



Differentiated infrastructure charging: a comparison of theory and practise

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Abstract

In the European Union, the infrastructure charging regimes that can be observed are often far from internalising external costs and are rarely based on efficiency principles. In this situation differentiation of existing charges appears to be a sensible intermediate step.

In this paper we study the empirical evidence of the different aspects that affect infrastructure pricing as described by theory. In order to do so information was collected from a number of case studies, and a set of indicators was defined, not only to allow for the analysis of price differentiation practise with respect to the degree of differentiation, but also to account for the level of ambition of the price setting actors.

The cross-case analysis was based on a number of hypotheses that were drawn from the theoretical framework. Testing for the hypotheses using the case study information allowed us to establish an overview of the current state of differentiated infrastructure charging.

Keywords: Price differentiation; Infrastructure; Special interest groups; Normative economics; Positive economics.

1. Introduction

In the European Union, levels and structures of transport infrastructure charges vary strongly across transport modes and countries. Some degree of convergence exists on the intention to apply the principle of marginal cost pricing in various transport sectors, but, in the presence of unsolved difficulties in funding transport investment and even serious concerns about marginal social cost pricing in several countries, any such

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convergence is slow. At present, the charging regimes that can be observed are often far from internalising external costs and are rarely based on efficiency principles.

In this situation differentiation of existing charges appears to be a sensible intermediate step. A possible way to increase the efficiency of pricing structures would be to take existing structures as a starting point and try to increase their efficiency by making them more differentiated. This may, however, lead to a number of questions such as: how differentiated should these price structures be in order to lead to efficiency gains, how will users react, what are the effects on equity and revenues, etc. The effects on revenues deserve particular emphasis here, because in many countries plans exist to replace the existing system of taxed based infrastructure financing with a system based on user charges.

Economic theory has brought us an ample set of considerations with respect to differentiated prices. Pigou showed already in 1920 in his economic analysis of road pricing and congestion costs that a levy equal to the marginal external costs should be levied in order to correct for suboptimal behaviour of individual road users. Over the decades, scholars have elaborated on behavioural, technical, political, and many other impacts on the optimal form of differentiated infrastructure prices.

In this paper we study the empirical evidence of the different factors that affect infrastructure pricing as described by theory. In order to do so information was collected from a number of case studies that were conducted in the DIFFERENT project. The case studies concern both real world implementations as well as desk based research of the introduction of differentiated infrastructure charges. A cross case analysis allows us to identify how key aspects of the theory of price differentiation are dealt with in the setting of actual implementations.

The theoretical framework that we use as a basis for our study is represented in figure 1.

