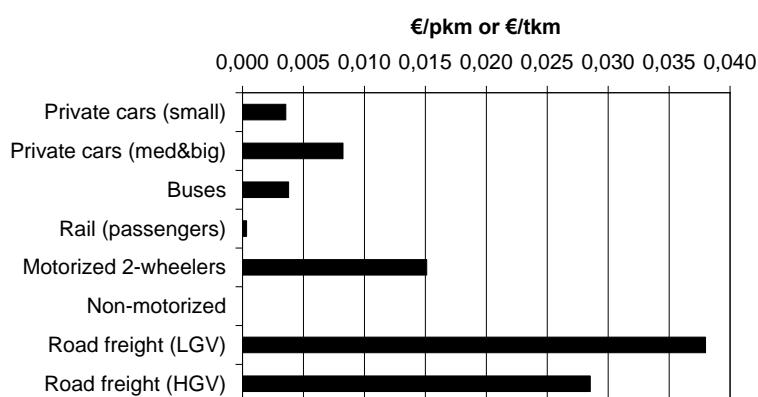


Figure 2-4 Damage from Transport Emissions in Urban Areas in 2020 (Baseline for Belgium)

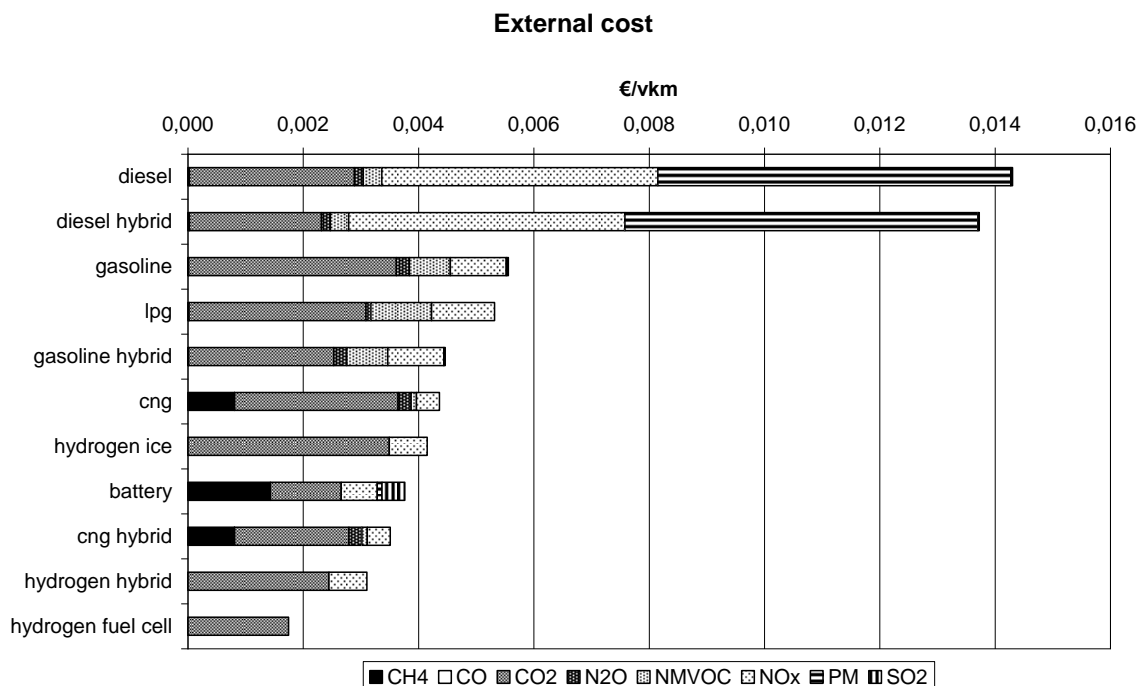


Figure 2-5 Damage from Emissions by New Private Cars 2020 (Baseline for Belgium)



Figure 2-4 shows average damage levels in urban areas in 2020 for the different modes. The difference between small vs medium/big cars can be explained by different shares of diesel technologies in both classes (small cars are nearly exclusively gasoline). For freight vehicles we observe that light goods vehicles (LGV) are more polluting than heavy goods vehicles (HGV). This is explained by low load factors for LGV vehicles combined with the rather loose emission standards that apply for this category of road vehicles.

Figure 2-5 details differences in emission damage from new private cars in 2020. The figures reflect a representative mix of urban and non-urban activity in Belgium (baseline). Diesel cars are by far the most polluting. All other technologies are below the 1 cent per kilometre level. Damage by carbon monoxide (CO) emissions is of a very small order of magnitude compared to other pollutants for all technologies.

The TREMOVE model allows for three behavioural reactions from transport users to avoid taxes: buy a cleaner vehicle, switch to a cleaner transport mode (peak vs off-peak travel is considered as different modes in the model, so the model allows for a shift to "cleaner" time periods) or decrease overall transport activity.

The emission tax results in a 5% reduction of overall transport emissions of NO_x, PM and SO₂. For CO₂, the decrease is smaller (about 1%), for gasoline related emissions (carbon monoxide and NMVOC) an increase is observed. Obviously a shift from diesel to gasoline is a welfare efficient way to reduce emissions.

Looking to the decrease in environmental damage from emissions, we note that in the short term a global decrease of demand has a rather large contribution (65% of total decrease), whereas in the longer term the vehicle stock can adapt and the contribution of technology is larger. Modal shift contributes only marginally to environmental improvements, it seems that such a shift is not a cost efficient reduction of emission damage.

Overall a modest environmental and welfare gain can be realised through a differentiated environmental tax on transport activity. It should be noted that fuel (and the corresponding CO₂ emissions) is already heavily taxed, any further tax on CO₂ is likely to decrease welfare rather than increase it due to a larger reduction in fuel tax revenues compared to the reduction in environmental damage. We will come back to this issue further in this section.

The study does not focus on different degrees of differentiation. There are however some indications of how the environmental taxation scheme could be simplified without losing too much of the corresponding welfare impact. A first observation is that for modern technologies (e.g. EURO IV emission standard), the bulk of the environmental damage by private car transport is caused by emissions of carbon dioxide (CO₂), nitrogen oxides (NO_x) and particulate matter (PM) so a tax scheme reflecting emissions of these three components only may allow to realise most of the welfare gain. For non-road modes, sulphur dioxide (SO₂) emissions should be added to that shortlist. At the other hand, further differentiation of the tax beyond the scope of the TREMOVE model may allow to realise further welfare gains.

It should however be noted that overall welfare gains are limited compared to what can be realised by optimising for congestion. This can be easily observed comparing the external cost components, which for emissions damage are in the order of magnitude of € 0,01 (per vkm) for recent passenger cars (EURO IV) compared to congestion up to € 3,00 (per trip).

An example of environmentally differentiated charges is the German LKW Maut which has different tax levels for freight vehicles according to emissions standard.

The exercise discussed in Knockaert (2007) focuses on the issue of CO₂ emissions by private cars and how these can be reduced by a fuel-specific tax. The rationale is here that CO₂ emissions per unit of fuel are more or less fixed in contrast to vehicle activity, so it is easier to levy a tax on the consumption of the fuel rather than the actual vehicle activity. Such a private car only CO₂ tax could be considered as a simplified version of the environmental tax scheme described above.



In this version of the TREMOVE framework, fuel efficiency is endogenised as a function of fuel price. The level of the fuel-specific CO₂ tax is optimised to reach an average testcycle emissions level of 120g per vkm for new private cars in 2012, in line with the EU Commission policy target. The optimal tax level in 2012 amounts to about 40 times the external CO₂ damage.

The simplified tax does obtain the simplified target (CO₂ emissions of new private cars only), but at a considerable welfare cost: the per ton abatement cost of CO₂ amounts to more than 100 Euro, compared to an exogenous damage cost in the order of magnitude of less than 20 Euro.

Although the results of both exercises may be difficult to compare, the CO₂ simulation indicates that a focus on CO₂ only may be a bridge too far. The level of historic fuel taxes is already far above the CO₂ damage caused, so any further increase is likely to result in a welfare loss (i.e. existing vehicles are too fuel efficient from a welfare point of view). Note that existing fuel taxes per ton of CO₂ emissions are higher for gasoline than for diesel, promoting an unnecessary shift towards diesel rather than the more environmental friendly gasoline cars.

2.5.3 Other Examples of Price Differentiation

Further examples of differentiated taxation include a weak routing choice on SR 91 in California where part of the road is taxed (2 centremost lanes of the freeway) whereas the parallel lanes remain untaxed. Similar schemes exist at some other places in the USA. There seems to be a somewhat complicating acceptability issue with the implementation of such a parallel road scheme. The construction of the tolled part is often privatised in order to keep construction and operation of the road out of the public budget. However, the owner of the private part is obviously not keen on variability in the capacity of the parallel untaxed road and the corresponding uncertainty regarding toll revenues. As a result this capacity is fixed in an agreement before construction (and financing) of the privatised road starts. After the tolled road enters into service, it may however turn out that capacity of both parts is not optimal, resulting in an aftermath situation that in the few cases observed ended in the public authority acquiring the private part (SR 91 but also the TEO ring road in Lyons (de Palma and Lindsey 2006)). Further study will reveal if this issue is structural.



3 POSITIVE ECONOMIC THEORY OF PRICE DIFFERENTIATION

3.1 INTRODUCTION

We have seen that various constraints can be identified which make first-best pricing rather unrealistic in practice. The last constraint mentioned in the previous section was the political. Economists most often assume governments and politicians to maximise welfare of their citizens. They may still do so when facing constraints of equity, cost coverage or cognitive limitations of the users. This will affect differentiation of the charge, but welfare is still maximised. However, politicians may well have different objectives leading to deviations of optimal prices.

The following sections assume that politicians and civil servants follow their own individual goals and that in doing so they are open to the influence of special interest groups (SIGs).⁷ This does not necessarily mean that under this approach decision makers never care for public welfare. First, there are limits to the discretion of decision makers due to competition for their offices. Second, there may be cases where following public welfare coincides with individual interests. Third, and perhaps most important, the decision maker must convince the public of his policies; usually this cannot be achieved without at least some regard to normative argumentation. Nevertheless, there may be cases where real-world policies can be better explained by assuming individual utility maximization than welfare maximization on the part of decision-makers.

It might be asked in which logical relationship the normative and the positive approach stand to each other. The answer is that both approaches are not in contrast but rather are complementary.

First, as far as the positive theory is concerned, there are limits to the possibility of individual maximization of utility of regulators and political decision makers. Decision makers always must convince the general public that the proposed policies are in its best interest. This, however, cannot be achieved without invoking at least some degree of normative argumentation. Second, there may be cases where the individual utility maximization of decision makers and the maximization of general welfare are compatible with each other. Third, there is always competition among decision makers for being promoted or re-elected. In many cases this competition leads to policies that correspond to normative standards. Finally, positive theory needs a theoretical benchmark against which its results and predictions can be compared.

Normative theory may be compared to the “frictionless” system in physics, whereas positive economics corresponds to theories incorporating friction. As in physics both approaches are needed and mutually shed light on each other.

Several economists have argued that basically the positive approach amounts to nothing more than adding a “political constraint” to normative economics. We have little to object to such a change of perspective, which in our opinion is basically a matter of semantics. It is of no avail whether one prefers to integrate the positive approach into normative economics in this way or not. The analytical difference between the two approaches is not affected by such a change of label.

3.2 THE POSITIVE THEORY OF REGULATION

SIGs have a huge impact on decisions made by policy-makers through interfering in the political process. There are two key reasons for their formation according to Noll (Noll, 1989): powerlessness of single voters and controlling politicians. To solve the problem of powerlessness voters can unite in SIGs to represent their political preferences better than through a simple voting process. Also costs of influencing and controlling politicians' activities are far too high for a single person but not for a whole group pursuing the same interests. Here the mentioned costs can be distributed over all members of the SIG.

⁷ In a world without special interest groups the policy maker would try to maximize overall welfare. The existence of SIGs makes therefore, the incorporation of the political constraint necessary in order to derive “real world” conditions. Thus, from the positive theory point of view, policy makers and SIGs are the main actors participating in the political game.



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The most important activities of SIGs are access gaining to policy-makers and supplying them with information, supporting and contributing election campaigns of preferred politicians, and “educating” the general public on their favoured policy.

Empirical studies showed that all of the above mentioned activities can be observed but their effect and influence on policy-makers is not clearly proved (see Grossman/Helpman 2001). The core problem of studies examining the effect of SIGs on policy-makers is the lack of comparability of their findings with situations without political intervention of special interest groups.

Provision of information and campaign contributions are the main fields in which SIGs concentrate their activities of interfering in the political process.

Provision of information and therefore gaining access to policy-makers is very important for SIGs. Although prices are not directly influenced through information supply, SIGs can persuade decision-makers to follow the group's most favourite policy. To do so, SIGs can utilize the information asymmetry between policy-maker and SIG. On the one hand politicians need to gain information but generally have limited information and limited resources available for gathering them. On the other hand SIGs possess these information through highly specialized knowledge of their members and cost advantages in gathering further information due to the fact that information costs can be spread among SIG members.

Apparently more than one SIG is likely to seize this influencing opportunity. In addition to that, politicians have limited time resources to communicate with all interest groups. Thus, politicians will separate “valuable” and “less valuable” information as well as “important” and “less important” SIGs by weighing their contributions.

Nevertheless policy-maker and SIG can have different aims and so gaining access to policy-makers does not automatically lead to a policy preferred by the SIG. Another problem is the credibility of information from the politician's viewpoint. Findings from Grossman/Helpman's research are that first policy-makers will always prefer information of moderate SIGs and second the optimal strategy for SIGs is not to give very precise estimates. Credibility of SIGs rises with giving an information level including more ranges rather than absolute values. The credibility problem becomes more difficult when political parties have already chosen their pliable position⁸ with respect to the issue in question. Especially statements of SIGs close to election time will become a major problem due to the fact that citizens will anticipate and evaluate the efforts of SIGs to influence decision-makers by supplying according information.

As already mentioned *campaign contributions* on the one hand have the aim to influence decision-makers and convince them to implement a certain type of policy/regulation and on the other hand have the goal to affect the voting behaviour of influenceable voters, especially in pre-election periods, to get the favoured party elected. Such voters can be manipulated in their voting decisions by advertising campaigns. Also the pliable position of a party can be readjusted to convince influenceable voters to vote for a particular party and therefore the pliable position will be geared toward the median voter. This is the reason why SIGs concentrate to manipulate the pliable position of a political party. In contrast to that strategic voters are well informed about a party's policy and position. To manipulate their voting decision is much harder if the fixed position of a party does not fit to their general political attitude.

The first step to examine effects of SIGs was taken by an empirical study of Friedland and Stigler (1962). By formulating an econometric model the effectiveness of regulation in the field of electric utilities was analyzed. Results showed that regulation in this industry had an insignificant effect on the average price of electricity. This led to the development of the Stigler/Peltzman model (Peltzman, 1976), the main model to examine effects of SIGs. Based on the findings of Friedland and Stigler the model includes the concept of “regulatory capture”, i.e. that after a while the regulator becomes an instrument of the regulated industry itself. Main reasons for this phenomenon are that:

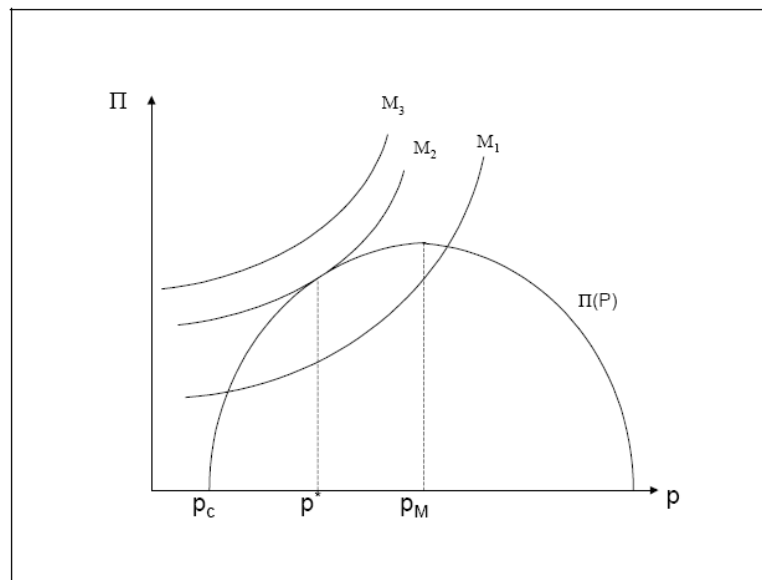
⁸ In political science parties have fixed and pliable positions. Fixed positions express the basic ideology of a party and serve to keep the voter base and pliable positions serve more to attract floating voters.



- Regulators gain from supplying regulation
- Industries can gain from regulation through restriction of competition
- Consumers are not well organized and informed but producers can form small but well organized interest groups.

The **Stigler/Peltzman model** is the standard model of regulatory capture consisting of two actors, politician/regulator and industry. The regulator's aim is to stay in office. To do so, he/she has to maximize net votes, modelled through a voting function (political support function) depending on the price level p and industry profits Π : $M(p, \Pi)$. A lower price level increases the support of voters whereas lower industry profit decreases political support of interest groups. Industry profit in turn is a function depending on the existing price level: $\Pi(p)$. The politician now has to find the optimal price to maximize his/her overall political support. The optimal choice is the tangential point between the profit function $\Pi(p)$ and the Iso-support-curve derived from $M(p, \Pi)$: $\Pi(M, p)$. As shown in Source: Peltzman, 1976

Figure 3-1 different levels of political support result in different Iso-support-curves M_1, M_2, M_3 . These curves show all profit-price combinations leading to the same political support M_i . Higher Iso-support-curves indicate higher political support. The optimal price p^* can be found between p_c (industry profits equals zero) and p_M (industry profit reaches its maximum).



Source: Peltzman, 1976

Figure 3-1 The Stigler/ Peltzman Model

However, the Stigler/Peltzman model ignores that influence on a decision maker increases with the contribution of a SIG. In addition to that, it is assumed that political candidates will actually implement the political programme as promised to the SIG. Further weaknesses are that the problem of credible commitment is not included and that in reality far more interest groups have to be considered.

The next step in developing the positive theory of regulation was taken by contributions of Gary **Becker** (1983, 1985). Regulation here is modelled as equilibrium of competing SIG's political pressure. The result will be relatively "efficient", if all SIGs are represented equally in the political process. Otherwise monopoly rents will be yielded by a political decision. It has to be mentioned that politicians, political parties and voters are not explicitly modelled by Becker's approach. They are included by incorporation in political pressure groups, which try to enhance the welfare of their members by using their political power. Although Becker does not integrate prices in his model, they are implicitly of interest since level of welfare is also a matter of price level. The result of these lobbying activities is described by an "influence function". This function relates the political influence of each pressure group to the pressure exerted by the given group and to the opposing pressure of all other social groups. The exerted pressure of a certain group depends on the benefits the members of the group can potentially receive. Related to that, the number of members of an interest group is a



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key issue. The more members of a group, the more resources for lobbying activities are available but the more the free rider problem within the group becomes a critical issue. According to Olson (see Olson, 1965) small and well organized interest groups are more efficient in lobbying due to higher net profits per capita from lobbying. The main reason for lower net profits per capita in bigger SIGs is the free rider problem that leads to disproportionally increasing lobbying costs. Thus, if a SIG can control the free rider problem it is then very likely to succeed. The idea of Becker that the policy outcome is an equilibrium of battling SIGs led many researchers (see Tullock, 1971) to the development of the rent-seeking literature. SIGs know that policy makers have the power to distribute rents resulting out of regulation and therefore they will compete for these rents. However, this type of literature has not been applied to price differentiation so far.

Keeler (see Keeler, 1884) developed the Stigler/Peltzman model and the Becker model in two dimensions. First, the two mentioned models were able to explain why regulation occurs, but not deregulation. Second, Keeler observed that in some cases policy-makers acted as predicted in the Stigler/Peltzman model but contrast to that in some other cases very close to normative theory. Keeler's approach was therefore to combine positive and normative features in his model. According to that, the Consumer Surplus of each interest group was integrated in the political voting function of Stigler/Peltzman's model:

$$W=W(CS_1, \dots, CS_n)$$

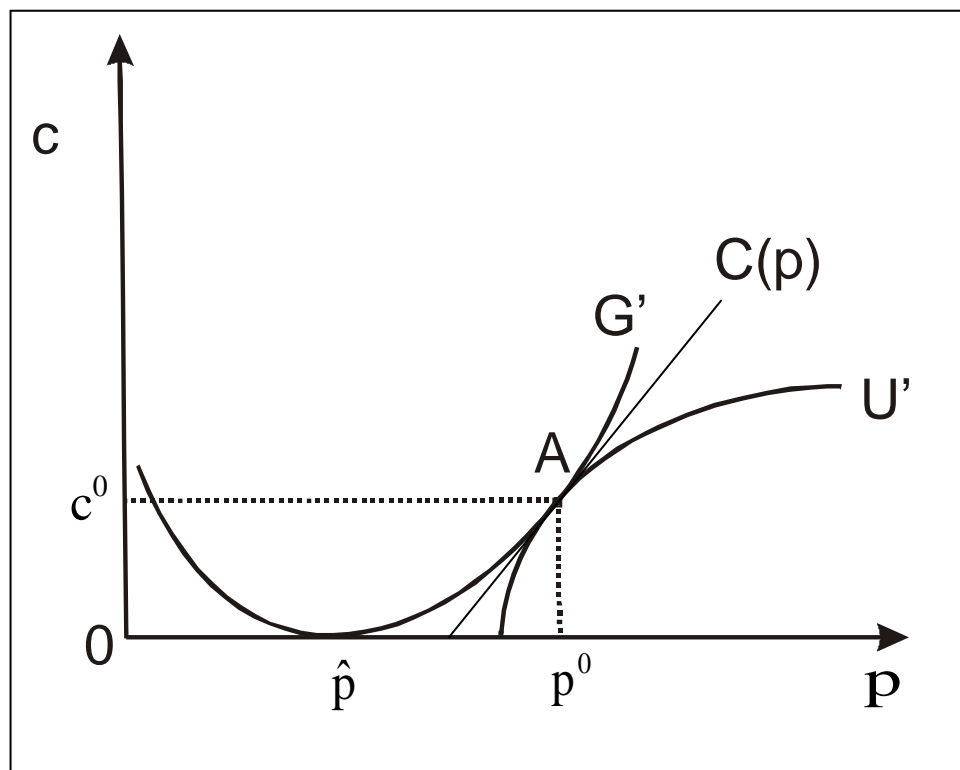
with CS_i representing Consumer Surplus of group i . The usage of Consumer Surplus shows the importance of the price for each interest group. A price level maximizing the utility of one SIG does not necessarily maximize the utility of all other interest groups.

Grossman and Helpman (see Grossman/Helpman, 2000) evolved Keeler's main axiom, that the adopted policy package incorporates both, normative and positive policy elements. Their research concentrates in political interaction between policy-makers and interest groups. In the following we will describe the main elements of the Grossman/Helpman standard model, referring to campaign contribution with one policy maker and one SIG.

On the one side there is the policy-maker who has the authority to decide about a policy set p . Campaign contributions c made by the SIG i influence his/her decision. The politician's utility function is therefore depending on p and c : $G(p,c)$. Assumptions are that first, the politician's utility is increasing in c , i.e. the utility increases with higher contributions for a given policy set. Second, the politician has preferences about the level of p for a given contribution level (graphically, $G(p,c)$ is single-peaked as a function of p for any given level of c). That is because the decision-maker's set of p has consequences to the future career and his/her chances to get re-elected.

On the other side the special interest group i also has a utility function depending on the same variables: $U_i(p,c)$. Naturally, the utility of SIG i decreases in c for a given level of p . The SIG's preference for a certain level of p can be varying. There can either be a maximum of U_i in p for a given level of contributions, or utility is steadily increasing or decreasing in p . The specified situation is shown in Source: Grossman/Helpman, 2000

Figure 3-2. G' depicts the indifference curve of $G(p,c)$ for a certain utility level of the policy-maker, U' illustrates the corresponding indifference curve of $U_i(p,c)$ for a certain level of SIG's utility. The indifference curves show all contributions-policy-combinations inducing the same utility level for the particular group.



Source: Grossman/Helpman, 2000

Figure 3-2 Policy Equilibrium and SIG Contributions

As shown in Source: Grossman/Helpman, 2000

Figure 3-2, with no contributions of SIG i the decision-maker will choose policy set \hat{p} . The SIG will try to influence the policy outcome p . To do that, the group has to formulate a contribution function $C(p)$ that shows the willingness to contribute for different levels of p (the vertical axis gives the level of contribution). This function is of course designed to maximize the SIG's objective function $U_i(p, c)$. As contributions rise, the politician is willing to change his most favoured policy set. As already mentioned, any contributions-policy-combinations on G' induce the same utility for the politician. The contribution function $C(p)$ therefore has to be constructed in a way that the politician with contributions will reach at least the same utility level as without any contributions. The problem for the SIG is first to anticipate the politicians' reaction on different contribution level (typical principal-agent problem of asymmetric information) to construct the contributions function. Second it has to convey to the decision-maker that different policy sets are connected with different donation levels. Corresponding to this the SIG has to give the policy-maker the impression of not being sold. Third the SIG has to induce a combination of p and c that maximizes its own utility.

The solution of the problem is based on tangency of both the politician's and the SIG's indifference curves as shown in Source: Grossman/Helpman, 2000

Figure 3-2. In point A determining contribution level c^0 and policy set p^0 no other policy choice and campaign contribution can make either one better off without harming the other.⁹ Thus A is jointly efficient. This property of equilibrium generalizes to situations with more than one policy issues p and more than one SIG. In order to find the equilibrium in these situations, the game theory based method of subgame perfect Nash equilibrium has to be applied. It can be shown that in the model with one SIG as well as in the model with more than one SIG an objective function containing a weighted average of interest group member' and general public's welfare is being maximized.

Considering price differentiation this would mean additional differentiation, which however has not any effect at all. The second implication is that at equilibrium policy makers will try to achieve a compromise, by maximising on the one hand social welfare and taking into account on the other hand

⁹ In point A the politician is still indifferent to the situation without any contributions. In order to reach point A the SIG has to contribute slightly more than c^0 .



the interests of the involved (most powerful) SIG's. Additional differentiation is in this case also a good means in order to appease SIG's.

All presented models have in common the attempt to describe the decision of policy-makers under the influence of special interest groups. Although methodically different the outcome of the models is a selection of a policy by the decision-maker which maximizes a weighted average of social welfare and his/her individual utility as a politician. Implications for transport markets are:

- Transport markets are going to be regulated
- SIGs will try to interfere with the political process of decision-making to achieve the best outcome for their members

3.3 HOW SPECIAL INTEREST GROUPS CAN MANIPULATE TARIFF STRUCTURES

In the subsections above we analysed the way that SIGs will intervene in the political process and came to the result, that regulation will be the primary objective of SIGs. While most of the existing models focus on the implementation of a certain price level only few models try to answer the question of how SIGs can influence the tariff structure. Within the next subsection we will present two examples of how SIGs can affect the tariff structure in order to enhance the utility of their members. Since price differentiation always creates winners and losers, it is very likely, that SIGs and / or the regulator will also use differentiation as an instrument to achieve their aims for the following reasons:

- SIGs can shift financial burden to other user groups via differentiation
- Policy makers can appease major burdened SIGs with an additional differentiation.

This situation is very likely to happen in the highly developed transport sector of the EU. Therefore price differentiation contains Keeler's basic element of the combination of normative and positive economical elements.

Laffont (see Laffont, 2000) and Laffont/Tirole (see Laffont/Tirole, 2000) tried to examine influences of special interest groups on pricing schemes.

Laffont's model contains an economy of two groups, which derive different utilities from a certain monopoly's output, for instance the highway network. It is assumed that these two groups alternate in power with a certain probability. The group in power will consequently implement such policies that maximize its member's welfare whereas the other group has to accept this policy. The opposition group's utility is therefore depending on the policy made by the group in power. As a basic political decision by the group in power two different pricing principles can be implemented, namely the Smith rule and second degree price discrimination. After the decision for one pricing system (basic pricing philosophy), the pricing structure is fixed and only the level of prices can be changed. The political process itself is disregarded in the model.

The *pricing rule of Adam Smith* concern full cost recovery and a tariff proportional to marginal cost, since a price equalling marginal costs leads to a deficit amounting to the fix cost. To avoid this deficit, Smith suggests inflating marginal cost prices by a constant mark-up factor δ to cover the total costs:

$$p_i = \delta MC_i \text{ and } TC = p_i q_i$$

Let TC be the total cost of the infrastructure facility and MC_i be the marginal cost of user-type i . The tariff for user-type i is described by p_i , the corresponding quantity of infrastructure services consumption by q_i .

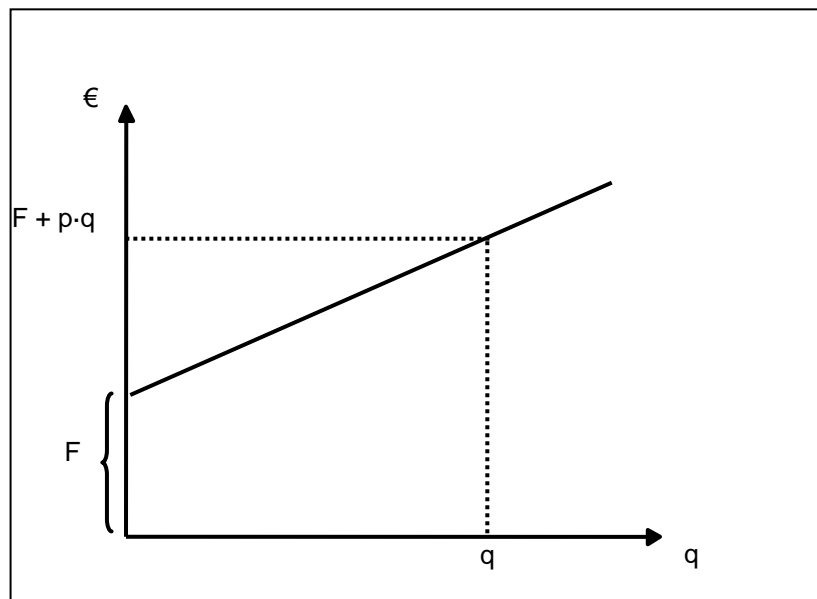
The Smith pricing rule is inferior to pricing schemes like Ramsey or non-linear pricing from the normative point of view due to higher welfare losses. According to Laffont, this result may change when SIGs affect the pricing scheme.

In situation of second degree price discrimination groups can choose between two two-part tariffs. Depending on whether a user is a low-use or high-use customer, he/she will choose a tariff with a high



fixed component F and a low usage fee p or a tariff with a lower fixed component but higher usage fee. One example of a two-part tariff is depicted in Source: Viscusi et al., 2005

Figure 3-3.



Source: Viscusi et al., 2005

Figure 3-3 Two-Part Tariff

By choosing one tariff the customers self-select themselves into two different user groups. If the tariff design is optimal, the selection will be efficient and the tariff system will be called “incentive compatible”.

Due to the fact that the Smith tariff is a uniform tariff, by choosing the Smith pricing rule the group in power can only decide on the production level of the natural monopoly, not on the particular structure of the tariff. As a consequence, only the price level, i.e. the level of mark-up δ , can be influenced, what has an impact on both groups, the ruling and the not ruling group. Hence the group in power can stipulate a level of production according to its consumption preferences, but a shift of the financial burden towards the other group is hardly possible. In contrast to this, in case of the two-part tariff the financial burden can be shifted towards the other group. Depending on the group's consumption level of infrastructure facility, the groups will choose the tariff which maximizes the welfare of their members. The shift of financial burden can now be achieved by consuming more or less than optimal. As a result, in case of a policy implementing second degree price discrimination the group in power has the opportunity to manipulate the two tariffs to maximize its welfare at the cost of the minority.

Based on the two situations mentioned above, Laffont compares the expected welfare of both Smith pricing rule and second degree price discrimination. Results show that within certain limits the Smith rule causes less distortions of expected welfare.

The welfare superiority of the Smith pricing rule decreases with increasing fixed costs. It is even possible that the Smith rule becomes inferior to second degree price discrimination if fixed costs exceed a certain level.

The welfare performance of the Smith pricing rule also depends on the heterogeneity of the groups, i.e. the derived utility from a given level of consumption. If the heterogeneity level is relatively low, both groups can be seen as one. In that case, shifting of financial burden becomes impossible. This fact leads to the conclusion that welfare losses of the Smith pricing rule exceed those of second degree price discrimination. In case of a high level of group homogeneity the Smith rule becomes inferior.

To apply Laffont's results to real-world problems it is highly necessary to study the precise framework conditions of every different case.



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Laffont/Tirole (see Laffont/Tirole, 2000) follow another way to show how SIGs can influence the structure of prices, starting from the idea of Ramsey pricing. Like the Smith pricing rule, the basic model of Ramsey pricing comprehends full cost recovery (profit equals zero). As objective function, the social welfare (sum of consumer and producer surplus) has to be maximized. The result is a pricing rule considering consumer's demand elasticities:

$$\frac{p_k - c_k}{p_k} = \frac{\lambda}{1 + \lambda} \frac{1}{\eta_k}$$

p_k : consumer k's market price
 c_k : marginal cost of consumer k
 λ : shadow cost (Lagrange multiplier)
 η_k : consumer k's price elasticity of demand

Consumers or consumer groups with a relatively high elasticity η_k have to pay a higher price premium on marginal cost than those with a relatively low elasticity. Generally speaking, consumption of services is valued at the corresponding elasticity of the customer.

This basic model is now extended with respect to externalities. An externality is defined as an impact on a third party which is not involved in the actual transaction and can affect the utility of the third party in a positive or negative way. To adjust the objective function to externalities, a parameter b_k is integrated:

$$S(q) - C(q) + \sum_k b_k q_k$$

$S(q)$: gross social utility depending on overall consumption q
 $C(q)$: total cost of overall consumption q
 q_k : consumption of service k
 b_k : externalities' marginal benefit ($b_k > 0$) or marginal cost ($b_k < 0$) of service k

Assumed that these externalities are not subsidized or taxed from general budget and that demands of services k are independent, the adapted Ramsey pricing rule is as follows:

$$\frac{p_k - \left(c_k - \frac{b_k}{1 + \lambda} \right)}{p_k} = \frac{\lambda}{1 + \lambda} \frac{1}{\eta_k}$$

Interpreting the equation, a positive externality reduces the production cost of service k (deflated by one plus the shadow cost of the budget constraint respectively full cost recovery). A negative externality in contrast increases the service's cost of production. As a result, the firm should lower its prices in the case of positive externalities and raise the prices in the case of negative externalities for a given level of λ .

The original (without externalities) Ramsey pricing rule can be even inversed in case of externalities. Imagine two user groups in urban rail transport. The first group consists of commuters who are relatively inelastic in prices. In contrast to this, the second group uses rail transport for leisure purposes and reacts therefore very elastic to price changes. According to the initial Ramsey pricing rule commuters have to pay a higher mark-up on marginal costs than leisure users. Assumed that commuter traffic has a high positive external effect ($b_k \gg 0$) the result would be the opposite. In fact, prices of urban public transit paid by commuters are lower than prices paid by other users in most European countries. However, it is questionable whether those positive externalities actually exist or even reach this magnitude. The assumption of political influence seems far more plausible.

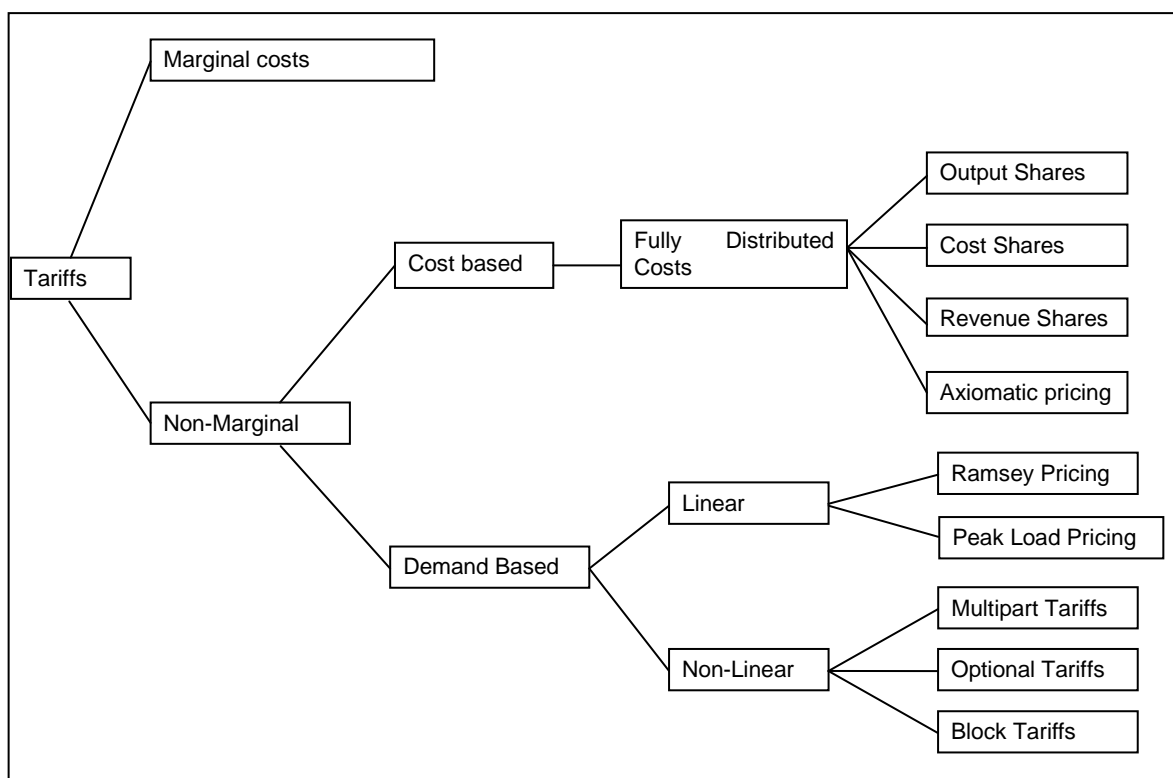


3.4 TARIFF POLICY AS A WEIGHTED AVERAGE OF PERSONAL AND SOCIAL WELFARE

Different pricing schemes induce different options of political manipulation for SIGs. Within this subsection we will give the possibilities of SIGs to manipulate tariff structures, given that a certain pricing scheme is adopted by policy makers.

Source: Wieland, 2005

Figure 3-4 gives an overview over the major pricing schemes.



Source: Wieland, 2005

Figure 3-4 Major Pricing Schemes

Beginning with cost-based pricing, it has to be mentioned that no generally accepted method of calculating infrastructure costs exists although there is a huge variety of infrastructure cost calculation methods.

There are several issues of cost calculation methods in discussion. First, economists argue whether calculation methods should be cash-based or pure economical. Second it is debated if a price, i.e. interest rate, should be requested on invested capital by the State. On the one hand opinions are that the State is not a private company and should therefore ask for no interest, on the other hand it is said (mainly from the perspective of business administration) that non-interest bearing capital is lost capital. In addition to that it is questionable which interest rate level is recommendable. An adequate rate can be the long run average interest rate of government stocks according to some scientists. Others propose higher or even lower interest rate levels. Third topic is the degree of detail regarding cost elements. The most controversial matter here is the cost inputs regarding capital costs which can be future or past oriented (e.g. perpetual inventory concept).

Due to above mentioned issues of argument it is very attractive for SIGs to interfere and manipulate the method of cost calculation. Especially the instrument of information provision is very useful to achieve the SIG's aims.

Marginal cost pricing as the basis of price differentiation would be very complex according to normative analysis. Exactly this characteristic of complexity offers possibilities for the SIGs to try to affect the degree of the differentiation of charges in their favour. We should expect therefore that a



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proposal to implement marginal cost pricing as a general principle will lead to lobbying for very elaborated and differentiated charges.

This conclusion might be too simplistic, however. In some cases more differentiated marginal cost pricing schemes might lead to a substantial increase in the expenses of some particular group. An example might be road-freight transport where a huge degree of differentiation of tolls for HGVs might increase the infrastructure bill for truckers substantially. On the other hand private car users are likely to lobby exactly for this type of tariff differentiation for the HGVs because this allows to shift more of the financial burden of infrastructure costs to trucks. According to the models cited above (especially the Grossman/Helpman model) it will depend on the distribution of voting power which interest group will prevail and which type of differentiation will finally be implemented. If truckers are more important to the politician (or more likely to react) less differentiation instead of more may be the result.

Next *Fully distributed costs* aim at full cost recovery. This can be achieved through several pricing instruments: Smith rule, axiomatic pricing, and cost distribution on the basis of output shares, revenue shares or cost shares.

The already described Smith rule applies prices proportional to marginal costs. Laffont's model showed that manipulation possibilities are comparatively low. However, the possibility to manipulate the cost calculation method is always existent.

The pricing scheme of *axiomatic cost allocation* was applied by Littlechild to propose a new charging system for the Birmingham International Airport. Based on game theoretical instruments Littlechild's solution (application of concept of Nucleolus from cooperative game theory) comprises a balanced charging system in which no airline has to pay too much relatively to a competing airline. However, notions of "fairness" may differ and by using different solution concepts it is possible to gain other cost allocations. Airlines and airports are likely to try influencing the solution concept and the resulting cost allocation in their favour, e.g. through increasing the number of user categories over which common costs are distributed.

The method of *cost distribution on the basis of output shares, revenue shares or cost shares* is less vulnerable to political distortions and manipulations than the already described methods. By reason of foundation on consumer behaviour of the relevant groups such pricing schemes should cause minor lobbying activity. Cost distribution on the basis of cost shares is still subject to manipulation, because cost calculation methods are arguable due to above mentioned reasons.

In contrast to cost-based pricing schemes, demand based pricing strategies use demand characteristics of users like elasticities to allocate resources efficiently.

The *Ramsey pricing* measure uses price elasticities of relevant consumer groups. Ramsey pricing could be a reasonable pricing instrument if the political balance of power corresponds to the relative financial burdens imposed by Ramsey pricing. Then the decision-maker would have implemented a policy that is a weighted sum of SIGs' and citizens' preferences.

An example of the Ramsey pricing rule usage is the "value of service pricing" scheme of U.S. railroads in the 19th century (ICC Act 1887). High valued goods had to pay a higher price per kilometre than low valued goods. This fact corresponded very well with the existing power distribution among SIGs in America at that time. Farmers, producing low valued agricultural goods, had to pay low shipping rates and were highly important for politicians to get re-elected due to substantial voting power. High valued manufactured goods received relatively high shipping rates which were distributed over many consumers (see Wieland 2005). The price effect of high transport rates was therefore negligible and unlikely to cause negative voting behaviour of affected groups. Additionally, railroad operators could carry out a moderate form of yield management which raised their profits. Ramsey pricing and yield management follow basically the same pricing rule: to set prices according to the consumer groups' price elasticity. The structure of resulting prices is similar, the level of prices is different due to the zero profit restriction of Ramsey pricing.

By using Ramsey pricing it is very likely to have two user groups paying different prices for the use of the same infrastructure services. Both groups will then lobby in order to pay less. Keeping in mind that the politician has the aim to get re-elected, the decision-maker has to avoid strong disadvantages



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of certain groups, even if the Ramsey prices given by the pricing measure correspond to a welfare optimum. When a group faces strong disadvantages the policy-maker can first abandon the pricing measure or second and more realistic compensate the disadvantaged group by additional price differentiations (creation of subgroups).

As mentioned beforehand, the consideration of positive externalities can inverse the Ramsey formula. This fact can cause political constraints. In order to implement the Ramsey pricing rule positive externalities have to be verified at first. The verification process can now be manipulated by SIGs to gain advantages out of it. Example for that are the commuting subsidies.

In situations with highly predictable demand fluctuations, which are a common phenomenon in transport, *Peak Load pricing* is a very useful measure. In general, we consider two periods of demand: off-peak period and peak period. The pricing rule stipulates to impose prices for off-peak infrastructure users covering only the marginal costs of the trip. In contrast, users in peak periods should pay the marginal costs of the trip as well as the infrastructure capacity costs. Manipulation options here are very limited due to the fact that peak periods are identifiable. It is therefore expected that SIGs will centre their lobbying activities on the aim to switch capacity costs to marginal costs and vice versa.

However, the policy-maker can still differentiate prices depending on the vehicle type to satisfy huge interest groups and achieve public acceptance.

Additionally, decision-makers in reality often try to shift demands from peak to off-peak period using existing free capacity in off-peak periods. To do so, they apply less drastic forms of peak load pricing measures, e.g. the so-called 9 o'clock monthly ticket in German urban transport¹⁰. Again this realizes the principle of maximizing a weighted average of individual utility and social welfare.

Non-linear pricing tariffs contain a fixed component reflecting the fixed costs and at least one variable component reflecting marginal costs. Optional tariffs comprise at least two two-part tariffs, where the user can choose one tariff fitting to his/her preferences. The decision will include a tariff selection minimizing the user's spending on consumption according to the consumer behaviour. Therefore optional tariffs can also be seen as multipart tariffs.

According to Willig (Willig, 1978) non-linear tariffs are Pareto superior to linear tariffs with prices greater than marginal costs, e.g. Smith rule. But self-selection possibilities will cause danger of political tariff manipulation. As Laffont stated in his model, by consuming more or less than the efficient level, a group can get the chance to shift financial burdens to other group. It is likely that SIGs try to achieve more price differentiation of the tariff's variable components or to shift several elements of the variable component to the fixed component.

A further example concentrates on airlines and airport charges. Today most airport charges have a fixed and a variable component. In the majority of cases aircraft weight determines the fixed charge, while the variable charge reflects the number of passengers carried. Due to demand fluctuations an aircraft flies at less than its full capacity, but the fixed charge has to be paid anyhow. Additionally demand forecasts almost always include estimation errors, so that a hundred percent suitable aircraft cannot be chosen by the airline. Hence in the current situation capacity risk is carried by the airlines so that all airlines together would prefer completely variable charges based on the number of passengers carried. This is equivalent to a shift of proportions of variable and fixed tariff components. In a scenario including entirely variable landing fees the airlines still have the problem of choosing an adequate aircraft size, but excessive landing fees due to aircraft size would be avoided. Capacity risk in this situation will be carried by the airport operator. For that reason airlines lobby for more variabilisation of airport pricing schemes (reduction or even cancellation of fixed charge components), which leads to less price differentiation (in case of completely variable landing fees that means charges based on constant average prices which are identical for every airline).