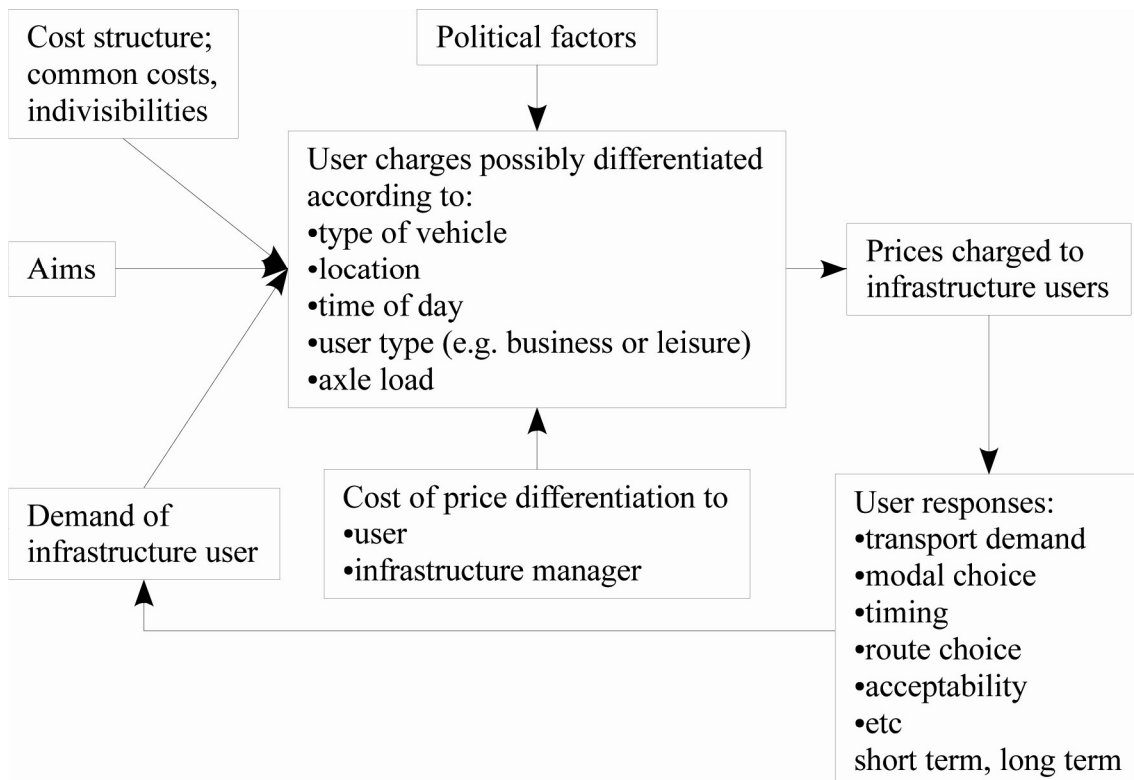


Figure 1: Analytical framework.

Figure 1 identifies five different factors that affect price differentiation. The left-hand side of the framework gives three (normative) arguments which may explain differences in price setting: objectives among infrastructure managers and operators may be different, with economic theory focussing on the role of economic efficiency and equity. Also the implications of the particular cost structure of the transport industry for pricing are being studied, as well as 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). The normative approach assumes that all politicians or regulators maximize welfare, but, at the same time, they may also pursue their own goals (e.g. re-election). Consequently, interest groups can have substantial influence on them. 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). For instance, a highly differentiated first best pricing scheme may have large implementation costs, if technically feasible at all. A high degree of sophistication also implies significant decision costs for the infrastructure user. 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, in an economy suggesting that less variety is sometimes better (Norwood, 2006), more choices (a consequence of a higher degree of differentiation) may also lead to more search costs.

In order to conduct our cross case analysis we needed to collect information in a consistent form. To do so a fact sheet was completed for all case studies. These case studies were drawn from the DIFFERENT project. The DIFFERENT research project was carried out from 2006 through 2008 in the 6th Framework Programme of the EU Commission. The objective of the project was to improve the understanding of user reactions to differentiated infrastructure prices in order to determine efficient charging schemes for infrastructure use. The project investigated user reactions to differentiated pricing through empirical as well as inter-related theoretical work. The empirical work encompassed real world case studies, as well as stated and revealed preference research. The scope of the theoretical work included normative and positive economic theory, and behavioural theory.

Furthermore, a set of indicators was defined in order to analyse price differentiation practise with respect to the degree of differentiation as well as to account for the level of ambition of the price setting actors.

The cross-case analysis was based on a number of hypotheses that were drawn from the theoretical framework. Testing for the hypotheses using the case study information allowed us to establish an overview of the current state of differentiated infrastructure charging.

2. Economic theory

Economic theory provides a contribution to differentiated infrastructure pricing along two main lines. The first contribution concerns the formulation of the optimal framework (the normative approach) for transport charges differentiation. This framework can be determined by 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 costs (throughout the economy) in order to achieve this goal.

The positive economic theory of price differentiation examines price differentiation from a different point of view: politicians are no longer assumed to be benevolent welfare maximisers, they are pursuing their own goals. So, instead of maximizing collective utility, they tend to maximize individual utility, in particular since they want to be re-elected. This makes decision makers dependent on interest groups.

Departing from the axiom of welfare maximization means that the question of how transport prices are actually set under real world conditions is more relevant than the question of how transport pricing should be set. How this affects pricing-regulation has been demonstrated in the past in a long series of models (Stigler, Becker, Keeler, Posner, Grossman-Helpman). In this part of the analysis of our paper we go one step further and examine the way in which the interaction between Special Interest Groups (SIGs) and decision makers is reflected in the adopted structures of transport pricing.

This change of perspective from normative to positive theory does not mean that the two approaches have no connection (in the sense of two different “schools” of economic theory or the like). First, many cases exist where both approaches make the same predictions, and second, every policy-maker needs to take normative considerations into account, if he wants to be re-elected (von Weizsäcker, 1982). In other words, the two approaches are complementary, or one may also say that one is a special case of the other, depending on perspective.

2.1. Normative economics

In this subsection we will introduce a selection of topics relating to price setting actors maximising welfare. The format is that of *capita selecta*. For a more extended introduction we refer to the literature or the project report.