Table 3-1 summarizes all findings of the discussion made above. The ticked boxes in this table show the manipulation opportunities for the SIGs in case the respective pricing scheme is implemented.

¹⁰ The 9 o'clock monthly ticket is a fixed monthly fare, which however is valid only for trips undertaken after 9 o'clock.



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The bracketed tick for more differentiation in case of peak load pricing refers to the policy-maker's opportunity to implement price differentiation according to the vehicle type.

Table 3-1 SIG Activities with Respect to Price Differentiation

Pricing Rule	SIG Activity owards				
	Cost Methodology	More Differentiation	Less Differentiation	Switch of Capacity Costs to Marginal Costs or Vice Versa	Change of Proportions of Variable and Fixed Tariff Components
Cost-Based					
Marginal Costs	✓	✓			
Smith Rule	✓				
Axiomatic Pricing	✓	✓			
Output Shares	✓				
Revenue Shares	✓				
Cost Shares	✓				
Demand Based					
Ramsey Pricing	✓	✓			
Peak Load Pricing		(✓)		✓	
Non-Linear Pricing		✓			✓

3.4.1 An Application of the Positive Theory: The Common European Transport Policy

The recent development of the EU policy regarding infrastructure charges showed that the basic infrastructure pricing rule is still in discussion. Using our theoretical results the ongoing course of action can be seen as a process of selecting the constitutional infrastructure pricing rule.

Initially the White Paper "Fair and Efficient Pricing of the Transport Infrastructure" of 1998 stipulated social marginal cost pricing as a favourable infrastructure pricing scheme. After criticism of several transport scientists like Rothengatter the basic railways pricing scheme was altered towards pricing according to short run marginal cost (Directive 2001/14 as part of the first railway package). However, some exceptions in the form of mark-ups to fully recover costs were allowed. Thus, to some extent this pricing scheme allows to reflect elasticities.

Later, pricing policy developed to marginal cost based pricing according to the White Paper "European Transport Policy for 2010: Time to Decide" of 2001, which is compatible with the Smith rule, Ramsey pricing and two-part tariffs. Furthermore, cross-subsidies to finance infrastructure construction in sensitive areas were allowed (Commission Paper IP/03/1097 of 2003).

In the case of road transport, the "Eurovignette-Directive" (1999/62/EC) and revised versions do not mention marginal cost pricing but a pricing scheme reflecting cost of infrastructure damage, i.e. structural maintenance cost (renewal of surface, regular annual maintenance) based on a axle-weight damage function of traffic, and investment costs. Again all types of FDC (fully distributed costs) pricing and multi-part tariffs are compatible. Additionally, with this proposal also differentiation with respect to distance travelled, place, infrastructure type, vehicle characteristics, time of day and congestion level and therefore pricing schemes of peak-load pricing, congestion pricing, and Ramsey pricing are allowed.

This shift in infrastructure charges policy shows that the EU Commission now favours price differentiation instead of pure marginal cost based pricing rules. A reason for that can probably be found in the different interests of centrally located and peripheral European countries. While the



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former group prefers full cost-coverage, the latter favours marginal cost pricing due to concerns of competitive disadvantages.

Coming back to positive theory, both groups, centrally located and peripheral European countries, can be seen as two competing interest groups. Naturally both groups derive welfare from a well-developed transport infrastructure, but it is still questionable how gains of welfare and financial burdens will be allocated. The Commission's approach to stipulate price differentiation harmonises with positive theory. A direct approach can be seen in the ATM (Air Traffic Management) charges Directive. ATM charges are mainly a uniform tariff with only one differentiation element. This refers to regional differentiation. Every Member State has discretion to set the differentiation factor on its own. Exactly, this differentiation element enabled political acceptance of the respective Directive by all Member States. Another example is the Directive on airport charges. The new proposal avoids to indicate a certain pricing rule and stipulates only three basic principles (transparency, consultations, and non-discrimination of carriers) and leaves the specific form of the tariff structure to the discretion of the participating actors (carriers, airport authorities, regulators). This can be seen as an equilibrium among all participants. The finally implemented tariff structure will therefore reflect in each case also regional political conditions.



4 CASE STUDIES

The previous chapters discussed the theoretical backgrounds of price differentiation in transport. It not only gives us a better understanding of the concept, it also allows us to identify important aspects for the assessment of the case studies. Various elements have been identified that may be relevant to the success or failure of a particular case study where price differentiation is implemented in practice. For instance, the objective of a certain charge may involve a type of differentiation which causes a certain level of effectiveness.

This section identifies important elements for the assessment of the DIFFERENT case studies and tries to operationalise the issues discussed before. We develop a so-called factsheet consisting of the main dimensions relevant to price differentiation. The aim is to provide common ground for the comparison of outcomes of the case studies, for example in terms of testing hypotheses on differentiated pricing. Moreover, it provides us with information about the type of analysis that is planned to be carried out in the case studies. A complete factsheet can be found in appendix 1. In a next step we provide a summary overview of the data collected through the factsheets and discuss some caveats in data collection. In a last step we formulate hypotheses and conduct a cross case testing of them.

4.1 FACTSHEETS

In order to collect data from the case studies in a generic way, a factsheet form was designed. The scope of the information collected is defined in the first place by the hypotheses we want to test. These hypotheses are formulated in section 4.4 and 4.5. Furthermore we want to collect information that allows us to establish some descriptive statistics in order to better illustrate the range of infrastructure case studies covered (section 4.2).

The factsheets were designed in an iterative process. A first version of the form was mainly inspired by the theoretical framework only (both economic and psychological frameworks), and the collected case study data were used for descriptive statistics. A second version extended the scope of the form to fully cover the hypotheses formulated in the meantime and reflected experience collected with the first version. The case study data were updated and used for a preliminary testing of the hypotheses. A discussion of the outcomes (including some gaps that were identified) resulted in a third and final version of the factsheet form. Again the forms were updated for all case studies.

The factsheet consists of two main parts (appendix 1). A first part introduces the topic, provides general instructions as well as a glossary in order to ensure a common understanding of the (economic) terminology used. A second part contains the form.

The factsheets are used to report the pricing situation that is the subject of the case study analysis, with the explicit instruction that exempt users have to be considered as an inherent dimension of differentiated price schedule throughout the factsheet.

The form consists of twenty thematic sections. We will go briefly through the entire form providing a summarised motivation for each section.

A first section discusses the case study morphology. Here we define the reference scenario, the unit to be charged, the spatial scope of the case as well as the type of exercise reported. The motivation for the section is to obtain a clear description of the (charging) subject as well as to allow for taking into account any possible heterogeneity between the different cases in further analysis.

The second section asks for the dimensions along which price differentiation is in place in the case reported. The initial list was based on literature (see chapter 2 and 3) and was further extended with dimensions reported throughout the data collection iterations.

The third section records the objectives behind the differentiated price schedule. It was asked to report objectives for both the entire scheme as well as for the different pricing dimensions separately.



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A fourth section focuses on degree of differentiation. For each dimension of the pricing schedule the number of price levels was asked for, as well as minimum, maximum and average price level. This section will provide a key input for testing of hypotheses with respect to degree of differentiation. We will discuss in section 4.2.2 how we define an indicator based on the information collected here.

A fifth section has a closer look to the motivation for differentiation across users. It is also here that information on exempt users is collected. Note that this information is also partly covered by the section on degree of differentiation, where exempt users correspond to a minimum price level of zero (but the inverse does not necessarily hold due to the definition of exempt users provided in the factsheet glossary).

A sixth section collects information on a couple of economic principles that are behind the price schedule.

A seventh and eighth section focus on the actors setting the price and paying the charge respectively. They contain a mixture of questions both on the nature of the actors as well as economic principles applied by them.

A ninth section collects information on cognitive burden and is motivated mainly by psychological theory.

A short tenth section checks whether the (existing) charging mechanism is a barrier towards further differentiation. This specialised information will serve to test a hypothesis on the topic.

An eleventh section checks the political dimensions of the case study.

The twelfth section collects information on the analytical approach(es) applied in case study analysis. This data will be mainly used to report on case study statistics, but ideally it would also allow for an analysis of findings by type of analytical approach.

The thirteenth section looks to enforcement.

A fourteenth section collects qualitative information on the size of user responses along different behavioural dimensions. These broadly cover the dimensions of the pricing scheme reported in an earlier sections. The information collected will serve to compare size of user reactions to degree of differentiation along the corresponding dimensions. A subsequent fifteenth section completes this information with quantitative data if available from the case study analysis.

A sixteenth section asks for the impact of the charging mechanism and in how far this impact corresponds to the aims set. A seventeenth section more specifically focuses on welfare impact of the price schedule (assuming that the objective set is an increase in welfare).

An eighteenth section stems from positive economics and queries any lobbying around the design and introduction of the differentiated pricing scheme.

The nineteenth section focuses on burden shifting and a twentieth and last section bundles all issues surrounding the topic of acceptability.

4.2 SUMMARY OF CASE STUDIES

In this section we provide an overview of the case studies based on the information collected through the factsheets. Factsheet information was provided for 27 case studies. In our discussion we consider five different types of case studies as per the definition provided in the project TA:

- Airlines (5)
- Shipping (8)
- Railways (4)
- Road haulage (4)



➤ Car drivers (6)

The information collected is not fully homogenous. The information on three case studies was not updated up to the last iteration of the factsheet. We will nevertheless include the available information on these three cases in our analysis. On the other hand, for one case study two factsheets were completed, one for passenger and one for freight transport. We will consider them as separate cases in the subsequent analysis.

Throughout our analysis the number of case studies considered may vary as a result of the heterogeneous character of both the information collected as well as the inherently heterogeneous character of the different case studies which we will discuss in a subsequent section.

Whereas in our discussion most attention will be paid to answers that fit in the predefined alternatives of the factsheet form, we will report on other (customised) answers where illuminating for the discussion at hand.

4.2.1 Objectives

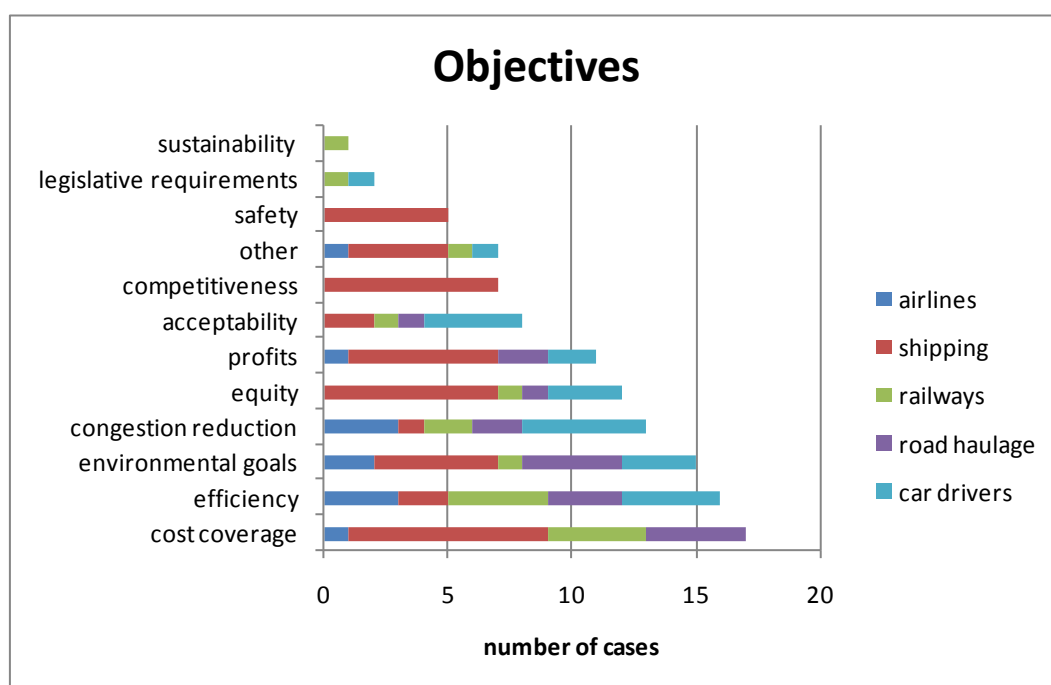


Figure 4-1 Main Objectives of Price Differentiation

Cost coverage is the most cited objective for price differentiation, closely followed by efficiency and environment (Figure 4-1). Legislative requirements and safety are considered as an objective in relatively few cases. If we consider different case study types, we observe that the overall ranking broadly holds for the individual types, be it with some noteworthy exceptions.

Safety and competitiveness are considered only by port cases. Especially for safety this seems odd, given the important safety problems in road traffic.

Port cases do generally not consider congestion, which probably fits the specific situation where congestion is a relatively small or even non-existent problem.

One surprising observation in railway cases is that in only one case environmental objectives are represented in setting differentiated prices. Given the choice that operators generally have between old, unregulated and heavily polluting diesel powered rolling stock or clean electrical ones, there certainly would be a case for environmental incentives in the price schedule.



The car drivers cases tend to focus on congestion, pay more than average attention to acceptability and any cost coverage objective is absent. This seems to fit the stereotypically setting of a congestion charge.

The average number of objectives per case is about the same for road and rail cases, but is larger for shipping cases and smaller for airport cases.

Obviously, the large variance in number of objectives should have its impact on the corresponding differentiated pricing schemes. In order to optimise a pricing scheme for a given number of objectives (assumed to be independent), one needs to tune a number of (independent) pricing dimensions that is (at least) the same.

In order to have a measure for the number of objectives addressed in the case study, we define the *degree of ambition*, which is simply the number of objectives reported.

4.2.2 Degree of Differentiation

We will first have a look at the behavioural dimensions along which price differentiation is considered in the case studies. In a next step we will introduce an indicator for price differentiation and discuss the application of it to the case study data.

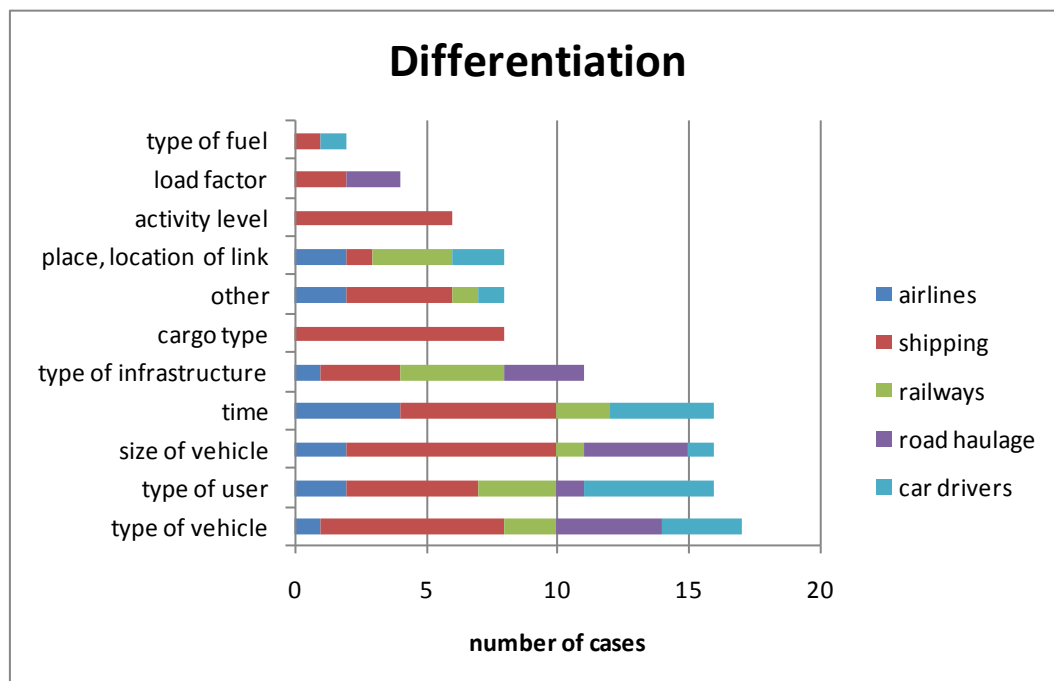


Figure 4-2 Types of Differentiation

The most often cited dimensions of price differentiation are type of vehicle, type of user, size of vehicle and time of travel (Figure 4-2). At the other side of the spectrum are load factor (or occupancy rate in passenger transport) and type of fuel.

Looking to oddities in the occurrence of differentiation dimensions, we observe that cargo type and activity level are used for price differentiation only in port cases. The differentiation along activity level obviously stems from the negotiable character of port prices. As for cargo type, it may both depend on costs related to handling or differences in demand elasticities (or willingness to pay).

Payload related price differentiation (load factor for freight, occupancy rate for passengers) is limited to freight transport only. The motivations for such a differentiation are not very clear, given that most (internal and external) infrastructure use costs are function of the vehicle rather than its load. But it deserves to be noted that occupancy rate infrastructure use differentiation does exist in the form of



carpool lanes, locally known as diamond lanes or high-occupancy vehicle lanes, and ubiquitous in many larger US urban areas.

The relative absence of fuel type differentiation may be explained by prices already being differentiated in the reference case (road transport) or most vehicles using the same fuel (air transport). It should however be noted that any existing differentiation in fuel taxes usually does not correlate to differences in external costs (see section 2.5.2), so there would be a case for further study of fuel price differentiation.

Airline cases typically focus on time of travel, probably with the intention to alleviate airport congestion or to abate noise pollution.

Road haulage cases somewhat surprisingly do not differentiate as a function of time of travel.

Differentiation along type of user is the most often reported dimension in car driver cases. The underlying dynamic is that these urban congestion charge case studies typically feature a myriad of user classes which are exempt from the charge. Where differentiation along user class exists in non-road cases, this is motivated by demand based arguments (elasticities, willingness-to-pay).

As with the number of objective per case study, we also observe a larger than average number of differentiation dimensions for the seaport cases, whereas airlines and urban congestion charge schemes typically feature a smaller than average number of pricing dimensions, the latter probably explained by the inclusion of the Spitsmijden experimental scheme.

A simple measure for degree of differentiation would be just to count the number of dimensions along which price differentiation is proposed. However, such a measure would classify two schedules with a different number of price levels along the same number of dimensions as equally differentiated. Intuition suggests that this is typically not what we are aiming at.

To account for the number of price levels along each dimension, we first look to a fictitious schedule that is differentiated along one dimension only. The minimum number of price levels is one (provided that zero is also a level), in which case the schedule is not differentiated and the indicator should reach a minimum level. The maximum number of price levels is infinity (in the case of the price being a continuous function of the behavioural dimension), in which case the indicator should reach a maximum level. We normalise minimum level to zero and maximum level to unity.

We still need to determine the functional form between both extreme points. Intuition tells us that the first additional price level (i.e. from one to two price levels) adds more to the degree of differentiation than let us say the 999th. We therefore want a functional form that is concave over the interval considered. Furthermore, we learn from literature on time optimal congestion charging (cfr. discussion in section 2.5.1) that about half of the maximum welfare gain is obtainable with the simplest case of a differentiated charge (i.e. two levels).

The simplest functional form that fulfils the requirements set out above (extreme points, convex, half the maximum value at two levels) is $1 - 1/n$ with n the number of price levels.

To aggregate the values along the individual dimensions we simply add them up (hence our choice to normalise the minimum level to zero). This is a rather coarse approach. Not only do we assume that differentiation along the different dimensions is equally important, moreover we assume the different dimensions to be not correlated which is highly unlikely e.g. for fuel and vehicle type.

With respect to the first issue we can only argue that this is the best we can get for a generic approach given the heterogeneity of case studies. With respect to the second issue, it seems safe to assume that price schedules are not randomly defined and that any price setting agent will refrain from schedules that introduce cognitive burden by pricing along heavily correlated dimensions.

It may be useful to note that the definition of degree of differentiation introduced here depends only on the pricing schedule and as such departs from the definition that was used in deliverable 2.1 where the objectives for differentiation entered the qualitative classification proposed there. The motivation for



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this change was to have an indicator that fits the setting of the hypotheses where degree of differentiation is meant to reflect the definition of the pricing schedule only.

The resulting indicator for degree of differentiation is presented in Table 4-1.

Table 4-1 Degree of Differentiation

Name of Case Study	Case Study Type	Degree of Differentiation
Port of Amsterdam	shipping	6.6
Port of Hamburg	shipping	5.1
Port of Gothenburg	shipping	5.0
Lerwick - Shetland Islands	shipping	4.4
Port of Valencia	shipping	4.4
Port of Duisburg - (Duisport)	shipping	3.5
France rail infra charge	railways	3.0
Trondheim road charge	car drivers	3.0
Scalloway, Shetland Islands	shipping	3.0
Effects of differentiated charges at Airport Hamburg	airlines	2.7
German Railways	railways	2.4
Stockholm City	car drivers	2.3
London City Centre	car drivers	2.3
The German HGV Toll	road haulage	2.2
Edinburgh road pricing	car drivers	2.0
Brenner TEN-T (freight)	road haulage	1.9
Brenner TEN-T (passenger)	road haulage	1.8
Swiss Heavy Vehicle Fee (HVF)	road haulage	1.7
Sullom Voe, Shetland Islands	shipping	1.6
Ljubljana Airport Case Study	airlines	1.2
Rail infrastructure charges in Austria	railways	1.2
Spitsmijden	car drivers	0.7

With the exception of the Brenner cases all entries in Table 4-1 concern real world implementations. For a number of cases we did not assess the degree of differentiation, either because sufficient information was lacking or because the setup of the case study did not allow for the calculation of an unambiguous value, especially where the case study focused on simulating an extended number of schemes.

We observe that the port cases typically carry a lot of price differentiation (with the exception of Sullom Voe). At the other end of the spectrum is the Spitsmijden case which concerns a limited time scientific experiment: in such a setting one typically wants to focus on a concise number of influences hence the low level of differentiation.

Urban congestion schemes (i.e. "car driver" in the table) typically feature an intermediate level of differentiation. While this may seem counterintuitive given the need to avoid cognitive burden, these schemes typically carry a number of excepted user classes which adds to their degree of differentiation.

There is no clear reason why shipping cases should carry more differentiation than e.g. road haulage cases. The figures do however suggest that there is much heterogeneity in price setting across the different transport modes. There seems to be no obvious difference in differentiation between freight and passenger transport cases (note that railway infrastructure pricing concerns both).

As discussed earlier, we expect there to be a positive correlation between degree of differentiation and degree of ambition. The relationship has been plotted in Figure 4-3. We observe a clear positive



Differentiation & Ambition

The scatter plot displays the relationship between ambition (x-axis) and differentiation (y-axis) for five professions. The x-axis ranges from 0 to 12, and the y-axis ranges from 0 to 7. The legend identifies the professions by color and shape: airlines (blue square), car drivers (orange diamond), railways (yellow inverted triangle), road haulage (green triangle), and shipping (maroon right-pointing triangle).

Approximate data points from the plot:

Profession	Ambition (x)	Differentiation (y)
airlines	1.0	2.7
airlines	3.2	1.2
car drivers	3.2	0.7
car drivers	3.2	3.0
car drivers	5.0	2.3
car drivers	6.0	2.0
car drivers	7.0	2.3
car drivers	10.0	4.4
road haulage	3.2	1.6
road haulage	4.0	2.2
road haulage	5.0	1.8
road haulage	5.0	2.0
road haulage	8.0	3.1
shipping	4.0	3.5
shipping	5.0	4.4
shipping	5.0	3.0
shipping	6.0	5.0
shipping	6.0	6.6
shipping	7.0	5.1
shipping	10.0	4.4
railways	2.0	1.2
railways	4.0	2.5
railways	8.0	3.1

4.2.3 Responsible Actor



If we consider the actor responsible for setting the price schedule (Figure 4-4), we observe that in most cases either the public sector or a semi-public firm is involved. The ranking of the type of price setting actors is similar for most types of case studies, only urban congestion charging schemes tend to be determined exclusively by public sector actors. On the other hand, the public sector is



completely absent as a price setting actor in airport cases where it is mostly a semi-public firm that sets the price levels.

For road haulage, shipping and railways cases we typically see a combination of different actors, whereas for car driver cases a public authority is in most cases the only responsible actor.

4.2.4 Analytical Approach

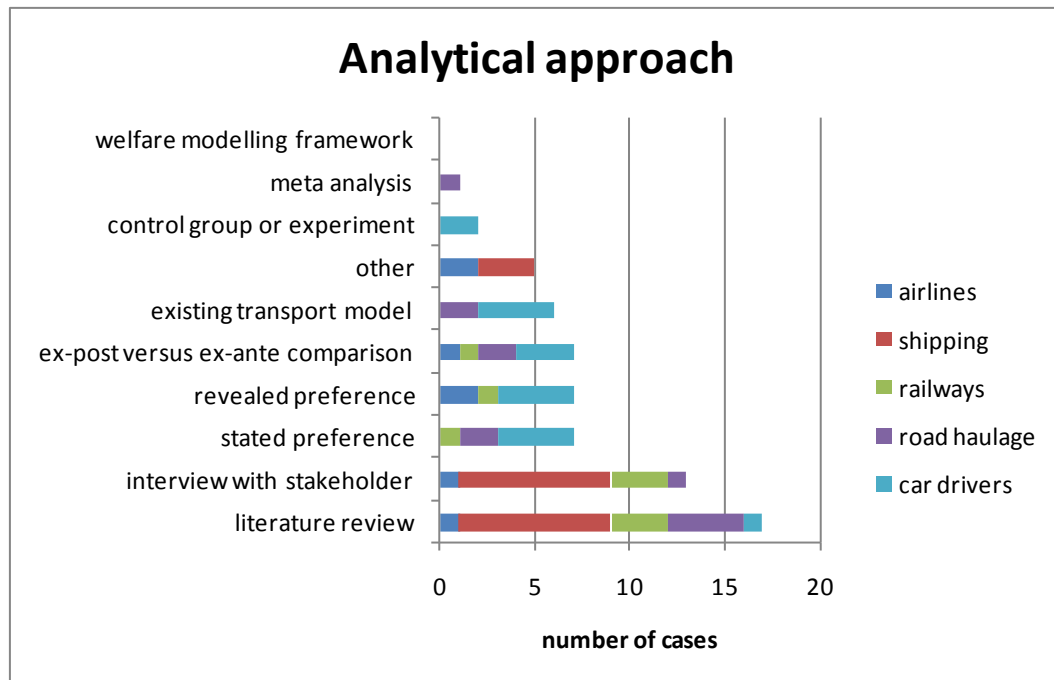


Figure 4-5 Type of Analytical Approach

There is no clear picture and all combinations of different analytical approaches seem possible under all settings (Figure 4-5). An exception however are the shipping case studies where the analytical approach is generally limited to literature review combined with stakeholder interviews.

Only in a minority of cases models are used as a vehicle of analysis. Encompassing welfare modelling frameworks are even reported to be absent in all case studies, which is somewhat surprising provided the high occurrence of efficiency as a differentiation objective. Apparently there is a duality between design and evaluation of a differentiated pricing schedule.



4.2.5 User Responses

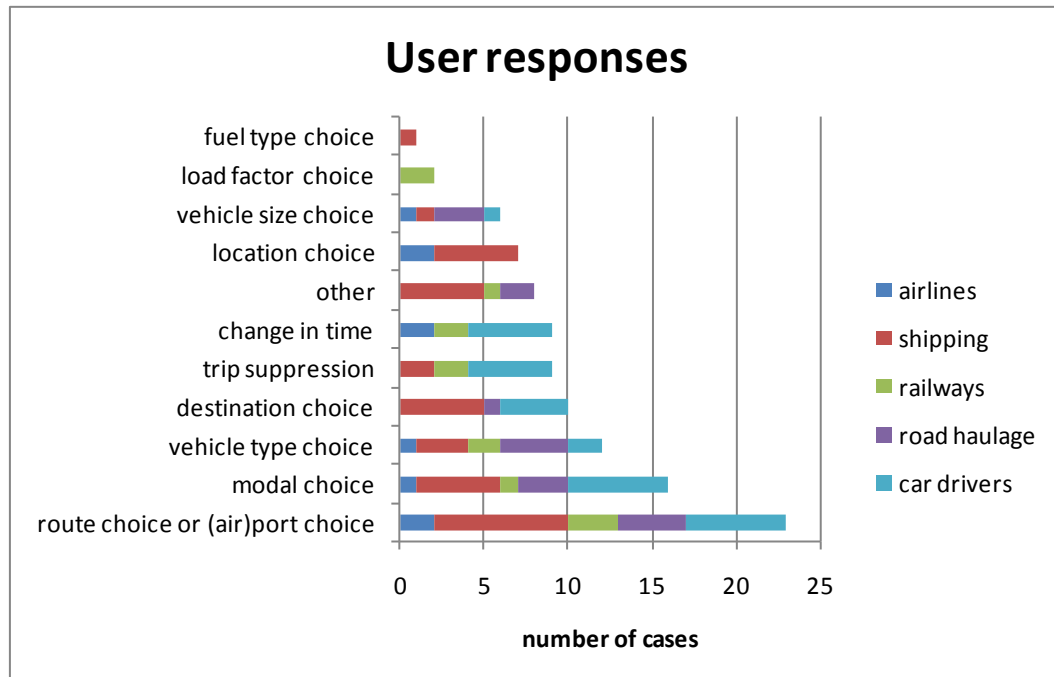


Figure 4-6 Type of User Responses Considered

Most case studies focus on more than one type of user response (Figure 4-6). As with the number of objectives and the number of differentiation dimensions, again the shipping cases carry the largest average number of user response dimensions and the airport case features the smallest average figure in all categories.

Nearly all case studies focus on route or (air)port choice. Somewhat surprising, overall demand levels (labelled as “number of trips” of the table but the actual unit of activity is case study specific) is the focus in only nine out of 27 cases. This reveals that in the majority of the price differentiation cases the total level of transport activity is assumed to be given. The focus is on substitution rather than suppression.



4.2.6 Effects Studied

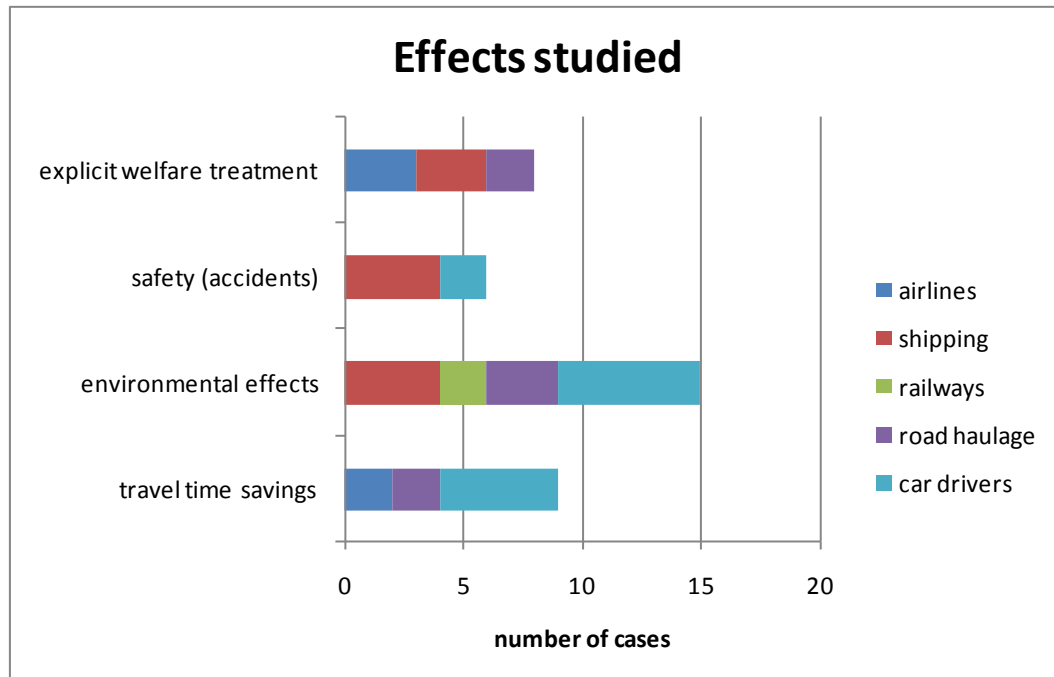


Figure 4-7 Type of Effects Covered

In the factsheet form a couple of questions ask for the effects covered in the case study analysis as well as the explicit treatment of welfare effects. In our analysis here we assume that for the many factsheets where one or more of these questions were left unanswered the study of the corresponding effects is absent in the analysis (rather than unknown).

The types of effects covered by the case studies mainly focus on environmental effects (Figure 4-7). The number of effects covered ranges broadly over the different case studies.

We note again the duality between objectives in the design and the evaluation of the pricing schedules. At one hand, efficiency being a primary objective only a minority of case studies carries an explicit welfare treatment, whereas at the other hand there are more case studies that study impact of the schedule on safety than there are cases that have safety as an objective for differentiation.



4.2.7 Actor Paying the Charge

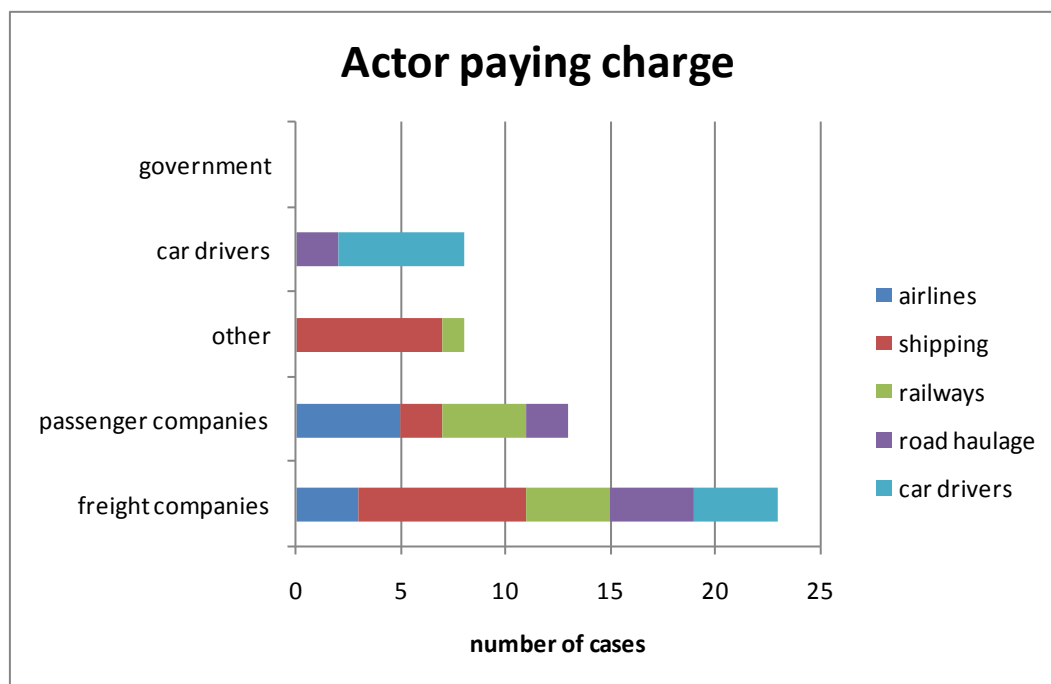


Figure 4-8 Main Actor Paying the Charge

The factsheets provide information on the actor paying the differentiated charge (Figure 4-8).

In each rail case study both passenger and freight operators have to pay. Unsurprisingly, in car drivers cases it are mainly the car drivers who pay. In a similar fashion it are primarily the freight companies who pay the charge in road haulage cases. Also port cases heavily focus on freight operators.

4.2.8 Concluding Remarks

In this section we provided a summary of the case studies analysed in the DIFFERENT project. The overview indicated a large degree of heterogeneity across the cases. Given that most cases concern non-experimental real world implementations, this does not come as a surprise.

The focus of our study is infrastructure price differentiation. For our subsequent analysis we introduced and discussed an indicator that captures degree of differentiation of a pricing scheme and allowing comparisons among schemes.

In order to allow for a cross-case analysis when testing the hypotheses (sections 4.4 and 4.5), we need to control for heterogeneity between the cases as much as possible. Our discussion revealed that the varying number of objectives explains this heterogeneity to some extent. For our analysis we therefore introduced and discussed a measure of ambition. The relationship between ambition and differentiation was shown to be positive, which is in line with (mathematic) intuition.

Nevertheless, we do recognise that the simple indicators we established only capture part of the heterogeneity. As already indicated, most cases study real world implementations and as it is often the case in such a setting, many variables are correlated.

Finally we note that there seems to be a duality between pricing scheme objectives and analytical evaluation of the impact of the differentiated scheme. Not only do many case studies fail to assess their welfare impact notwithstanding their efficiency objective, also many cases do evaluate impacts such as safety that are rarely an explicit objective of the pricing scheme.



4.3 CONTRIBUTED DATA

The factsheets collect case study information in a standardised way. This has the clear benefit of providing a common ground for hypothesis testing. There are however also some drawbacks in the use of the factsheets for data collection.

A first problem experienced has already been noticed and relates to incomplete factsheet information. For some cases, questions were left open for varying reasons. Whereas in early versions of the factsheet form the instructions to complete them were unclear for some questions, this was improved towards the final version mainly by reorganising the layout. Another reason for not completing questions however directly relates to their generic nature, whereas some questions may not be applicable given the setting of a particular case study.

A second problem may arise from the terminology used in the factsheets (efficiency, externality, Ramsey Pricing, etc.). This terminology stems from economic theory, and researchers with a different background may not always have an identical understanding about the subject of the question. In order to address these concerns, a glossary was added to the factsheet.

A third type of problem is one of inconsistency in the information provided in a given factsheet. We will come back to this issue in a next section where we test the hypotheses. We do however already mentioned here that the extent of incompatibility was greatly reduced towards the final version of the factsheets.

A fourth and last type of problem relates to processing the information contained in custom fields (“other” and “detail”). Towards a generic hypothesis testing, information collected by these fields is of limited use. The instructions accompanying the form therefore encouraged the respondent to limit their use as much as possible. Moreover, recurrent custom answers were included in the predefined list towards the final version of the form.

4.4 NORMATIVE ECONOMICS HYPOTHESES

4.4.1 Introduction

In order to achieve sufficient focus and coherence in the case studies carried out in the DIFFERENT project, we formulated a number of hypotheses. The hypotheses provided to some extent the direction of research carried out in the case studies. In this deliverable, we test the hypotheses by means of outcomes of the case studies. The focus is on cross-case analysis.

In the formulation of the hypotheses we focus on two research questions:

- A. What explains that certain differentiated price structures are adopted?
- B. What are the consequences of differentiated prices for travel behaviour, welfare and acceptance?

The hypotheses will be divided in general and specific ones.

The formulation of the hypotheses was amended where adequate after a preliminary testing was carried out.

In this section we will present and test the hypotheses related to normative economics. In a subsequent section 4.5 the focus will be on the hypotheses stemming from positive economics.

4.4.2 Hypotheses on the Determinants of the Choice for Differentiated Price Structures

General hypothesis A *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.*

Below a number of specific hypotheses follow.



Hypotheses on the Role of Aims of Price Setting Agents

Normative economic theory as described in chapter 2 underlines the importance of the objectives of the responsible decision makers in price setting. This leads to the formulation of the following hypotheses.

H1.1 *The higher the weight that price setting actors attach to equity considerations, the more they will be inclined to apply price differentiation where customers that would deserve support from an equity perspective will be confronted with low charges compared with other customers.*

Different user categories can be confronted with different charge levels simply because differentiation across user types is applied, or because pricing is differentiated across a variable that is correlated with user type.

The hypothesis closely follows the definition of equity (as provided in the factsheet glossary) which corresponds to vertical equity (see section 2.3.1). Hence it describes how equity objectives are realised.

We conduct a qualitative comparison between the equity objective being present in the case study (section two of the factsheet) and the users which are exempt from or being favoured by the scheme (section five of the factsheet). We consider the following types of customer support: preferential treatment of frequent users, users that live in a geographically confined area and handicapped users.

Across all types of cases where equity is an objective, we find that *frequent users* tend to be favoured. It is unclear in how far we can consider frequent users as to deserve support from an equity perspective (there may be some degree of correlation).

Another type of user that is favoured when equity is an objective, are *users that live in a geographically confined area*. In passenger transport cases, this mostly corresponds with the political influence of these people (but again there may or may not be correlation with equity). In the other cases, where freight transport companies pay the charge, we mostly observe protectionist tendencies in the favoured user types.

A last type of user being favoured in all equity driven car driver cases are *handicapped users*. This is a category that probably truly deserves support from a (vertical) equity perspective.

To summarise we conclude that the hypothesis seems to be confirmed in private car driver cases. In other cases where companies pay the charge, equity motivation may be a disguise for protectionist tendencies.

H1.2 *The higher the weight that price setting actors attach to efficiency considerations, the more they will be inclined to apply price differentiation where prices reflect the marginal costs to transport (for example, marginal congestion costs, marginal maintenance costs).*

The hypothesis basically follows the fundament of welfare optimal pricing where user prices are set equal to marginal costs (section 2.2.1).

Comparing the case study data in section three of the factsheet (objectives) to section six of the factsheet (economic principles behind differentiated pricing scheme), we cannot confirm the hypothesis. The limited number of cases where external or marginal internal cost pricing is applied seem to be randomly distributed over the different weights reported for efficiency consideration.

H1.3 *Consider the case where cost recovery is imposed on price setting actors (for example infrastructure managers). Given the side condition of cost recovery, the higher the weight that price setting actors attach to efficiency considerations, the more they will be inclined to deviate from average cost pricing, implying a move towards differentiated pricing structures.*

Although not explicitly stated by the hypothesis, the effect described is conditional upon the degree of ambition.



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We have information on the presence or absence of (partial) cost recovery (section six of the form) for eighteen of the case studies, all of which have sufficient information to assess the value of the indicator for degree of differentiation.

There is imposition of at least partial cost recovery on the price setting actor in fifteen of the eighteen relevant cases. If we compare the information on efficiency as an objective for differentiation (section three) to the indicator for degree of differentiation and ambition (section 4.2.2), *no obvious pattern is revealed* (Figure 4-9). There probably is another (unidentified) effect that plays a role in the background.

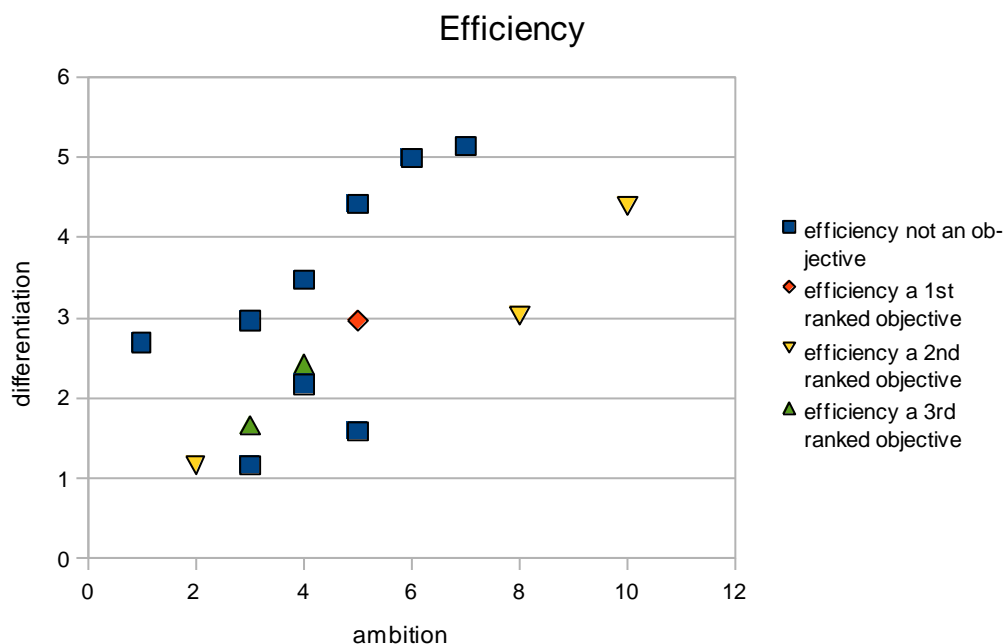


Figure 4-9 Importance of “Efficiency” Between the Differentiated Pricing Scheme Objectives

Note that the formulation of the hypothesis is to some extent ambiguous: average cost pricing is used here as a synonym for undifferentiated pricing, whereas in a different context it may be used for a differentiated price structure based on average cost as opposed to marginal cost (which would make sense in a situation of increasing returns to scale, see section 2.3.1).

H1.4 Profit maximising monopolists will use price differentiation based on willingness to pay in various sub-markets.

Out of fourteen case studies for which sufficient information was provided in section seven of the factsheet, four feature a profit maximising monopolist. Of these four case studies, there are two where, according to the information entered in section six, willingness to pay (WTP) has a small influence on the determination of differentiated price levels. In the other cases, no influence was reported. *This seems only a weak indication of the hypothesis.* The sample used is however very small.

It should be noted that there seems to be some inconsistency between information collected in by sections five and six with respect to willingness to pay being a motivation for differentiation. In some cases, section six indicates that WTP has no influence on differentiated prices, whereas it is indicated in section five to be a motivation for differentiation across type of user. This inconsistency however mainly surfaces in the cases without a profit maximising monopolist.

It may be that price setting actors are lacking explicit quantitative information on WTP or are unfamiliar with the formal concept of WTP and hence do not make statements on this respect. Moreover, it is not unlikely that WTP is correlated with other behavioural variables (e.g. time of travel), in which case the



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presence of price differentiation along the other (more tangible) variable may make WTP based differentiation seem much of an academic exercise to the price setting actor.

Hypotheses on the Role of Cost Structures in Price Setting

Normative economic theory as described in chapter 2 underlines the importance of cost structures in price setting. This leads to the formulation of the following hypotheses.