Efficiency: marginal social cost pricing

The concept of economic efficiency is derived from the theory of welfare economics, and is related to the allocation of resources in an economy. Welfare economics takes a rather wide view of pricing, considering pricing as a method of resource allocation, maximising social welfare rather than simply the welfare of the supplier (Button, 1993). According to this view, prices should equal marginal social cost in order to maximise social welfare. By pricing at marginal cost, in effect, transport services are being provided up to the point where the benefit for the marginal unit is equal to the costs of providing that unit (Button, 1993). In some cases, private provision of the good or service may also result in maximising the social welfare. If not, regulatory policies may be formulated so that private companies will change their pricing policy, so that social, rather than private welfare, is maximised.

A market equilibrium under this optimal pricing rule only can exist under a stringent set of conditions. Clearly, this equilibrium will not exist 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.

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.

Constraints in transport 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 prefer. 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 existing constraints.

Equity

Finally, transportation often raises equity concerns that seem to conflict with marginal cost pricing. Marginal cost pricing may result in very differentiated charges with the consequence that no one transport user pays the same price; this may be perceived as unfair. Equity is important in the context of acceptability of pricing. Many stakeholders raise objections about pricing measures that they perceive as unfair. If a pricing measure is unfair either to themselves in relation to other people or to people who are considered to be less well off in society, significant acceptability problems could occur. 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 that allow certain groups within a community to be exempted from pricing, or compensate some groups with a lump-sum transfer are therefore discussed. 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. Then, price discrimination becomes relevant. In public transport, for instance, it is common that different prices are charged for the same service. Particular groups in society, e.g. the elderly, may benefit from the fare policy of governments .

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.

User responses

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).

Elasticities can provide indicative and useful answers to the questions on the effectiveness of policy measures. However, policy makers must realise that no unique value of the elasticity of one particular measure does exist. Elasticities of travel demand will vary with circumstances and very much depend on the context. Relevant circumstances 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 is useful when a clear description of the dependent and independent variables (which price changes and which demand is affected) exists.

2.2. Positive economics

This part of the analysis first gives a brief overview of the positive economic theory of regulation.¹ Subsequently, the positive approach will be linked to transport pricing. Finally, the dimensions of price differentiation will be presented.

To start with the existence of Special Interest Groups (SIGs), Noll (1989) states that the reason for the existence of SIGs is mainly due to the lack of power of single voters and the desire to control politicians. To solve the problem of lack of power, voters can unite in SIGs which represent their political preferences better than the simple voting process. Also the 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 where costs can be distributed over all members of the SIG. However, SIGs often face the problem of free riding. Olson (1965) notes in this respect that small and well organized interest groups are more efficient in lobbying because the free rider problem is much smaller.

To motivate the use of the positive theory of regulation in this paper it is necessary to give a brief historical overview of the emergence of the positive economic literature. In the 60s more and more economists observed that decision makers failed to regulate industries effectively. In fact, regulation in many markets served the interests of the industry it was supposed to regulate. The initiating empirical study by Stigler and Friedland (Stigler and Friedland, 1962) that mainly resulted in the Stigler/Peltzmann model and other theories on regulatory capture gained acceptance among economists in the 70s. The main proposition of these models is that regulators gain from supplying regulation and industries gain from regulation through restriction of competition. The underlying assumption is that consumers are not well organized and informed but producers can form small but well organized interest groups.

Thus, the widely known Stigler/Peltzmann Model assumes that decision makers maximize their political support (political support is assumed to be a function of industry profits and the respective price). In the equilibrium politicians will impose regulations on unregulated industries or partly deregulate completely regulated industries. Although at present much deeper positive economic models exist, the Stigler/Peltzmann economic contribution comprises a result, which has proven to be robust in most models of this type: The outcome of the political process is a compromise between total regulation and total deregulation.

¹ An overview of political economy can for instance be found in Noll (1989).

The next major contribution in the positive economic theory was provided by Gary Becker (Becker, 1983, 1985). Becker extended the above mentioned models by incorporating the idea that more than one SIG (with partially conflicting interests) influences the political process. According to Becker, regulation thus occurs as a result of battling SIGs. Becker ignores the politician's own preferences. However the outcome of his model comprises a politician's decision, in which all SIGs preferences are (at least partly) incorporated. In the equilibrium the regulator implements a policy which is a weighted sum of the involved SIGs' preferences. Several researchers (Tullock, 1971) dealt with this topic from a different point of view: SIGs know that policy makers have the power to distribute rents resulting from regulation and will therefore compete for these rents. Due to the existence of rent-seeking behaviour, only one SIG will win the regulatory game, an element which is strongly connected to the degree of political power of the participating SIGs.