H1.5 *When the costs of price differentiated charging mechanisms are high for the price setting agents, they will choose simple (cheaper) charging mechanisms as second best strategies.*

The idea behind the hypothesis is that the cost of an upgraded charging mechanism is prohibitive compared to the (social) benefits to be expected by the larger degree of differentiation.

To check the hypothesis we use the case study information reported in section ten of the factsheet (barrier) and compare it to degree of differentiation and degree of ambition (Figure 4-10).

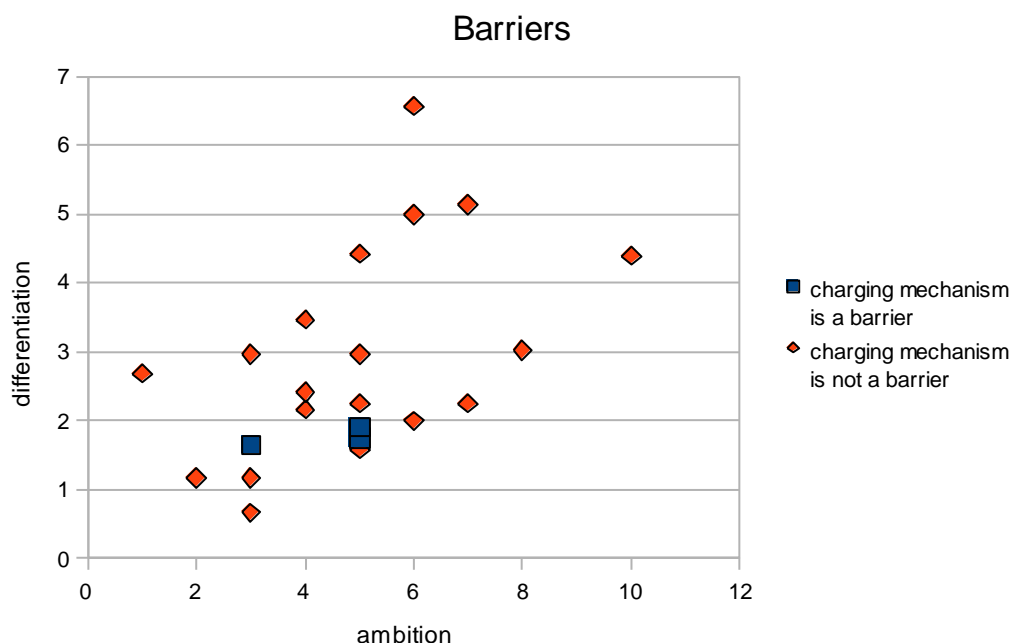


Figure 4-10 The Charging Mechanism as a Barrier towards Further Differentiation

Although one may expect the hypothesis to implicitly assume a constant degree of ambition, it may well be that price setting actors moderate their ambition when faced with the limitations of an existing charging mechanism. We should hence check for the degree of differentiation independently from ambition. We then observe that the cases where the mechanism is a barrier tend to the bottom of the differentiation spectrum.

We therefore conclude that the case study data is in line with the hypothesis.

H1.6 *When transport cost structures are characterised by increasing returns to scale monopolistic tendencies will prevail more than in the case where increasing returns to scale are absent.*

The theoretical background of this hypothesis relates to the setting of increasing returns to scale where the marginal cost is smaller than the average cost (see section 2.3.1). Such a setting is generally regarded to be a reality in quite a number of transport related markets.

When the marginal cost is lower than the average cost, there is no case for competition between private firms which according to economic theory should happen at the marginal cost to obtain a stable equilibrium. Therefore a monopolistic situation is a likely alternative for the market to happen.



All relevant case study information is contained in section seven of the factsheet. Of the fifteen cases for which sufficient information was provided, ten feature a situation of increasing returns to scale. There is however no clear relationship between the presence of the situation and the reported information on monopolistic tendencies in the corresponding markets. Hence *we cannot confirm the hypothesis based on case study data.*

Hypotheses on the Role of the Demand Side

Normative economic theory as described in chapter 2 underlines the importance of the demand side in price setting. This leads to the formulation of the following hypotheses.

H1.7 *The degree of charge differentiation is larger when the variation in willingness to pay, and in the price elasticity of demand is larger among subgroups of consumers.*

The heavy focus of the project on non-experimental real world case studies allows to collect information on a broad range of topics. However, somehow inherent to this approach is that it focuses on life-as-it-is without much questioning where we would have ended up under alternative settings. This seems especially true with respect to measuring the user responses.

As such, attention in the case study analysis seems to focus more on absolute demand levels, whereas in order to test theoretical hypothesis we are typically more interested in how these levels change under small variations in input levels (most importantly prices). This severely limits the potential for testing the hypothesis at hand.

Only half of the case studies report in section fifteen of the factsheet to have quantitative demand information available (thirteen out of 27). For a number of these case studies, it is further detailed that only limited information is available. We conclude that *the available information is too limited for a cross case study testing of the hypothesis.*

H1.8 *The more monopolistic power of the price setting agent, the higher the probability that price differentiation will be applied between different user groups.*

To check this hypothesis against the case study information we compare the information on the monopoly position of the price setting actor (section seven of the factsheet) to user type differentiation being present (section two). *We could not determine a significant pattern* between both variables.

As noted earlier, it may well be that user type differentiation actually happens through differentiating prices along another variable that is correlated with user type. To verify this we substituted the indicator for degree of differentiation for the user type differentiation and compared again with the monopoly position of the price setting actor (Figure 4-11). But to no avail, no meaningful pattern could be determined (even when controlling for degree of ambition).

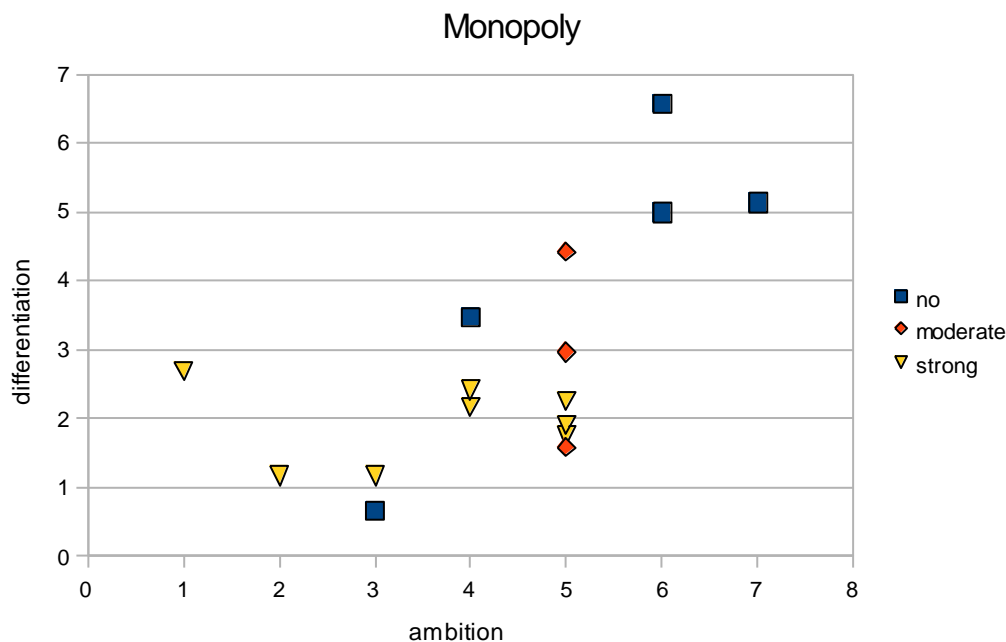


Figure 4-11 Monopoly Position of the Price Setting Actor

While we ignore the mechanism behind it, we rather observe the opposite correlation where a stronger monopoly position is linked to lower degrees of differentiation and ambition.

The hypothesis is hence not confirmed by cross case study comparison.

4.4.3 Hypotheses on the Consequences of Differentiated Prices

General hypothesis B *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.*

Specific Hypothesis

H2.1 *Effectiveness of a price measure increases with the level of differentiation, but after a certain level, the effectiveness stabilises or may even decrease. The negative counter effect is stronger for individuals (e.g. car drivers) paying the charge compared with companies (e.g. rail freight operators). And it is stronger for frequent users compared with infrequent users.*

The initial increase in effectiveness as a function of degree of differentiation is a direct result from convergence towards the first best optimal pricing schedule for which effectiveness reaches its maximum level by definition.

As we stated earlier, in order to realise a given number of (independent) objectives, one needs to differentiate prices along (at least) the same number of (independent) behavioural dimensions. This is mathematically determined. As such, the initial increase in effectiveness is dependent on the degree of ambition (i.e. the number of objectives to fulfil). For a smaller number of objectives, the initial increase will be stronger and reach the (first best determined) maximum value for effectiveness earlier than a case with a larger number of objectives.

The intuition behind the expected decrease in effectiveness is based on the various decision making costs users incur due to differentiation. This decision making cost is likely to increase as an exponential function of the differentiation level and independently from the degree of ambition.



We expect the negative counter effect to be mitigated to some extent by companies as they have more opportunities to invest in expertise with respect to dealing with a larger degree of differentiation. Frequent users at the other hand can build up experience with the scheme and are hence expected to have smaller marginal decision making costs compared to infrequent users. Although there probably is some correlation between both categorisations in that companies are likely to be more frequent users compared to individuals.

A way to test the hypothesis would be to compare degrees of ambition and differentiation to the data contained in sixteen of the factsheet which is reporting on impact of the charge. Only a limited number of cases are reported to have an impact that is not or only partially in accordance with the aims set. Of these cases, failure to meet the objectives is in some cases attributed to lobbying, which is clearly not what we are looking for here.

Considering that most cases are real world pricing schemes, it seems safe to assume that they are designed to be (close to) optimal. As we already observed in comparing the observed degree of ambition to the observed degree of differentiation, there seems to be a relationship (Figure 4-12). This relationship indicates that a given degree of ambition corresponds to an optimal level of differentiation, which is basically what the hypothesis poses.

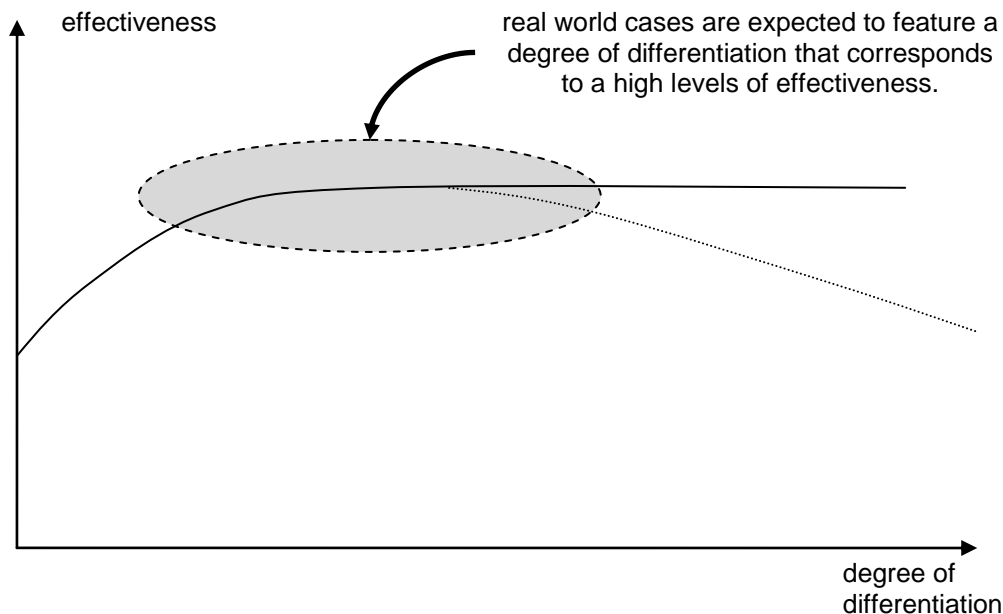


Figure 4-12 The Relationship Between Degree of Differentiation and Effectiveness

Redrawing the relationship between differentiation and ambition and limiting to the cases that are reported to have an impact in accordance with the aims set, the picture even becomes clearer (see Figure 4-13). For smaller levels of ambition the optimal level of differentiation increases with ambition. For larger levels, the increase becomes smaller, which is an indication that the decision making cost plays a role. And for a given level of ambition, the optimal level of differentiation is smaller for car drivers compared to companies.

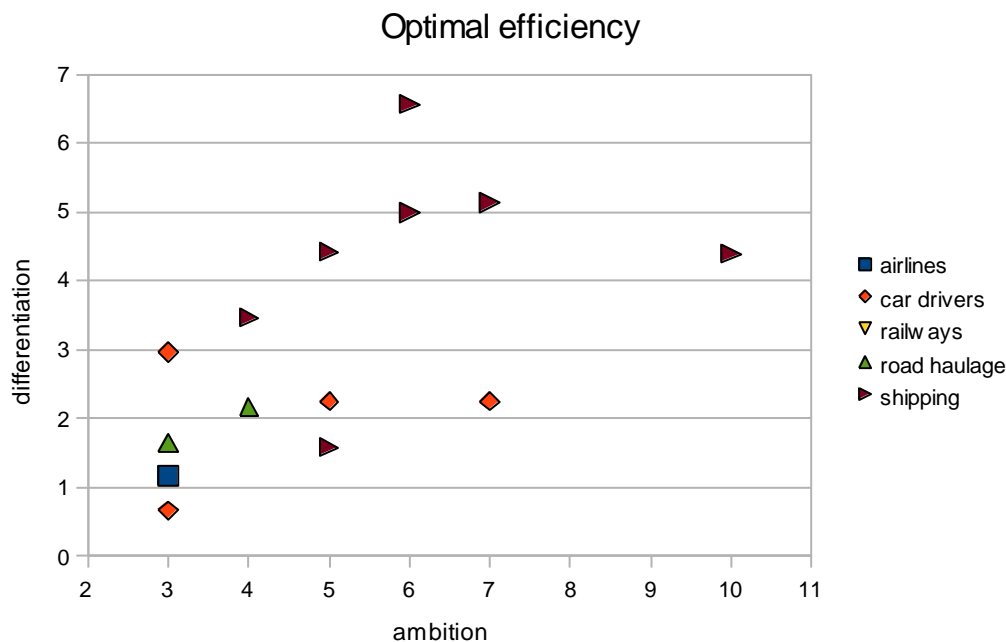


Figure 4-13 Case Studies for Which the Impact of the Charging Scheme is Reported To Be in Accordance with the Aims Set

We therefore consider the case study data to be in line with the hypothesis.

H2.2 *Exemptions to pricing schedules have an adverse effect on the effectiveness of the price measures.*

The rationale for this hypothesis is that exemptions deviate from first best pricing, hence the reduced effectiveness. Although not explicitly stated, the hypothesis does not address price measures that are designed with equity as a primary objective (but note that such a scheme can hardly be considered to be transport policy related).

Comparing the exempt user data from the factsheets (section five) to the effectiveness indicator (using section sixteen data as a proxy; see above), *we cannot identify much of a pattern in case study data*. A main cause is limited variability in both variables.

It is interesting to note here that section five of the case studies asked for the share of exempt users, but hardly any valid information was provided. A quantitative figure would make the hypothesis testing more practicable. But that is not to say that it would necessarily result in more illuminating insights. It may well be that the definition of exemptions used in the factsheets has a too limited scope: only fully exempt user categories are concerned, whereas there are cases such as the London Congestion Charge where large user categories apply for a 90% reduction. Strictly spoken these users are not exempt, but it is likely that the rationale for such a large reduction is similar to that for an exemption, and hence any hypothesis studying exemptions should address them as well. The required information on substantial reductions is however not collected by the factsheets.

H2.3 *When price differentiation takes place in a certain domain (for example time differentiated tolls), the strongest behavioural response takes place within the same domain (change in departure time). Effects in other domains tend to be smaller.*

The basic assumption behind the hypothesis is that consumers try to optimise their behaviour such that maximum utility is obtained with minimum effort. In reaction to a differentiated infrastructure price schedule, the traveller will try to mitigate the pricing impact while minimising the discomfort of behavioural adaptations.



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The hypothesis then basically states that the easiest way to adapt behavioural activity along a given dimension is primarily to change behaviour along that same dimension and minimise efforts along other dimensions.

It goes without saying that the hypothesis does not address pricing dimensions that do not correspond to behavioural domains. An example is user type differentiation: a given user will probably perceive pricing on this dimension as invariable when considering behavioural reactions.

The setting in which the hypothesis is formulated is rather artificial as compared to the reality of the case studies: most case studies carry differentiation along different dimensions and many case studies do not provide information on the relative importance of the different behavioural reactions (and neither on the ranking of the differentiation dimensions).

Moreover, the link between behavioural reactions and pricing dimensions is not always unique. Especially with respect to spatial differentiation, many pricing dimensions (place, infrastructure) are connected with many behavioural domains (routing, destination, location).

In that respect, the time-based example provided in the hypothesis may be illuminating but somehow suggest a too straightforward link between pricing and doing. Elaborating a little bit on that specific example, one could argue that from an activity based point of view, rescheduling of trip chains may be a different behavioural response that belongs to the time domain as well.

To study the link between price differentiation dimensions and behavioural responses in the case studies, we use the data provided in sections two and fourteen of the factsheet. In our analysis we link the most important differentiation dimensions to the most important user reactions. An overview is provided in Table 4-2.

**Table 4-2 Occurrence of the Most Important Differentiation Dimensions and User Reactions
Reported by the Case Study Factsheets**

Dimension of Differentiation	Behavioural Response										
	Routing	Activity	Timing	Modal	Destination	Location	Vehicle Type	Vehicle Size	Fuel Type	Load	Other
time	4	1	5	4	1	1	1	1	0	1	2
place	4	2	2	1	0	1	1	0	0	1	1
infrastructure	9	2	2	1	0	2	1	0	0	2	3
user	6	2	4	2	2	1	0	0	0	1	3
vehicle type	10	3	1	0	2	3	4	2	0	1	2
fuel type	1	0	0	0	0	0	1	0	0	0	0
vehicle size	10	1	2	2	2	3	3	2	0	0	3
load	2	0	0	1	0	0	0	0	0	0	1
activity	4	1	0	0	1	3	1	0	0	0	3
cargo	3	1	0	1	1	1	1	0	0	0	2
other	3	0	0	1	0	1	2	1	0	1	2

The most often reported reaction to time differentiation is a change in trip timing. The example provided in the hypothesis is confirmed here.

Differentiation of infrastructure prices along spatial dimensions (place, infrastructure) is mainly linked to route choice behavioural responses. Again, this is in line with the hypothesis.

Price differentiation based on vehicle technology is somewhat surprisingly linked to route choice responses. That seems somewhat pointless. This is in part explained by cases where a combination



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of vehicle technology and spatial dimensions is used for price differentiation. There are however a number of cases where route change is reported to be an important user reaction whereas no spatial differentiation dimension is reported. It is our guess that the user reaction in consideration relates to route changes of trips to infrastructure outside of the geographical area to which the differentiated pricing scheme is confined. This guess is in line with the observation that route change seems generally over-represented in the user responses reported by the case studies.

Making abstraction from the route choice issue discussed above, we observe that the second most reported user response in reaction to differentiation along vehicle technology dimensions (size, type, fuel) is choice of vehicle technology related domains. It should be noted here that the different dimensions in consideration (size, type, fuel) are heavily correlated. As such, the hypothesis seems confirmed again.

Given the earlier discussed heterogeneity between case studies as well as the caveats related to the real world setting of most cases, *we consider the case study findings to be a confirmation of the hypothesis.*

H2.4 *In the context of efficiency oriented or profit maximising price differentiation, the acceptance of pricing schemes decreases with the level of differentiation. The negative effect on acceptance is stronger in the case of public price setting agents.*

The hypothesis is meant to complement with H2.6 that addresses equity oriented policies. As such, one should understand it to address 'not equity oriented price differentiation' rather than efficiency or profit maximising schemes only.

Using the information provided in the factsheets, seven cases are concerned by the hypothesis. They reveal *no obvious relationship between acceptability and differentiation*, with or without controlling for level of ambition. Probably the subset is either too small or the cases are too heterogeneous.

H2.5 *In competitive markets the burden of differentiated transport pricing is passed on from carriers to shippers. This is often not well understood by parties involved, implying an overestimate of the cost increasing effects which hampers acceptance.*

Of the case studies that consider burden shifting (section nineteen of the factsheet), only three report on both how well the phenomenon is understood by the parties involved and acceptability by the general public (section twenty of the factsheet). This is *a too small sample for meaningful cross-case hypothesis testing.*

H2.6 *In the case of equity oriented pricing policies, the level of acceptance of pricing schemes increases with the degree of differentiation.*

Although not stated explicitly, the hypothesis assumes a constant degree of ambition.

In order to check the hypothesis against the case study information, we select the cases where equity is an objective (section three of the factsheet), that report on acceptability (section twenty) and for which a value is available for degree of differentiation and ambition. The resulting subset counts ten case studies, which we plotted in Figure 4-14.

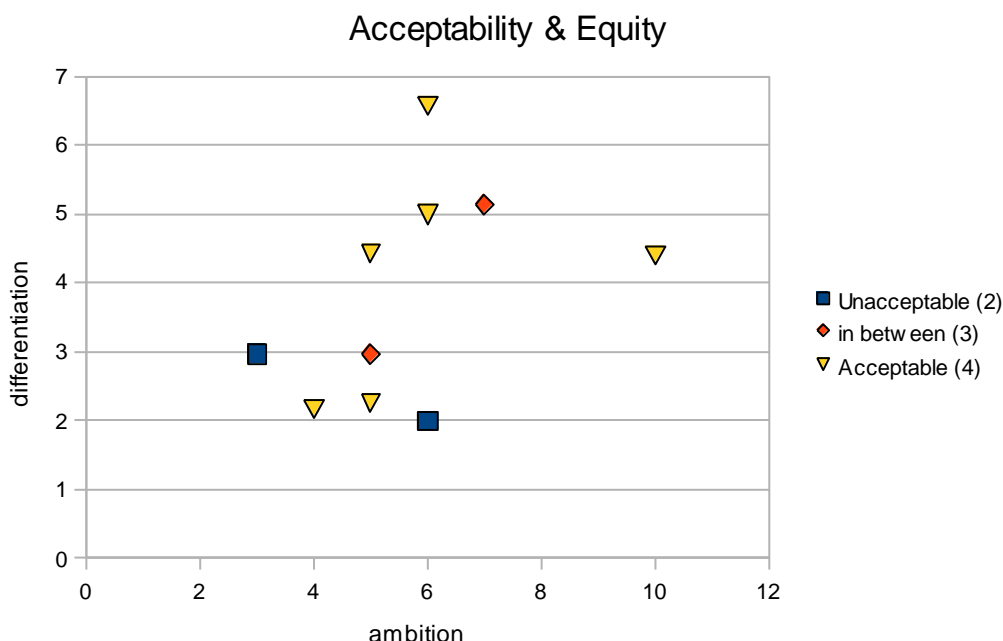


Figure 4-14 Acceptability in Cases Where Equity is an Objective (Rated on a Scale from 1 to 5, with 1 Meaning Very Unacceptable and 5 Meaning Very Acceptable)

Although not very sharp, there is an indication that the cases with a lower level of acceptability (two or three on a scale from one to five) correspond to lower levels of degree of differentiation. The higher level of acceptability (four) occurs with all levels of degree of differentiation.