Curiously, at the time these theories were being developed, a process of deregulation all over the world set in. As a result of this deregulation movement taking place in the last three decades, many economists concluded that positive theory is of limited importance and has little explanatory power. This idea was picked up by Keeler, who argued that positive theory can allow for deregulation. Keeler (Keeler, 1984) combined elements of both positive economic models described above (by using the consumer surplus of more than one SIG) with normative economic elements (by using a social welfare function). Although from the modelling point of view Keeler's idea needed to be improved, in many cases modern positive economic literature is based on the simple insight that the implemented policy is a mix of normative and positive policy elements.

Modern theory of political economy focuses on elections, the provision of information and campaign contributions as the main fields in which SIGs concentrate their activities of interfering in the political process.

Grossman and Helpman (2000) formalized Keeler's main axiom so that the adopted policy package incorporates both normative and positive policy elements more fully. Their research concentrates on political interaction between policy-makers and interest groups. Using advanced game theoretical methods Grossman and Helpmann showed that SIGs will "educate" voters in the pre-election period, will provide credible information to policy-makers and will make contributions to politicians and parties in order to achieve their favourite policy set. On the other hand policy makers will select those SIGs which are most valuable to them, and will maximize their probability to get re-elected. This causes decision makers only to deviate from their personally most favoured optimal policy set, if they receive enough campaign contributions without worsening their re-election chances.

All these presented models have in common that they attempt to describe the decision-making process under the influence of special interest groups. Although methodically different, the outcome of the models is a set of policies, selected by the decision-maker, containing the element of compromise. Since the transport sector is a traditionally highly regulated sector, this kind of analysis could be applied to transport markets. In all transport modes there are major or minor SIGs trying to interfere with the political process (e.g. drivers associations, environmental organisations, airline and airport associations etc). The first implication from the positive theory point of view is that in transport markets SIGs will try to interfere with the political process of decision-making to achieve the best outcome for their members. Naturally SIGs and also regulators prefer regulation. However, a simple regulation of transport markets is

usually not possible. First, nowadays, it is difficult to impose apparent unnecessary regulations, because voters are much better informed than they used to be in the past. Second, in almost all cases in European transport there are at least two major SIGs with contrary interests intervening in the political game. Take for instance the construction of a new airport runway. Airport administration and (perhaps) airlines will certainly push the construction plans. In contrast, the inhabitants of neighbouring towns will oppose to these plans (due to noise pollution). Usually these inhabitants will be very successful in their opposition because of their ability to form an interest group quickly and efficiently. The outcome in many of the cases like the one just described is that the runway is constructed, but with substantial flight restrictions (e.g. night flights). This is exactly the element of compromise we mentioned above.

These considerations have two major implications. First, in most of the cases a compromise will be the only way to achieve some degree of consensus among all participating actors. Second, powerful SIGs should find more subtle means than claiming the introduction of regulation in order to enhance the welfare of their members.

One possibility to take the welfare of all (major) SIGs into account is the construction of infrastructure charging structures that reflect the interests of the participating SIGs. Price differentiation plays a major role here. On the one hand, additional differentiation can appease protests. On the other hand maximising social welfare and taking into account the interests of the involved (most powerful) SIG's will also lead to additional differentiation. In the example above with the runway construction this would mean additional surcharges for night flights.

It seems that up to now the "political economy aspect" of regulated tariffs has been addressed rarely in the literature. Laffont/Tirole (Laffont and Tirole, 2000) emphasised the danger of political manipulation of Ramsey pricing, if (positive) externalities are to be included in the Ramsey formula. The most important contribution up to now seems to be a formal model in which Laffont (2000) compared the Smith pricing rule with an optional tariff in terms of expected welfare in a scenario where two SIGs alternate in power with a certain probability. He arrives at the surprising result that the inclusion of political distortions by SIGs can lead to superiority of the Smith rule.

In a subsequent section this analysis will be applied to the empirical evidence concerning the effects of lobbying for price differentiation.

3. Case studies

The previous section 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 for the success or failure of a particular case study where price differentiation is implemented in practice.

In this section we will provide a summary overview of the case studies carried out in the DIFFERENT project. We will also briefly address the methodology used for data collection and define indicators to be used in our cross case analysis carried out in the next section where we test the hypotheses.

In order to collect data from the case studies in a generic way, a factsheet form was designed. The fact sheet consisted 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. The complete factsheet design is documented in the project report.

3.1. Generalities

In this section we provide an overview of the case studies based on the information collected through the factsheets. Factsheet data were provided for 27 case studies (see table 1). In our discussion we consider five different types of differentiated infrastructure charging case studies:

- Airlines (5)
- Shipping (8)
- Railways (4)
- Road haulage (4)
- Car drivers (6)

The case studies are spread over in all EU-countries plus Switzerland and Norway. The wide geographic scope together with the various user types leads to a heterogeneous collection of case studies.

The information collected is not fully homogenous. For three case studies the factsheet was completed only partially. We will nevertheless include the available information from 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 both the heterogeneous character of the information collected as well as the inherently heterogeneous character of the different case studies. This will be discussed in a subsequent section.

Whereas in our discussion most attention will be paid to answers that fit in the predefined answering alternatives of the factsheet form, we will report on other dimensions where appropriate.

3.2. Objectives of the price setting agents

Cost coverage is the most cited objective for price differentiation, closely followed by efficiency and environment (figure 2). 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.

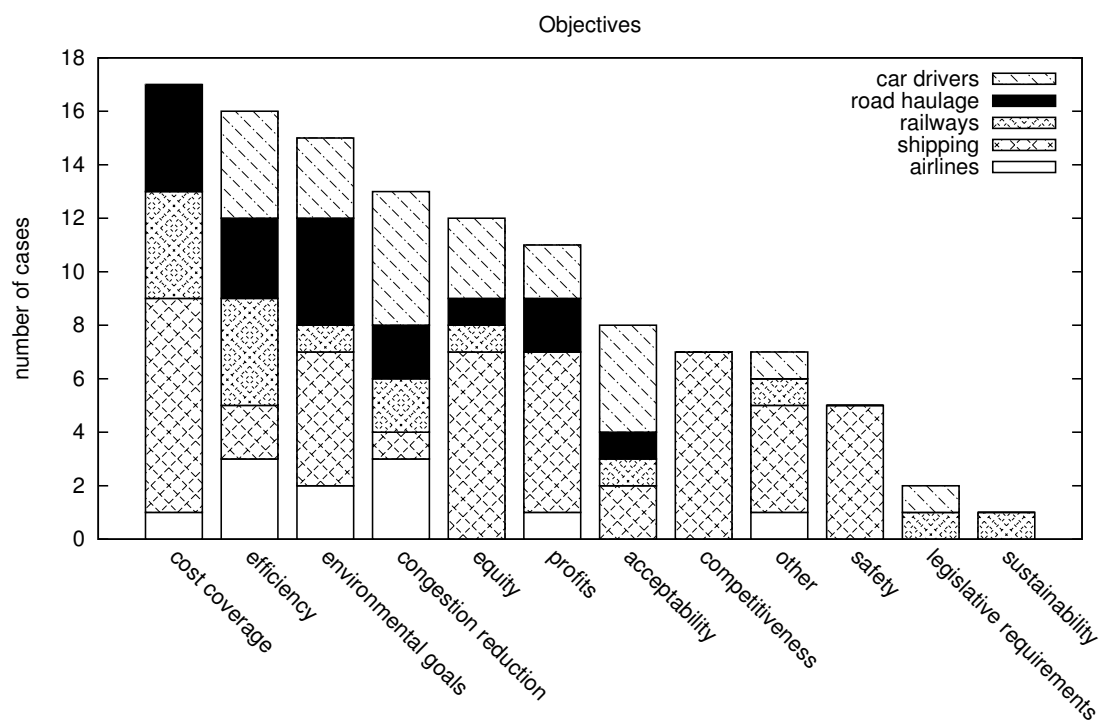


Figure 2: Main Objectives of Price Differentiation.

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 the number of objectives should have its impact on the corresponding differentiated pricing schemes. 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 (see table 1).