Although the information used is somewhat limited in scope, it does seem to fit in with the hypothesis.

H2.7 Exemptions to pricing schedules improve their acceptability.

This hypothesis could be considered to be a special case of H2.6.

The information contained by the factsheets seems not to confirm this hypothesis. As discussed earlier, the applied definition of exemptions is probably a bit narrow provided that the hypothesis probably also concerns major reductions. On the other hand, nearly all case studies do feature exemptions so the dataset does not feature not much variance in that variable. For a more successful testing *it would be necessary to have sufficient information on the share of exempt/reduced users as independent variable.*

4.4.4 Concluding Remarks

Based on the theoretical framework presented in chapter 2, two general hypotheses were formulated. In a subsequent step this led to specific hypotheses. In our analysis we first discuss the hypotheses and how they should be understood in the setting of our cross-case approach. Special attention is paid on how to control for heterogeneity and more specifically where our indicator for degree of ambition enters the story. Subsequently we test the hypotheses using the case study information collected through the factsheets.

A first general hypothesis describes the factors that inspire price setting actors in adopting a degree of differentiation. These factors include demand parameters, cost structures and the aims of the actors. A number of specific hypotheses were formulated to operationalise this relationship. In our analysis we could confirm only a limited number of the specific hypotheses, whereas for the other hypotheses no clear picture was obtained or in one case even the reverse was revealed.

The summary of the case studies already revealed a first relationship where we found that the degree of differentiation is positively correlated with the degree of ambition (section 4.2.1).



A first series of specific hypotheses focuses on the role of aims of price setting agents. H1.1 was confirmed for private car cases in our analysis. It states that the higher the weight that price setting actors attach to equity considerations, the more they will be inclined to apply price differentiation where customers that would deserve support from an equity perspective will be confronted with low charges compared with other customers. For other cases (where companies pay the charge), it was found that equity motivation might be a disguise for protectionist tendencies. Also for H1.4, which states that profit maximising monopolists will use price differentiation on willingness to pay in various sub-markets, a weak indication was found in the cross-case analysis.

The subsequent specific hypotheses address the role of cost structures in price setting. Here we found confirmation for H1.5 in the cross-case analysis. The hypothesis states that when the costs of price differentiated charging mechanisms are high for the price setting agents, they will choose for a lower degree of price differentiation as a second best strategy.

The specific hypotheses on the role of the demand side proved difficult to test due to limited (generic) quantitative data availability.

A second general hypothesis relates degree of differentiation to user responses. The user's travel behaviour (modal choice, trip generation, temporal choice) in turn results in changes in transport flows, the efficiency of pricing measures and the level of acceptance of the measures. The outcome of our analysis is clearer here. For three out of seven specific hypotheses we could identify the relationship described in our data set, especially where we relate effectiveness to (optimal) degree of differentiation as well as how user reactions are related to dimensions along which price differentiation occurs.

A first specific hypothesis confirmed in our cross-case analysis is H2.1 that discusses the relationship between degree of differentiation and effectiveness. From a theoretical point of view, a highly differentiated scheme is optimal, whereas in real world effectiveness is likely to reduce beyond a certain degree of differentiation due to decision making costs. Our selection of successful case studies further reveals that the resulting optimal efficiency is smaller for private car pricing schemes as well as for schemes with a smaller degree of ambition (number of aims set).

Subsequently we found confirmation in our case study data set for specific hypothesis H2.3. This hypothesis links the dimensions of price differentiation to the dimensions of behavioural response. As stated by the hypothesis, case study data reveal that when price differentiation takes place in a certain domain, the most important behavioural response takes place within a corresponding domain. There is however a caveat here: provided that any pricing scheme applies to a geographical confined area, there is always a spatial dimension involved. Hence (some) users are likely to adapt their behaviour along a spatial dimension, e.g. reroute their trip in order to avoid the pricing scheme.

Finally, our analysis found case study data to be in line with specific hypothesis H2.6. This hypothesis states that in the case of equity oriented pricing policies, the level of acceptance of pricing schemes increases with the degree of differentiation.

For the remaining specific hypotheses either sufficient data was lacking or difficulties in measuring were identified. With respect to the latter we note here that the theoretical concept of exemptions is somewhat difficult to capture in real world schemes, where large reductions sometimes are a substitute for exemptions. Moreover, real world schemes without exemptions seem to be uncommon, making it difficult to test for the impact of exemptions in our cross case analysis.

The hypotheses presented are based on the theoretical framework presented in chapter 2 and are rather plausible with respect to within case variation in differentiation. However, a cross comparison of wildly customised cases is less straightforward. Not only come cases in a myriad of flavours, each one with its own quirks and particularities, making any subset of real world cases to be a showcase of heterogeneity rather than a laboratory for hypothesis testing. But even if we leave aside cosmetic issues and focus on the essentials, there seem to be a number of key variables that are difficult to control for in our setting of hypothesis testing, not in the least because they are difficult to capture in a generic way.



In our analysis we tried to accommodate for these concerns by defining an indicator that captures degree of ambition of a differentiation policy. Our approach proved successful for a number of hypotheses, but failed to reveal meaningful insights for others. It is unclear in how far the latter can be attributed to misspecification of our indicators, absence of key variables in our analysis or more generally our dataset being too limited in size (or quality).

4.5 POSITIVE ECONOMICS HYPOTHESES

4.5.1 Derivation of Hypotheses

The theoretical work in WP 2 and WP 3 (see Del. 3.1/ Del. 2.1) resulted in a set of detailed hypotheses with respect to the positive theory of infrastructure charges. These hypotheses proved in Del. 3.2 to be too specific and fine differentiated and therefore very difficult to be tested. With the existing data material from the factsheets it was impossible to test such specific hypotheses. Therefore in order to generate simplicity and enable testing we reformulated the hypotheses into four major ones (see Del. 3.2). According to the above analysis we formulate two basic axioms of the positive theory of infrastructure charges.

Basic axiom 1 *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.*

Basic axiom 2 *Policy makers will react to lobbying influences and implement a kind of SIG equilibrium (like in the Stigler-Peltzman model or the Grossman/Helpman model described above). Infrastructure charges which correspond to such equilibrium may be termed “politically acceptable”. In most cases this rules out tariff-structures, which increase the welfare (as compared to the status quo ante) of only one SIG even if total welfare effects should be positive.*

From these axioms we can subsequently derive the following hypotheses:

H1 *The structure of infrastructure charges always reflects the political power of Special Interest Groups (SIGs). A regulatory charging system will only conform to normative pricing principles if this charging system also corresponds to a political SIG-Equilibrium.*

H2 *More differentiation makes it easier to reach a SIG-Equilibrium. Therefore, in a tariff setting process with many SIGs, tariffs will tend to become more differentiated (notwithstanding that one or another SIG will lose from the tariff structure).*

- a. *If the implemented pricing scheme is on the basis of marginal costs then attempts at tariff manipulation will take the form of increasing the number of the cost categories that enter into the calculation of the charging system. The observable degree of differentiation with respect to different cost categories will depend on two factors: the question in how far total lobbying expenses for a particular group increase or decrease, and the voting power of the concerned SIGs. The more powerful group will succeed in implementing the charging system that minimizes its own expenses.*
- b. *If non-linear pricing is implemented, and if there are many SIGs, then both, the fixed and the variable component of the tariff will tend to become more differentiated.*

H3 *Different proposed pricing rules lead to different behaviour of SIGs:*

- a. *An implementation of non-linear pricing will induce the SIGs representing the users of the infrastructure to lobby for a lower fixed component of the tariff and a higher variable component. In doing so, they can shift a larger burden of the capacity risk on the infrastructure owners. The infrastructure owners will do the opposite.*
- b. *Ramsey pricing leads to attempts to manipulate information on elasticities and to bring real or apparent externalities into play. In some cases this may even lead to inverse Ramsey pricing.*



- c. Taking SIG influence into account, fully distributed cost pricing methods will cause comparatively less welfare distortions than other pricing schemes (see Laffont 2000).
- d. If peak load pricing is the intended pricing-policy then SIGs representing the peak-users concentrate their activities on shifting capacity costs to marginal costs (e.g. by producing corresponding studies etc). The SIGs representing off-peak users will do the opposite.

4.5.2 Summary of the Relevant Information

Within a first step it is intended to acquire first impressions on whether lobbying is a relevant factor on pricing issues or not. Therefore, the information needed, corresponded to the answer of the following questions:

- Are lobby activities within the effective pricing framework (of the case study concerned) recognisable?
- Does the implemented pricing measure achieve political acceptance (by all important participating actors)? Politically accepted charges mean in economic theory that no participating actor has an incentive to intervene in order to change the tariff structure. Exactly this situation is described as a Nash-equilibrium.

At a further step the findings could be linked with the pricing scheme concerned and become a sufficient indicator on the topic of SIG activity when a certain pricing scheme is implemented.

To begin with it is clearly recognisable that the political dimension plays a decisive role when implementing charges for the use of infrastructure services. Figure 4-15 depicts this situation very clearly. In 87 percent of all case studies the political factor is recognised as a crucial constraint in pricing issues.

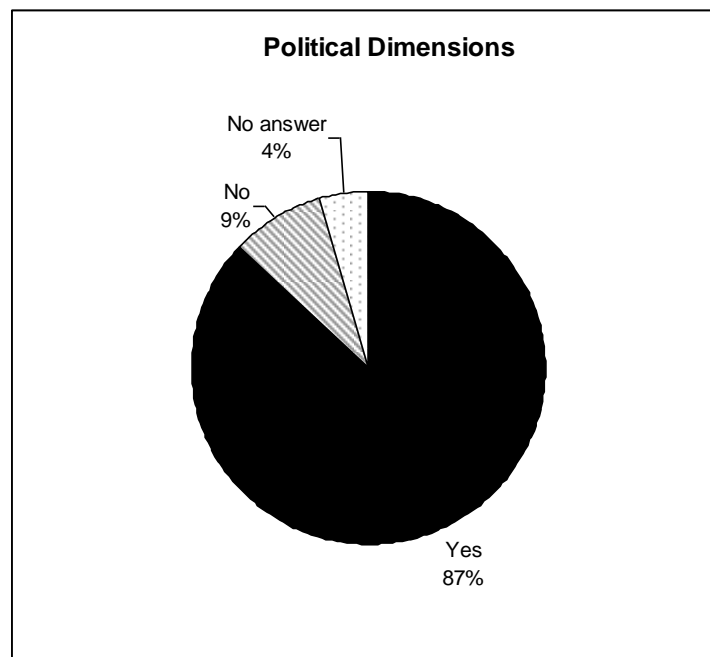


Figure 4-15 Existence of Political Dimensions

The findings in Figure 4-15 confirm the already assumed high relevance of the political constraint when scheduling pricing schemes. However, the political dimension does not play in all case studies a key role. The port of Valencia for instance (a port with a relative high degree of differentiation) is subjected to governmental regulation. However, the charge is not completely regulated in order to enhance competition with other ports and in further terms in order to promote efficiency. Therefore the political factor does not play a key role for the port of Valencia. In general, the case studies show what



should be expected. The higher the degree of regulation, the higher is the importance of the political dimension.

The range of the political dimensions covers all transport modes and all countries. Making a closer examination of all case studies, there is only one case in which there is clearly no political dimension at all, namely the Spitsmijden experiment, which however is only desk research and therefore cannot recognize any political dimensions at all. The very big share of case studies indicating political dimensions therefore conforms with Basic Axiom 1.

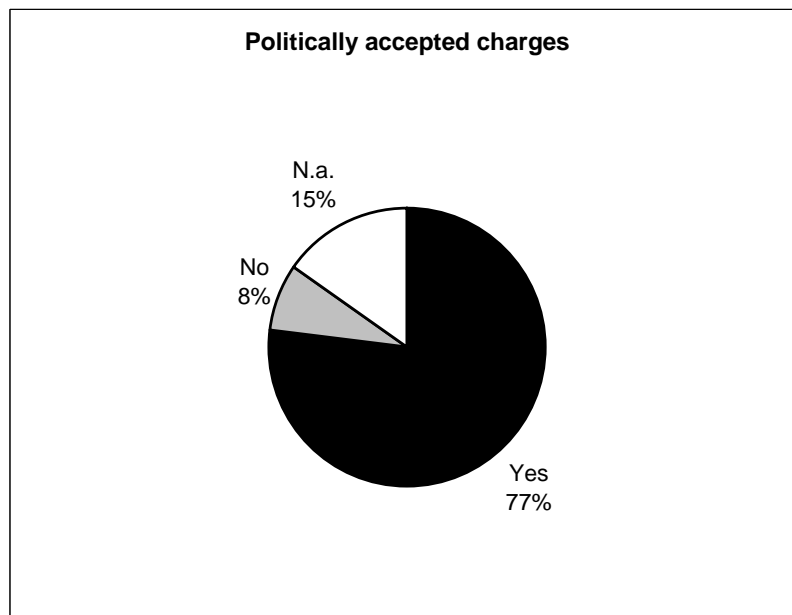


Figure 4-16 Politically Accepted Charges

Turning to acceptability issues it is very important to deal with political acceptability in order to have first hints whether the implemented charging practice is accepted by the major Special Interest Groups or not. Figure 4-16 reveals major similarities with Figure 4-15.

It is clearly observable in the factsheets that politically accepted charges can be found in all transport modes. Even though lobby activity does not lead to politically accepted charges in every single case study, it can be safely stated that lobby activity in most cases achieves political compromises and therefore results in politically accepted charges. This is the first hint indicating that charges can be manipulated by certain Special Interest Groups in order to enhance the welfare of their members. Additionally both figures are very serious indicators to confirm *Basic Axiom 2*. In order to make this clearer, there is a majority of cases indicating the relevance of the political dimension on infrastructure charging. At the same time a vast majority detects politically accepted charges, which means fewer complaints and therefore less lobby activities. A highly relevant political dimension and at the same time less lobby activities imply an SIG equilibrium as a policy outcome.

4.5.3 Further Information from the Factsheets

So far we have recognised that first, political factors play an important role in infrastructure pricing issues and second, implemented tariff structures are politically accepted. We now move to further fields of information from factsheets. In particular, in this subsection we will address lobby activities as an explanatory variable of the implemented tariff structure.

We start our analysis with the effectiveness of the pricing scheme. The respective answers at first glance do not seem to fit with the rest of the answers (see Figure 4-17).

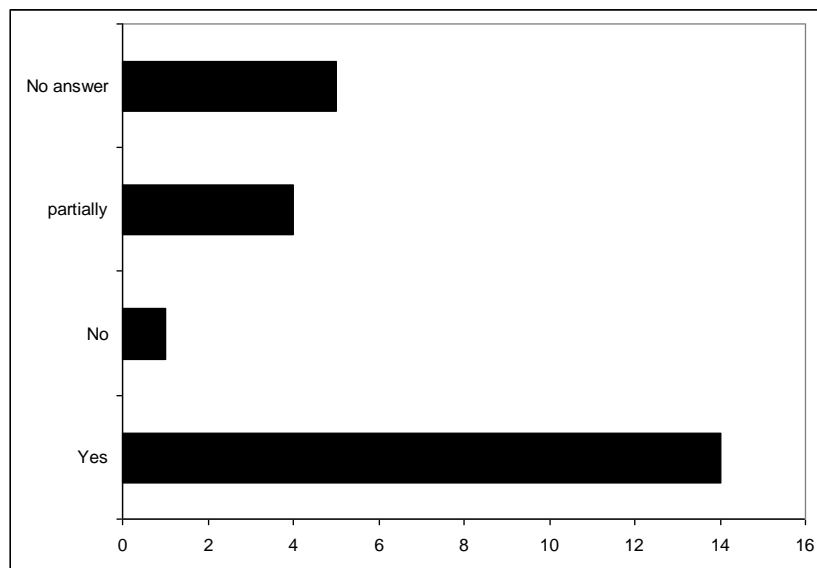


Figure 4-17 Effectiveness of the Pricing Scheme

To begin with, the share of the case studies which gave no answer to this question is comparatively high. This is partly connected with the nature of the analysis. Some case studies deal just with the calculation of elasticities and therefore are not in the position to provide further “real world” details. In addition, the majority of the case studies (14 in number) stated that the effects of the price structure are in accordance with the aims set. At the same time the majority of the case studies gave efficiency to be the main objective. Combined with the fact that in the majority of the cases lobbying was recognisable, the results depicted in Figure 4-18 seem to be characterised by inconsistency, since lobbying causes in many cases welfare losses¹¹ and therefore the aim of efficiency can not be fully attained.

Taking a deeper look at this issue we focus on the cases of no or partial aim achievement of infrastructure charging and search for the possible reasons. Here lobbying was the major reason (see Figure 4-18). Figure 4-18 shows clearly that if a pricing reform fails (in terms of generating additional welfare), then the most responsible factor is lobbying.

¹¹ In general lobbying causes welfare losses. However, there are specific cases in which the intervention of SIGs could lead to an increase of welfare (see Grossman/ Helpman, 2001).

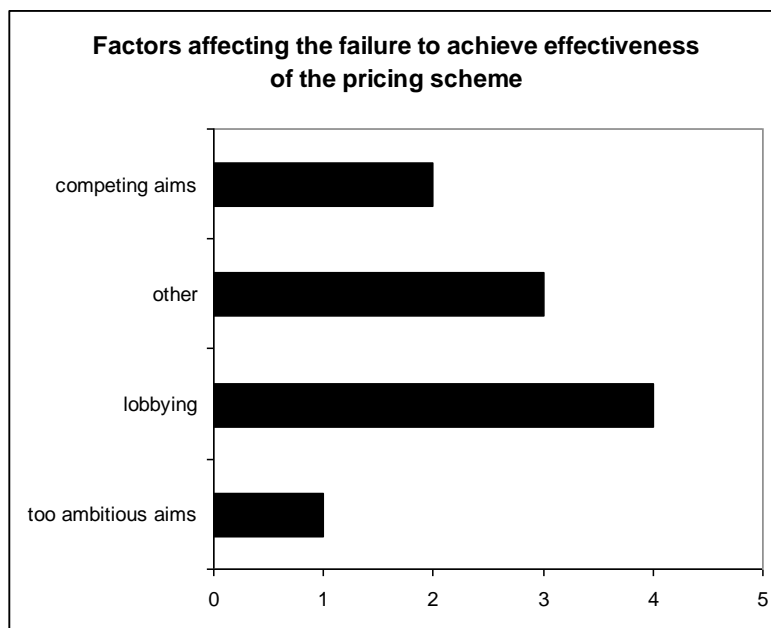


Figure 4-18 Factors Affecting the Failure to Achieve Effectiveness of the Pricing Scheme

Further, in the majority of the cases lobbying is clearly recognisable (see Figure 4-19).

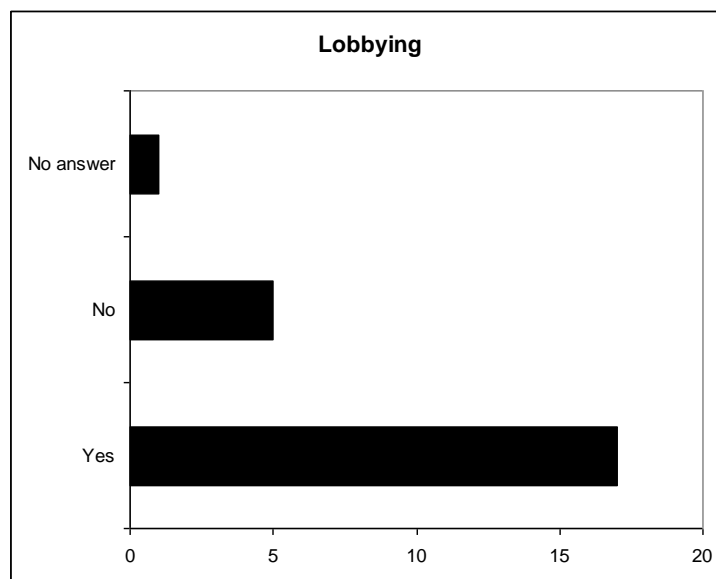


Figure 4-19 Lobbying Activities

In Figure 4-19 there are just five cases in which lobby activities play a minor role. Due to the nature of the analysis (modelling work) most of them do not consider lobbying. The only exemption in this respect is the port of Duisburg. However, factsheet information, such as differentiation according to the type of user within the environment of a two- (or multi-) part tariff and at the same time political acceptable prices, indicates that lobby activities could be an issue. Therefore, Figure 4-19 depicts only the lower limit of lobby activities. The real dimension of SIG influence is expected to be higher. Lobby activities are recognisable in all transport modes and EU countries analysed. This phenomenon is especially noticed in almost all case studies regarding ports. Here there may be a direct link to the tariff structure, since almost all ports charge on the basis of two- (or multi-) part tariffs. A multipart tariff with differentiation elements according to the type of user seems to fit exactly to the interests of users (e.g. shippers).



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Given that political influence is important in setting infrastructure tariffs, it is also important to take a closer look at the type of actors who benefit from the price structure.

Figure 4-20 shows clearly that in most cases the main beneficiary parties are the users of infrastructure services.

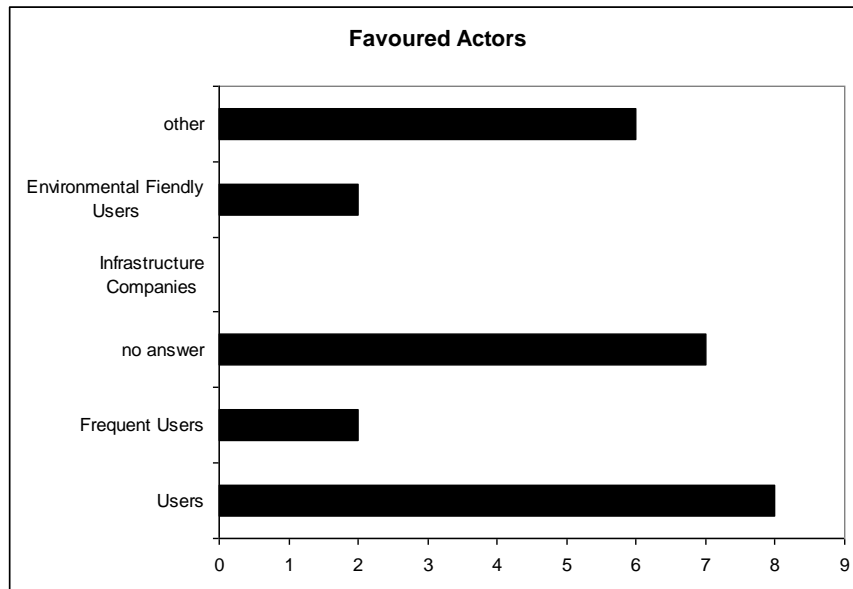


Figure 4-20 Favoured Actors of the Price Structure

The lion's share here goes to the users of infrastructure services. This comes as no surprise, since in almost all European countries users of infrastructure have well formed and well organized interest groups. For instance car drivers are organised in automobile clubs which do not only provide technical assistance but also get involved with issues of transport policy. Their voting power seems to be very high due to campaigns and printed media. Commuters seem also to profit in this constellation due to their frequent driving. Besides, particular shippers (mostly oil-industry involved) are favoured from the price structure as well. Shippers managed to form small but very effective interest groups and therefore they are in the position to keep the free rider problem under control which means that shippers have incentives to contribute in financial terms to their lobby group. With respect to the rest of the cases it has to be stated that they are depending on the type of infrastructure analysed. Airport charges for instance are relevant for airlines and tour operators (as the major users). An interesting finding here is that infrastructure companies do not seem to be able to establish their favoured tariff structure. This is only partly understandable, because infrastructure companies are in the most cases public or semi-public companies. For the future, as the degree of privatisation increases, it is expected that infrastructure companies can also be the winners of the setting process of the tariff structure.