3.3. Dimensions of price 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 this indicator to the case study data.

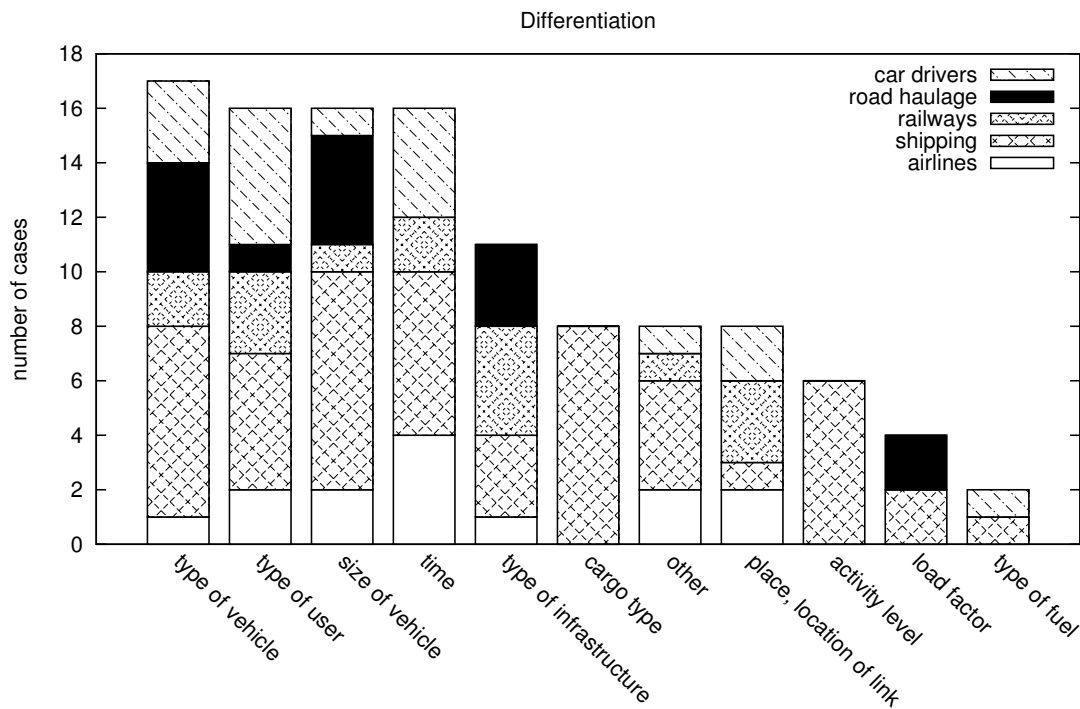


Figure 3: Types of Differentiation.

The most often cited dimensions of price differentiation are: type of vehicle, type of user, size of vehicle and time of travel (figure 3). At the other side of the spectrum we find the dimensions: load factor (or occupancy rate in passenger transport) and type of fuel.

Looking at oddities in the occurrence of differentiation dimensions, we observe that cargo type and activity level are only used for price differentiation 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 existing differentiations in fuel taxes usually do not correlate to differences in external costs. This would justify further research on fuel price differentiation.

Airline cases typically focus on time of travel (day versus night), 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 objectives 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 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 at a fictitious schedule that is differentiated along one dimension. 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 infinite (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 Arnott, de Palma and Lindsey, 1993) 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 that the different dimensions are not correlated, which is highly unlikely e.g. for fuel and vehicle type.

With respect to the first point above 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 point, 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.²

The resulting indicator for degree of differentiation is presented in table 1.

² Provided the limitations that are identified with respect to correlation and other issues and that apply to both the indicator for degree of ambition and degree of differentiation, it would be an interesting exercise to test for different specifications of said indicators to assess the robustness of the conclusions drawn here. Unfortunately the dataset we use does not provide sufficient information to allow for alternative (and potentially more refined) specifications to be established.

Table 1: List of case studies.

| Name of Case Study | Case Study Type | Degree of Ambition | Degree of Differentiation |
|--|------------------------|---------------------------|----------------------------------|
| Port of Amsterdam | shipping | 6 | 6,6 |
| Port of Hamburg | shipping | 7 | 5,1 |
| Port of Gothenburg | shipping | 6 | 5,0 |
| Lerwick - Shetland Islands | shipping | 5 | 4,4 |
| Port of Valencia | shipping | 10 | 4,4 |
| Port of Duisburg - (Duisport) | shipping | 4 | 3,5 |
| France rail infra charge | railways | 8 | 3,0 |
| Trondheim road charge | car drivers | 3 | 3,0 |
| Scalloway, Shetland Islands | shipping | 5 | 3,0 |
| Effects of differentiated charges at Airport Hamburg | airlines | 1 | 2,7 |
| German Railways | railways | 4 | 2,4 |
| Stockholm City | car drivers | 7 | 2,2 |
| London City Centre | car drivers | 5 | 2,2 |
| The German HGV Toll | road haulage | 4 | 2,2 |
| Edinburgh road pricing | car drivers | 6 | 2,0 |
| Brenner TEN-T (freight) | road haulage | 5 | 1,9 |
| Brenner TEN-T (passenger) | road haulage | 5 | 1,8 |
| Swiss Heavy Vehicle Fee (HVF) | road haulage | 3 | 1,7 |
| Sullom Voe, Shetland Islands | shipping | 5 | 1,6 |
| Ljubljana Airport Case Study | airlines | 3 | 1,2 |
| Rail infrastructure charges in Austria | railways | 2 | 1,2 |
| Spitsmijden | car drivers | 3 | 0,7 |
| London airports | airlines | 3 | |
| Madrid Barajas Airport | airlines | 2 | |
| Rail infrastructure charges in Britain | railways | 2 | |
| Gran Canaria Airport | airlines | 2 | |
| Rome road pricing | car drivers | 1 | |

With the exception of the Brenner cases all entries in table 1 for which a degree of differentiation is provided, concern real world implementations. For a number of cases we did not assess the degree of differentiation. This was 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 the 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 practise 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).

4. Hypotheses

In this section we use the theoretical framework presented above as a base to define hypotheses with respect to infrastructure price differentiation practise, and proceed to a cross-case testing of these hypotheses.

In the setting of this paper we will limit the discussion to a selection of hypotheses that proved to be insightful. For a full overview of all hypotheses tested we refer to the project report (Knockaert et al., 2008).

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

- What explains the adoption of certain differentiated price structures?
- What are the consequences of differentiated prices for travel behaviour, welfare and acceptance?

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

4.1. Normative Economics

For each of the research questions formulated we first present a general hypothesis. In a next step we present a number of specific hypotheses based on the corresponding general hypothesis. Each hypothesis is discussed with respect to the theoretical framework and subsequently tested for using the case study information.

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.

The first general hypothesis addresses the determinants of the choice for differentiated price structures. We will discuss two specific hypotheses: one considering the role of aims of the price setting agents, and one considering the role of cost structures in price setting. Specific hypotheses on the role of the demand side in price setting were also formulated, but testing them proved not to be clarifying so we do not discuss them here.

Specific hypothesis A-1 The degree of differentiation of pricing schemes increases with the ambition of price setting actors.

We observe a large variance in the number of objectives or degree of ambition across the case studies. 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 figure 4 the relation between degree of ambition and degree of differentiation is plotted. The positive relation suggested by the hypothesis is confirmed by the trend reflected in the figure.

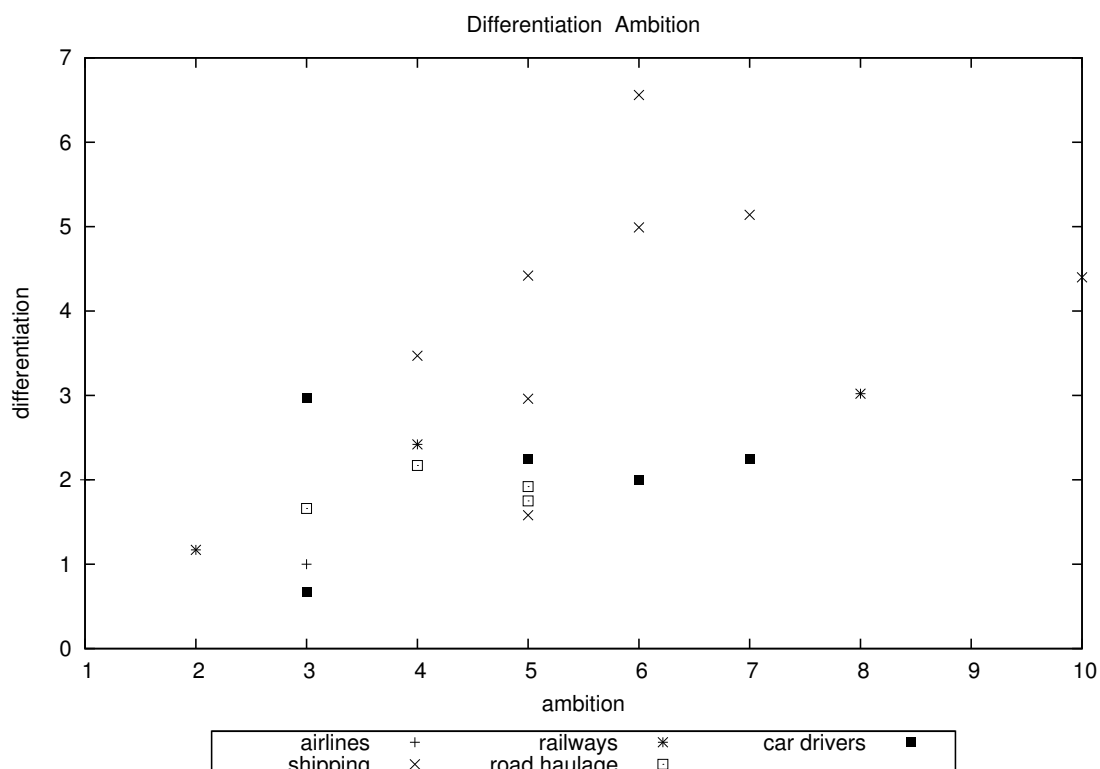


Figure 4: Degree of differentiation versus degree of ambition.