In order to analyse this issue deeper we proceed with the (political) power of the benefiting groups (see Figure 4-21).

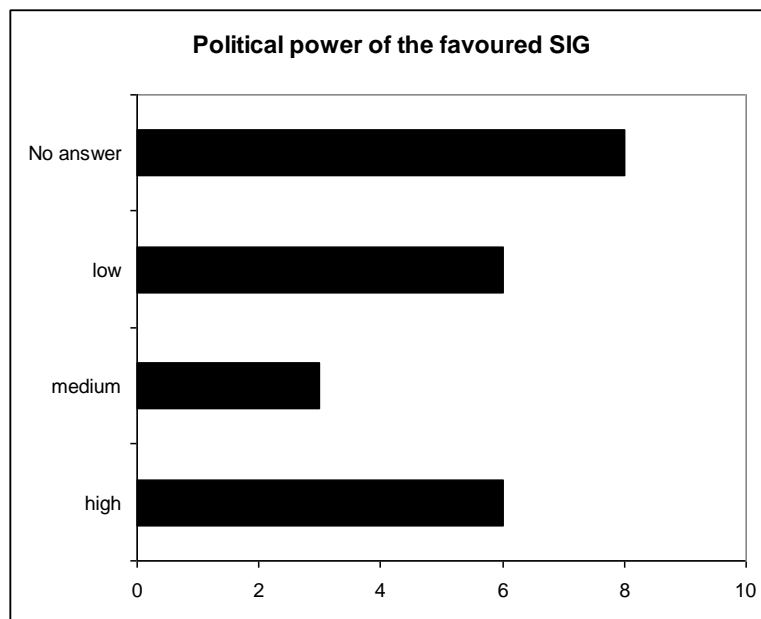


Figure 4-21 Political Power of the Benefiting SIG

In Figure 4-21 the large number of the case studies which did not respond to that question shows the difficulty of the problem. It is very difficult to deal with the issue of measuring political power. In some cases there are certain indications if for instance decisions are taken permanently in favour of a certain SIG. Only in a minority of cases it is possible to measure welfare losses and therefore to reveal political distortions.

Additionally, the reasons for the interference in the political process for the sake of a certain price structure can be not safely recognized. The most likely reason could be the shift of financial burden to other users.

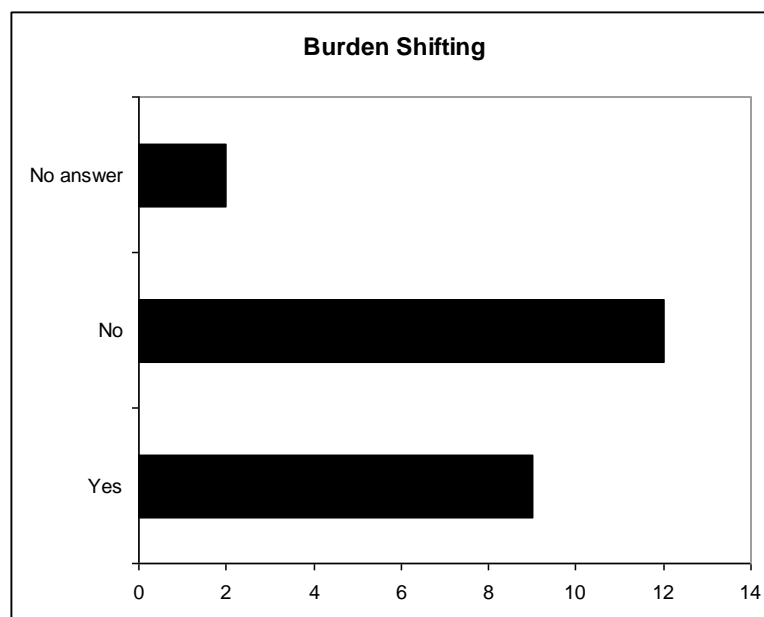


Figure 4-22 Burden Shifting

Figure 4-22 shows that in nine case studies such a shift is recognizable. However, there are serious doubts whether this is true in all cases where lobby occurs. The reason is that lobby activities can result (as already described) in lobby reactions by other SIGs and therefore in an equilibrium which leads to more price differentiation but not to shift of financial burden.



As a conclusion in this subsection, we subsume that lobby activities play a key role when designing tariff structures. In almost all cases users of infrastructure facilities are favoured by the tariff structure.

4.5.4 Advanced Information from the Factsheets: Lobby Activities and Price Differentiation

In this subsection we first deal with the degree of differentiation as already described above. Figure 4-23 links the degree of differentiation with lobby activities. The trend in Figure 4-23 is clear. The degree of differentiation increases when lobby activities take place. When, however, the degree of differentiation has a value of around 1.5 to 3.0 both situations (with and without lobby activities) are conceivable. Hence due to this “grey” area we can not safely conclude that the degree of differentiation increases with increasing lobbying activity. It is apparent that also other factors, such as voting power of the participating SIGs, play a key role.

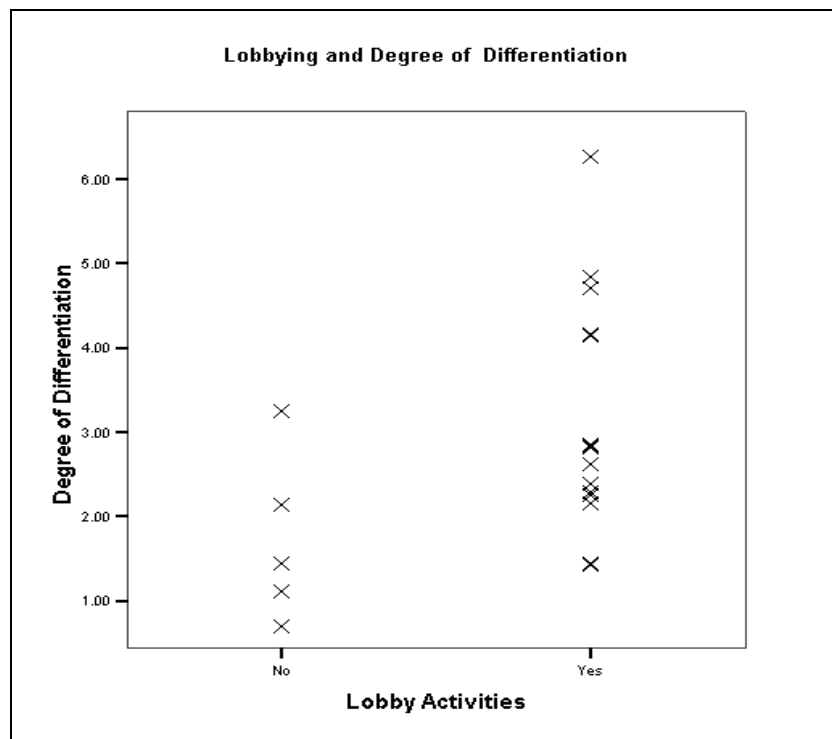


Figure 4-23 Lobbying and Degree of Differentiation

As a result from Figure 4-23 we state that Hypothesis H2 can not be rejected. We however have not enough evidence in order to confirm it. This can only be done after studying political power and the degree of differentiation.

To do this we plot the degree of differentiation against the three possible levels of political power (see Figure 4-24).

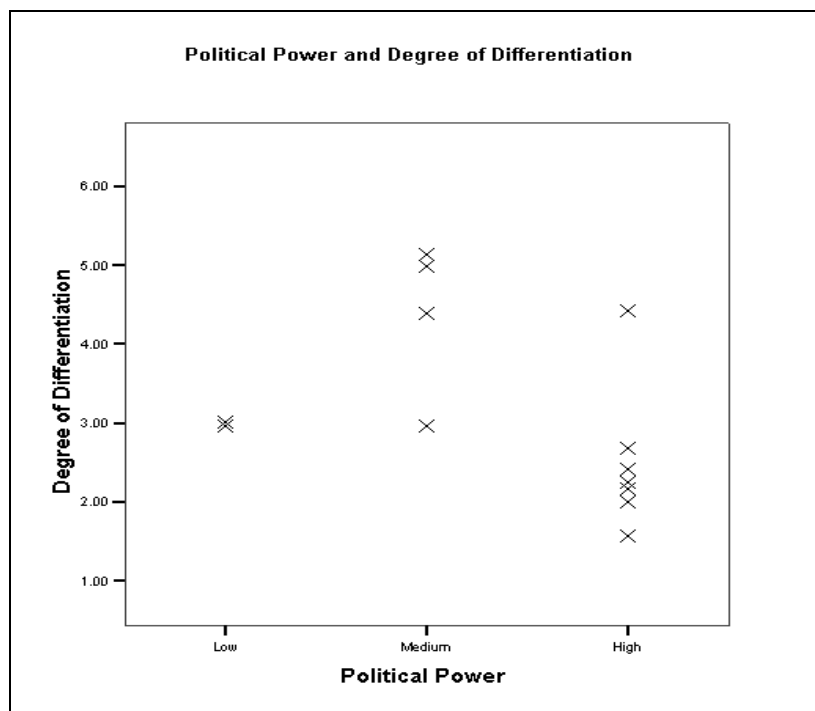


Figure 4-24 Political Power and Degree of Differentiation

In Figure 4-24 three possibilities are recognisable:

- The low number of cases (two cases) with low political power of the respective SIG does not allow to draw safe conclusions.
- If political power of the dominant SIG is high, then the degree of differentiation tends to decrease. This can happen because only one SIG will prevail at the end and hence the finally implemented charge will reflect the needs of the members of this particular SIG.
- If political power is medium, then it can be safely stated that more than one SIG is active. In this case decision makers will take into account the utility of (at least) the most powerful ones. Thus, the degree of differentiation tends to be higher than in all other cases.

At this point we must underline that while tendencies seem to be clear when political power is high, there are only few case studies indicating a medium political power. However, drawing both results together, we conclude that there is evidence for confirming H1 and H2.

We proceed with the real tariff manipulation in each case study. In a further step we will then try to link these findings to the tariff structure. It is essential for this analysis to examine in which direction the tariff structure evolved, taking into account the influence of special interest groups. Therefore, the following manipulation possibilities (as described above) have been taken into account in the factsheet:

- More differentiation;
- Less differentiation;
- Change of proportions between the fixed and the variable components of the charge (for two- or multipart tariffs);
- Shift of capacity costs to marginal costs and vice versa;
- Manipulation of the cost calculation method;
- Other.

Figure 4-25 depicts the situation, where a single SIG can effectively exert influence on tariff structure. It is clearly observable that SIGs will focus their activities on changing the degree of differentiation. In



what direction the degree of differentiation will move depends upon the position of interest of the dominating SIG. Regarding the rest of possibilities to manipulate a tariff structure it must be stated that the lack of additional case studies does not allow to derive reliable results. Each of the mentioned manipulation possibilities appears only once within the range of the case studies. Therefore, this is an issue which needs further data and further research.

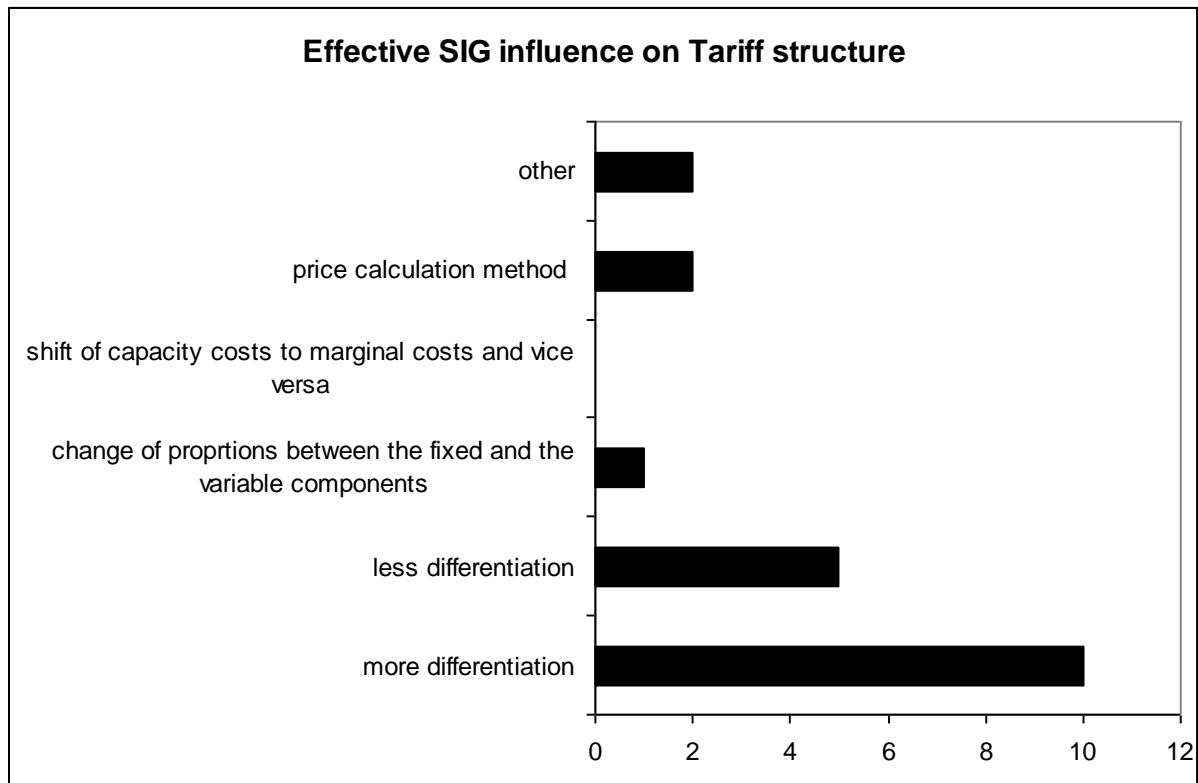


Figure 4-25 Effective SIG Influence on Tariff Structure

First, it has to be stated that almost all case studies analysed turned out to comprise more than one element of pricing rules. Most ports for instance levy cost based charges and differentiate them according to the transport volume (multipart tariff), but sometimes also according to time (peak load pricing element). Therefore, a clear pricing rule in the sense of the economic theory does not exist in practice. This enables on the one side SIGs to influence the tariff structure easier than initially expected, but on the other side it makes the whole pricing landscape more opaque.

Regarding the tariff structure the major findings can be categorised as follows:

- **Two- or multipart tariff:** in four cases the interference of SIGs led to a higher degree of differentiation. This was mostly the case in the port sector. Here shippers managed to impose a more differentiated tariff. Thus, there is some evidence for confirming H2 b at first glance. However, the intervention of SIGs in airport sector led to a less differentiated charge. Therefore, we conclude that if the pricing principle is a two part tariff, then it depends on the transport mode, in which direction the charge will evolve. From this perspective H2 b must be rejected.
- In three cases complex charges resulted in **uniform charges with a certain degree of differentiation**. Two of them come from the aviation sector. The reason here is that airlines oppose strongly peak load pricing as an element of differentiation.
- **Cost based pricing:** In three cases SIGs managed to impose a less differentiated (as compared to the status quo ante) cost based charge. In eight other cases the charge became more differentiated. This was the case in almost all ports (four case studies).
- **Fully Distributed Costs:** In two cases the implementation of fully distributed costs led to a more differentiated charge.
- **No clear pricing principle.** One case study identified directly no clear pricing principle.



Let us take up the question of variabilisation next. Variabilisation refers to the case of a two-part tariff. It means that the variable component of the charge increases and the fixed component decreases respectively. Within the factsheets there was just one case in which the influence of SIGs resulted in a more variable charge. This case refers to Hamburg Airport. Variabilisation seems to be an important issue for airports. At the moment there is some evidence for a variabilisation of taking off and landing fees in Europe (see Rolshausen, 2008). For this reason only an inclusion of all European Airports could provide safe results on this topic. The respective hypothesis can be therefore neither confirmed nor rejected.

Next to the variabilisation issue we consider Ramsey pricing. The implementation of Ramsey pricing in the case of the French Railways led to a finely differentiated charge. In addition, there is little indication of inverse Ramsey-pricing. This does not mean, however, that inverse Ramsey-pricing does not occur. In several charging schemes there are exemptions for certain user groups (e.g. handicapped users, military, new city pairs in air transport, etc.). This could be a case of inverse Ramsey pricing, which is therefore not always directly recognisable. In particular, the Edinburgh city tolling system reported ten categories of exemptions of user groups and at the same time lobby activities on behalf of the residents in the outer suburbs, a fact which finally led to a more differentiated charge. It seems that the finally implemented charging structure could be strongly connected with an inverse Ramsey pricing scheme. Similarly in the Trondheim road charge case study inverse Ramsey pricing is clearly recognizable. In this case tag holders are evidently favoured from pricing scheme. Nonetheless, inverse Ramsey-pricing often correlates with the equity constraint and therefore the identification of lobbying activities in this case is much more complex than in the rest of the cases. Both cases show that inverse Ramsey pricing can be an issue when city tolling systems are to be implemented. Policy makers could use inverse Ramsey pricing in order to achieve acceptability of the toll. As a result the respective hypothesis can neither be confirmed nor rejected.

In addition, no case study deals with peak load pricing in reality. The airports of Gran Canaria and Ljubljana as well as the Spitsmijden experiment consider in this respect peak load pricing. However, there are no hints, how SIGs will react, if peak load pricing is proposed. Additionally, some other case studies include elements of peak pricing (e.g. the London tolling system). In these cases no lobby activity towards a shift of capacity costs to marginal costs was reported.

4.5.5 Concluding Remarks

Within this part of our analysis we have found out that the political issues are important when considering infrastructure pricing. In addition, lobby activities explain the degree of differentiation in a majority of the case studies. SIGs are not only interested in imposing a certain regulatory regime but also in the tariff structure. Depending on the distribution of the political power price differentiation was in many cases a useful device for SIGs in order to enhance the welfare of their members. In most of the cases where lobbying occurs the profiting actors are user groups.

Taking into account all findings analysed above, we can conclude, that there are certain indications for accepting **basic axiom 1**: *“The setting of Infrastructure-tariff 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 **basic axiom 2**: *“Policy makers will react to lobbying influences and implement a kind of SIG equilibrium (like in the Stigler-Peltzman model or the Grossman/Helpman model described above). Infrastructure charges which correspond to such equilibrium may be termed “politically acceptable”. In most cases this rules out tariff-structures, which increase the welfare (as compared to the status quo ante) of only one SIG even if total welfare effects should be positive”*.

In general the tariff structure reflects the political power situation of SIGs. If the political power is shared among more SIGs then the result will be a “compromise” and the degree of differentiation will increase. If there is only one powerful SIG then the degree of differentiation will decrease. We therefore conclude that **H1**: *“The structure of infrastructure charges always reflects the political power of Special Interest Groups (SIGs). A regulatory charging system will only conform to normative pricing principles if this charging system also corresponds to a political SIG-Equilibrium”* and **H2**: *“More differentiation makes it easier to reach a SIG-Equilibrium. Therefore, in a tariff setting process with many SIGs, tariffs will tend to become more differentiated”* can not be rejected.



In addition it is likely, that applying a two part tariff or an optional tariff will tempt SIGs to impose more or less differentiation. This differs from mode to mode. Therefore, **H2b**: *“If non-linear pricing is implemented, and if there are many SIGs, then both, the fixed and the variable component of the tariff will tend to become more differentiated”* must be rejected.

With respect to the degree of variability of the charge (hypothesis **H3a**) the analysis made above showed that it can not be accepted for all transport modes. This hypothesis can only play a role in air transport.

Likewise hypothesis **H3b** (Ramsey Pricing) can not be totally rejected. As already analysed, SIGs will try to influence the degree of differentiation. Its direction however (more or less differentiation) will depend upon the interests of the politically dominant SIG. In city tolling systems Ramsey pricing may turn to inverse Ramsey pricing. Therefore this hypothesis can not be rejected.

Next to Ramsey pricing we found little evidence that fully distributed costs (hypothesis **H3c**) will cause comparatively less welfare distortions. Lobby activities led by cost based pricing schemes in most cases to a more differentiated charge. Since a more differentiated charge can lead to welfare gains it impossible to conclude safely, that these possible welfare gains are higher than the due to lobbying possible welfare losses.

Finally, we found no evidences on SIG activity, if peak load pricing is considered (hypothesis **H3d**). Therefore this hypothesis can neither be confirmed nor rejected.



5 CONCLUSIONS

In this deliverable we discussed the economic background of infrastructure user price differentiation. The theoretical framework was developed along two branches. A first branch is the normative approach which describes how price differentiation is affected by cost structures, policy objectives and demand aspects. The second branch is the positive approach which elaborates on the impact of policy makers and interest groups (SIGs) on the differentiated price structures. Based on the theoretical framework, a number of hypotheses with respect to price differentiation are formulated.

The DIFFERENT project conducted a number of case studies on infrastructure price differentiation in different markets. In order to allow for a cross-case testing of the hypotheses, we developed a factsheet in order to collect the necessary information from the case studies.

The information collected reveals that the majority of the case studies concern non-experimental real world schemes. There is a high degree of heterogeneity among the different cases which are customised in a large number of variables to meet local settings. In order to allow for a cross-case analysis, the need arises to control for this heterogeneity. One way to do this is by defining an indicator for degree of ambition as we demonstrated. However, this only captures part of the heterogeneity.

The case studies cover a large spectrum of price differentiation degrees. For our cross-case analysis we defined a generic measure for degree of differentiation. This indicator proved to perform quite well in testing hypotheses that address a broad range of issues.