While the hypothesis is motivated by basic mathematical evidence rather than specific economic theory, we use it as a starting point since the revealed relationship will prove to be very useful in controlling for heterogeneity in degree of ambition in our further analysis.

Specific hypothesis A-2 The higher price setting actors value equity considerations, the more they will be inclined to apply price differentiation, where users that deserve support from an equity perspective will be confronted with lower charges than other users.

Different user categories will 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 our definition of vertical equity. We conduct a qualitative comparison between the equity objective in the case study and the users

which are exempt from or being favoured by the scheme. We consider the following types of user support: favouring 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 from an equity perspective why frequent users should deserve support (there may be some degree of correlation).

Another type of user that is favoured under equity considerations, are users that live in a geographically confined area. In passenger transport cases, this mostly corresponds to the political influence of these users (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 protectionism 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, from a (vertical) equity perspective, should deserve support

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

Specific hypothesis A-3 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 costs of an upgraded charging mechanism are prohibitive compared to the expected (social) benefits by the larger degree of differentiation. The studied relationship is plotted in figure 5.

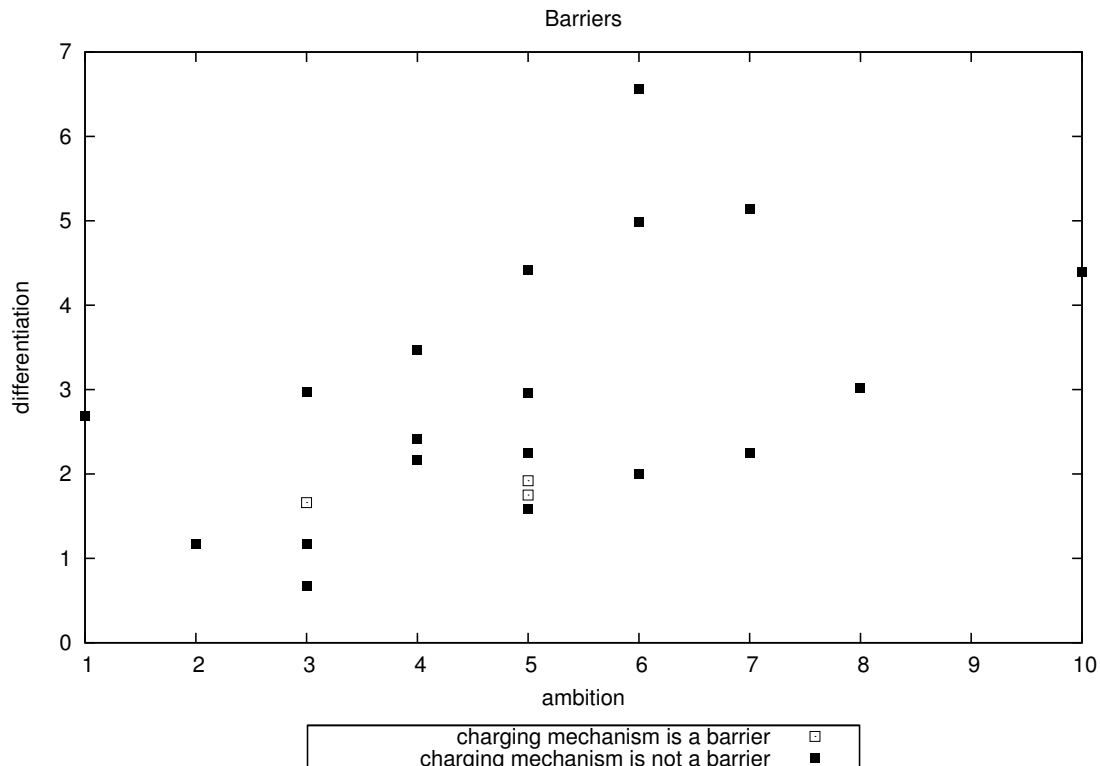


Figure 5: The charging mechanism as a barrier towards further differentiation.

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.

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 these measures.

The second general hypothesis addresses the consequences of differentiated pricing. Again will we discuss a selection of three specific hypotheses. Other hypotheses can be found in the project report (Knockaert et al., 2008).

Specific hypothesis B-1 Effectiveness of a price measure increases with the level of differentiation, but above 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 than for companies (e.g. rail freight operators). And it is stronger for frequent users than for 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.