The main findings of the normative approach include:

- The theoretic framework describes how pricing schemes and their degree of variability is determined by the actors involved, their aims, general demand parameters as well as cost structures. The relevant aims of the price setting agents include considerations regarding equity, efficiency, cost recovery objectives and in the case of a monopolist the aim of profit maximisation. The main aspects of the cost structure impacting the pricing scheme are the presence of increasing returns to scale as well as the implementation cost. Properties of the demand side affecting the differentiated price structure include variation in willingness to pay as well as the degree of competitiveness of the market.
- A cross-case analysis of the case study data with respect to the behaviour of the price setting actor revealed that there is a positive relation between the number of aims set and the degree of differentiation. Furthermore, the data show how profit maximising monopolist 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. When the implementation mechanism is a barrier, price setting actors tend to adopt a less differentiated scheme as a second best strategy. However, not much confirmation was found in the cross-case study analysis when testing the hypotheses with respect to the behaviour of the price setting actor. There probably is too much heterogeneity across the cases which we could not control for, or alternatively the size of the dataset was too limited (which in part may be caused by the heterogeneity itself).
- The theoretical framework further elaborates on how user responses in terms of travel behaviour depend on the degree of differentiation. From a theoretical point of view, a highly differentiated price scheme is optimal. However, real world effectiveness is likely to reduce beyond a certain degree of differentiation as a result of decision making costs. User reactions can be expected to be the strongest in the domain of the price differentiation. Elasticities can provide an indication of the effectiveness of a policy measure. It is however important to stress that the elasticity of some measure does not exist: elasticities of travel demand depend very much on the context.
- The theoretical statement with respect to effectiveness (see above) implies that there is an optimal level for price differentiation. Cross-case analysis reveals that this optimal level is lower for cases with a smaller degree of ambition, and it is lower as well for schemes (mainly) targeting private car drivers. Furthermore it was confirmed that users mainly react along dimensions that correspond to the pricing differentiation, be it that behaviour along spatial dimensions is generally present as a result of geographical limitations of the pricing scheme. However, we failed to



successfully test hypotheses that describe the role of exemptions in differentiated schemes. Exemptions seem to be everywhere in real world cases. It became clear that reductions are sometimes substituted for exemptions. Moreover, not much is known about share of exempt/reduced users in most cases.

- Literature presents strong modelling frameworks to assess welfare impact. This modelling research has mainly focused on congestion and environmental impact of transport activity. It shows how congestion can be alleviated using pricing schemes that are differentiated mainly along spatial and temporal dimensions. Even schemes that carry a low degree of differentiation allow for a substantial welfare gain. Research focusing on the environmental externality reveals that it is of a much smaller order of magnitude compared to congestion. Furthermore, a lot of behavioural dimensions play a role, of which car type and spatial aspects seem to be the most important. For CO₂, abatement costs are likely to be at a prohibitive level to allow for any welfare gain as a result of an emission reduction in the (road) transport market.

The main findings of the positive approach include:

- Theory describes how policy makers maximise their personal utility but at the same time takes into account normative elements such a general welfare; SIGs will try to influence the political process in order to maximise welfare of their members.
- Case study analysis indicate that the two basic axioms are confirmed; in general lobby activities are a major explanatory variable for the tariff structure. In addition, political acceptability of a certain pricing scheme can only be achieved, if the most powerful SIGs do not object to it.
- The tariff structure reflects the political power of SIGs; the more equal the distribution of political power among SIGs, the more likely is that additional price differentiations will occur.
- Different pricing schemes result in different manipulation possibilities by SIGs. These possibilities have however different relevance for different transport modes. Qualitative analysis showed that variabilisation is a major issue in air transport, whereas inverse Ramsey pricing is likely to play a role in city tolling systems and a more differentiated two part tariff in the shipping sector.
- Finally further fine differentiated hypotheses could not be accepted or rejected. The normative economic findings concerning data limitations can also be confirmed by positive theory.

The findings of this deliverable will be translated in policy recommendations which will be presented in deliverable 11.1.



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APPENDIX 1

APPENDIX TITLE

This appendix features the (empty) factsheet form.

DIFFERENT project: Fact sheet for differentiated charging scenarios

Case study and charging scenario definition

A *case study* addresses a geographically delimited area where one or more differentiated charging schemes are studied. To test hypotheses with respect to the differentiated charging practise, a fact sheet is designed to collect the necessary data from the case studies. At least one fact sheet is to be completed for each and every case study.

To fill in the fact sheet, a clear *differentiated charging scenario* needs to be defined. Such a definition includes a reference case as well as the actual *charging scheme* reported. A charging scenario is always defined incrementally: the charging scheme reported should carry a larger degree of differentiation compared to the reference case. There are no restrictions with respect to the timeline: the reference case scenario may come in after the differentiated scheme reported is abolished.

A differentiated charging scheme defines the amount to be paid by the user for his (or her) use of the transport infrastructure. This amount is the product of a (differentiated) unit price with the actual level of transport activity by the user. The unit of activity charged may differ over case studies. In one scheme it may be the number of trips which is charged, whereas in another scheme it is the distance driven that is addressed by the charge, and in still another scheme it may be access to an area over a predefined time period that is charged. It is the differentiated unit price which is the subject of this fact sheets.

The entire scope of the fact sheet form is to be covered by all case studies. However, it may not be possible to cover the entire fact sheet by a single differentiated charging scenario. In such case, we do encourage the case study leader to report on different charging scenarios in order to provide information for all fact sheet sections. *Using a separate fact sheet for each scenario is the way to proceed.*

Please do **in no case** report on different charging schemes or reference cases in one single fact sheet.

For each differentiated charging scenario you are reporting, please fill out the corresponding fact sheet as complete as possible. Do not leave sections blank for which you do have information because you already completed them for another charging scenario of the same case study. For some hypotheses testing we combine information provided in different sections as an input, in such case the combination needs to be available from the same charging scenario in order to be useful.

General instructions

Please read the questions carefully.

Many sections carry a customisable “other” alternative. While this is provided to allow for completeness, please do only use it if you are deeply convinced that your answer does not fit the predefined answering options.

In case you feel that we should know something that is not contained by the predefined answering form, most sections carry a “details” field. While it's a free form field, do not consider this field as a substitute for the predefined answering options.

We encourage you to refer to background documentation where available data is too voluminous to fit in the fact sheet form. Please include sufficient detail in your reference to any document, including the file name, page/table number etc. And do not forget to provide us with an electronic copy of the actual document.

When filling in the fact sheet, remember that we process the completed fact sheets manually. So where appropriate (and necessary) you can provide indications on your understanding of the question or refer to answers provided elsewhere. Upon entering your answers in our database we will take care that all information ends up in the correct field.

Glossary

Throughout the fact sheet words that are explained in this glossary are underdotted.

charging mechanism the technological implementation used for the collection of the differentiated charge; a charging mechanism may be a barrier when it does not allow for further differentiation, meaning that a new (costly) infrastructure needs to be implemented

demand elasticity ratio of relative change in demand to (corresponding) relative change in price

distance based charge the charge level is the product of a (differentiated) unit price with the distance travelled; *in case of a distance based charge it is the unit price per vehicle kilometre which is the subject of the fact sheet*

efficiency to maximise social welfare

equity to redistribute wealth so as to improve conditions for low income or otherwise vulnerable travellers such as elderly or disabled, or economic sectors that are considered to be weak

exempt users/exemptions users that for whatever reason are exempt of the differentiated charge; exemptions should be considered throughout the fact sheet as integral part of the charging scheme

externality/external cost a cost that is not (fully) borne by the producer of a good or service, such as environmental damage

fully distributed cost pricing scheme geared to average costs; its main feature is the allocation of common costs (other than marginal costs, e.g. infrastructure investment) to the users concerned (e.g. car drivers and lorries)

gross weight the maximum weight of a vehicle (which is the sum of the empty vehicle, the maximum amount of fuel and the maximum load mass)

increasing returns to scale economies of scale in service provision; it implies that the average cost of providing a service is higher than the marginal cost

internal cost a cost that is borne by the producer of a good or service

load factor the actual payload mass of a freight transport vehicle (which is smaller than the gross weight)

lump-sum charging users are paying a fixed sum regardless the actual transport activity level

marginal cost the cost that is related to an increase in supply of one unit (of transport activity)

monopoly position dominant position in the market

occupancy rate the actual number of passengers occupying a passenger transport vehicle

peak load pricing pricing scheme in which users in the peak season pay their marginal costs plus the capacity costs and in the off-peak season their marginal costs

public service obligation obligation to provide public services under legal requirements or constraints

Ramsey pricing attempt to charge more where demand elasticities are low

reference case see definition in the section above

transport activity the use of the transport infrastructure that is charged by the differentiated scheme; depending on the scheme you report on this may be distance travelled (for a distance based charge), trip frequency (e.g. for a cordon charge), access to an area (e.g. in the London congestion charge) or still something else

two or multipart tariff pricing scheme consisting of a fixed component (independent from transport activity level) and one (or more) variable components (function of transport activity level)

type of user a group of infrastructure users defined (based on characteristics that are not related to the user's transport activity level under the differentiated charging scheme)

unit price the price that is charged for the consumption of one unit of transport activity, as a result the overall amount paid by the user for the use of the transport infrastructure is the product of the unit price with the transport activity level; the subject of this fact sheet is the differentiated unit price

welfare impact overall social benefit as defined in normative economics; this is the sum of change in consumer surplus, producer surplus, tax revenues and external benefits or damages (such as environmental impact)

willingness to pay the maximum amount of money a user is prepared to pay for the use of the transport infrastructure

Questions & Answers

What if others studied the same differentiated charging scenario I am reporting on? There is no need to limit the information you provide to your own research output.

What should I do when it is difficult to rank the the applicable alternatives in order of importance as requested? Consider that equal rankings are allowed, in the extreme case you could attribute an equal ranking to all applicable alternatives.

Fact sheet form

Institute:

E-mail:@.....

Comments by VU:

....

1 Charging scenario morphology

	Case study name:
<i>Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.</i>	Spatial scope of the case study: <input type="checkbox"/> regional <input type="checkbox"/> national <input type="checkbox"/> international
<i>Choose one of "airlines", "shipping", "railways", "road haulage" or "car drivers".</i>	Case study type: airlines / shipping / railways / road haulage / car drivers / test
<i>Please indicate the item relevant for the charging scenario (1 choice). Use 1 for applicable and 0 if not applicable.</i>	Differentiated charging scheme reported in this fact sheet concerns: <input type="checkbox"/> scheme that is currently implemented <input type="checkbox"/> scheme that is decided to be implemented <input type="checkbox"/> scheme that is proposed but not yet decided <input type="checkbox"/> experimental scheme that has been tested in real world circumstances on a limited base (both geographically and in time) <input type="checkbox"/> sandbox simulation (academic fantasy scheme evaluated using modelling techniques) <input type="checkbox"/> other:
<i>Please indicate the item relevant for the charging scenario (1 choice). Use 1 for applicable and 0 if not applicable.</i>	Unit of transport activity charged: <input type="checkbox"/> distance travelled <input type="checkbox"/> number of trips (for instance a cordon charge) <input type="checkbox"/> access to an area over a predefined time period (for instance the London congestion charge), please specify: <input type="checkbox"/> other:

Please indicate the item relevant for the charging scenario (1 choice). Use 1 for applicable and 0 if not applicable.

Reference case for this fact sheet:

- ☐ no charging (or lump-sum charging independent of transport activity level)
- ☐ undifferentiated charge that was implemented: equal charge for all users under all circumstances; provide information of prices or cost levels in the reference case:
- ☐ status quo ante (differentiated charging scenario that was implemented); please provide details:
- ☐ previously proposed undifferentiated charge (proposed but never implemented); provide information of prices or cost levels in the reference case:
- ☐ previously proposed differentiated charging scheme (proposed but never implemented); please provide details:
- ☐ other:

Please provide details:

2 Type(s) of differentiation

Please rank in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Type(s) of differentiation in the differentiated charging scheme reported:

- ☐ time
- ☐ place, location of link
- ☐ type of infrastructure
- ☐ type of user (not related to transport activity level), i.e.
- ☐ type of vehicle (including environmental performance),
- ☐ type of fuel
- ☐ size of vehicle (gross weight)
- ☐ load factor (freight transport) or occupancy rate (passenger transport)
- ☐ transport activity level, e.g. a season pass for frequent users (for a distance based charge this would mean that different unit prices apply depending on total vehicle mileage by the actor paying the charge)
- ☐ type of cargo
- ☐ other, i.e.

Please provide details when needed:

3 Main objective(s) of price differentiation

Please rank for each type of differentiation selected in section 2 of the fact sheet the objectives in order of importance.

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Overall ranking of objectives for the differentiated charging scheme:

- ☐ efficiency
- ☐ profits
- ☐ cost coverage
- ☐ environmental goals
- ☐ equity
- ☐ acceptability
- ☐ safety
- ☐ congestion reduction
- ☐ meet legislative requirements (e.g. new decree)
- ☐ competitiveness
- ☐ sustainability
- ☐ other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **time** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **place, location** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **type of infrastructure** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **type of user** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **vehicle type** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **fuel type** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **vehicle size** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **load factor/occupancy rate** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **transport activity level** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **type of cargo** differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please rank the objectives in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Ranking of objectives for **other** (as specified in section 2) differentiation:

- efficiency
- profits
- cost coverage
- environmental goals
- equity
- acceptability
- safety
- congestion reduction
- meet legislative requirements (e.g. new decree)
- competitiveness
- sustainability
- other:

Please provide details when needed:

4 Degree of differentiation

Please indicate for each type of differentiation selected in section 2 of the fact sheet the number of charging levels, as well as the minimum, maximum and mean charge.

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **time** differentiation:

- number of levels: levels
- minimum charge: ,000 euro
- maximum charge: ,000 euro
- mean charge: ,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **place, location** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **type of infrastructure** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **type of user** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **vehicle type** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **fuel type** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **vehicle size** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **load factor/occupancy rate** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **transport activity level** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **type of cargo** differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please indicate the number of charging levels (including zero if applicable) and the minimum, maximum and mean charge (in euro). For the mean charge you may use an approximation.

Characteristics of **other** (as specified in section 2) differentiation:

number of levels: 0 levels
minimum charge: 0,000 euro
maximum charge: 0,000 euro
mean charge: 0,000 euro

Please detail as much as possible, provide values, you can refer to a background report if appropriate (please provide an electronic copy of the report concerned). There is no need for brevity in this section.

Summarise relevant details of the size of price differentiation alternatives such as is the price structure fixed (and certain) or dynamic (and less predictable)?

5 Differentiation across type of users

We are talking about differentiation across type of users based on characteristics that are **not** related to the user's transport activity level under the differentiated charging scheme.

Please rank in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

In case there is differentiation across type of user, how is this differentiation motivated?

- ☐ differences in demand elasticity
- ☐ differences in willingness to pay (WTP)
- ☐ equity
- ☐ legal (compliance with a law)
- ☐ differences in observed behaviour (including transport activity level) in the reference case
- ☐ public service obligations
- ☐ other, i.e.

Which users are favoured by the differentiated charging scheme compared to other users in the same scheme?

Answer "yes" or "no".

In particular: are there particular user groups which are exempt from the differentiated charge (i.e. do not have to pay the charge at all)? yes / no

If yes, please specify:

What is the ratio (in percent) of the number of exempt users to the number of users that are not exempt from the differentiated charging scheme? %

How important is the political influence of the favoured users (including the ones that are exempt)? (e.g. in terms of voting power)

Please provide details when needed:

6 Economic principles behind the tariff structure

Indicate the level with a number from 1 to 5, with 1 meaning a small influence and 5 meaning a strong influence; use 0 if not applicable.

Please indicate to what extent the following items contribute in the determination of infrastructure user price levels of the differentiated charging scheme:

- ☐ average internal cost
- ☐ marginal internal cost
- ☐ external cost
- ☐ fully distributed costs
- ☐ two or multipart tariff
- ☐ uniform pricing
- ☐ peak load pricing
- ☐ willingness to pay
- ☐ Ramsey pricing
- ☐ experimental design
- ☐ other, i.e.

Answer “yes, recovery of total cost”; “yes, recovery of percentage of total cost”; or “no”

Does cost recovery play a role? yes, recovery of total cost / yes, recovery of percentage of total cost / no

Answer “yes” or “no”.

Are there any indications of inverse Ramsey pricing? (The low elasticity demand gets the low mark-up) yes / no

7 Main actor responsible for differentiation/setting price

Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.

Which is the main actor responsible for setting the price?

- ☐ public sector, i.e.
- ☐ semi public firm, i.e.
- ☐ private firm, i.e.
- ☐ regulator, i.e.
- ☐ academic institution (in case of an experimental design), i.e.
- ☐ other, i.e.

Please indicate the item relevant for the charging scenario (1 choice). Use 1 for applicable and 0 if not applicable.

Does this actor have a monopoly position? Please indicate the extent of the monopoly position:

- ☐ no monopoly at all
- ☐ moderate monopoly power only
- ☐ strong monopoly power in the relevant market

Answer “yes” or “no”.

In case the actor has a monopoly position, does he use it for profit maximisation? yes / no

Answer “yes” or “no”.

Is the price setting situation one of increasing returns to scale? yes / no

Please provide details when needed:

8 Main actor(s) paying the charge

Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.

Who is the main infrastructure user paying the charge? Note that in the case of a negative charge (i.e. a reward), this actor is being paid rather than paying.

- ☐ companies supplying freight transport services
- ☐ companies supplying passenger transport services
- ☐ car drivers
- ☐ the government
- ☐ other, i.e.

Answer “yes, both in the short and the long run”; “yes, but only in the long run” or “no”.

Do most carriers pass costs to shippers? yes, both in the short and long run / yes, but only in the long run / no

Please provide details when needed:

9 Dimensions of cognitive burden

Is there any evidence that the cognitive burden on payees is an issue?

10 Dimensions of charging mechanism

Answer "yes" or "no".

Is the charging mechanism a (technical) barrier towards further differentiation? ☐ yes / ☐ no

Please provide details when needed:

11 Political dimensions

Answer "yes" or "no".

Does the political factor play an important role in the process of setting the charge? ☐ yes / ☐ no

Please provide details when needed:

12 Type of analytical approach to determine impact of pricing

Please rank in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.

Please indicate the type(s) of analytical approach:

- ☐ stated preference
- ☐ revealed preference
- ☐ existing transport model
- ☐ control group/experiment
- ☐ ex-post versus ex-ante comparison
- ☐ meta analysis
- ☐ literature review
- ☐ welfare modelling framework (e.g. partial equilibrium model)
- ☐ interview with stake holder
- ☐ other, i.e.

Please provide details when needed:

13 Attention paid to payment information/enforcement

Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.

Please indicate which items are relevant for the charging scenario:

- ☐ access to information about charges and payment (e.g. internet, phone, radio, on-route)
- ☐ availability of information systems helping user
- ☐ enforcement/fines (type and level), i.e.
- ☐ number of errors (unintended) and violations, i.e.
- ☐ modus of payment (e.g. direct/indirect, daily/monthly/yearly), i.e.

Please provide details when needed:

14 Evidence on the size of user responses

<p><i>Please rank in order of importance; 1 is the most important, 2 the second most and so on. Equal rankings are allowed. For non-applicable options enter 0.</i></p>	<p>Please provide an indication of the size of the different user responses:</p> <p><input type="checkbox"/> route choice, including airport (terminal)/port choice</p> <p><input type="checkbox"/> change in level of <u>transport activity</u></p> <p><input type="checkbox"/> change in timing, i.e.</p> <p><input type="checkbox"/> modal choice</p> <p><input type="checkbox"/> destination choice/changes in distance</p> <p><input type="checkbox"/> location choice</p> <p><input type="checkbox"/> vehicle type choice</p> <p><input type="checkbox"/> vehicle size (gross weight) choice</p> <p><input type="checkbox"/> fuel choice</p> <p><input type="checkbox"/> change of <u>load factor/occupancy rate</u></p> <p><input type="checkbox"/> other, i.e.</p>
	<p>Please provide details when needed:</p>

15 Measures of user responses

<p><i>Answer "yes" or "no".</i></p>	<p>Do you have measures of user responses such as <u>elasticities</u>, <u>willingness to pay</u> or some other format? <u>yes / no</u></p>
<p><i>Please detail as much as possible, provide values, you can refer to a background report if appropriate (please provide an electronic copy of the report concerned). Our very special interest goes to knowing how user responses differ across different user groups. There is no need for brevity in this section.</i></p>	<p>Please provide details: what are the user responses, how are they related to price differentiation, what is their size, to what extent detailed for different <u>type of user</u>?</p>

16 Impact of the charge addressed in the charging scenario

<p><i>Answer "yes", "no", "partially" or "unknown" for each impact.</i></p>	<p>Please indicate the impacts of the differentiated charging scheme compared to the <u>reference case</u>:</p> <p>travel time savings: <u>yes / no / partially / unknown</u></p> <p>environmental impact: <u>yes / no / partially / unknown</u></p> <p>safety improvement (e.g. accidents reduction): <u>yes / no / partially / unknown</u></p>
<p><i>Answer "yes", "no", "partially" or "unknown".</i></p>	<p>Do you think that the impact of the differentiated charging scheme is in accordance with the aims set? <u>yes / no / partially / unknown</u></p>
<p><i>Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.</i></p>	<p>If the impact of the differentiated charging scheme are not or only partially in accordance with the aims set, what were the factors, which impeded this?</p> <p><input type="checkbox"/> false calculation</p> <p><input type="checkbox"/> too ambitious aims</p> <p><input type="checkbox"/> lobbying</p> <p><input type="checkbox"/> competing aims</p> <p><input type="checkbox"/> other, i.e.</p>

Please detail as much as possible, provide values, you can refer to a background report if appropriate (please provide an electronic copy of the report concerned). Our very special interest goes to knowing how user responses differ across different user groups. There is no need for brevity in this section.

Please provide details: what are the impacts of the differentiated charging scheme, what is their size, how do they relate to the user responses observed?

17 Welfare impact

Answer "yes" or "no".

Explicit treatment of welfare impact (social costs and benefits) in case study analysis? ☐ yes / ☐ no

Please detail as much as possible, provide values, you can refer to a background report if appropriate (please provide an electronic copy of the report concerned). There is no need for brevity in this section.

Please provide details on the size of welfare impact:

18 Lobbying

Answer "yes" or "no".

Was there effective lobbying recognisable? ☐ yes / ☐ no

Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.

If yes, how did lobbying affect the price structure?

- ☐ more differentiation
- ☐ less differentiation
- ☐ change of proportions between the fixed and the variable component of the charge (in a two or multipart tariff scheme)
- ☐ allocation of capacity costs to marginal costs and vice versa
- ☐ price calculation method
- ☐ different categorisation or boundaries
- ☐ other, i.e.

Please provide details when needed:

19 Burden shifting

Answer "yes" or "no".

Explicit attention to burden shifting of charges on other actors (for example: customers, employers)? ☐ yes / ☐ no

If yes, provide details on burden shifting: by whom towards whom?

Please indicate the level of understanding with a number from 1 to 5, with 1 meaning not understood at all and 5 meaning very well understood. Use 0 if unknown.

Is, according to your understanding, the issue of burden shifting well understood by the parties involved? ☐ 0

20 Acceptability

Please indicate the level of acceptability with a number from 1 to 5, with 1 meaning very unacceptable and 5 meaning very acceptable. Use 0 if unknown.

How do you assess the acceptability in the view of the general public of the differentiated pricing scheme (compared with the reference case)?

0

Please indicate the level of influence with a number from 1 to 5, with 1 meaning not at all (the use of the revenues does not affect the public's view on acceptability) and 5 meaning strongly (the use of the revenues strongly affects the public's view on acceptability). Use 0 if unknown.

To what extent is the above result on acceptability influenced by the use of the revenues of the differentiated pricing scheme?

0

Please indicate which items are relevant for the charging scenario. Use 1 for applicable and 0 if not applicable.

Please indicate which items are relevant for the charging scenario with respect to acceptability and equity of differentiated prices:

- ☐ low political and public (and firms) acceptance
- ☐ low understanding of charge (differentiation)
- ☐ perceived as unfair (may relate to the use of revenues and exemptions); can specific groups be identified that feel treated unfair

Please provide details: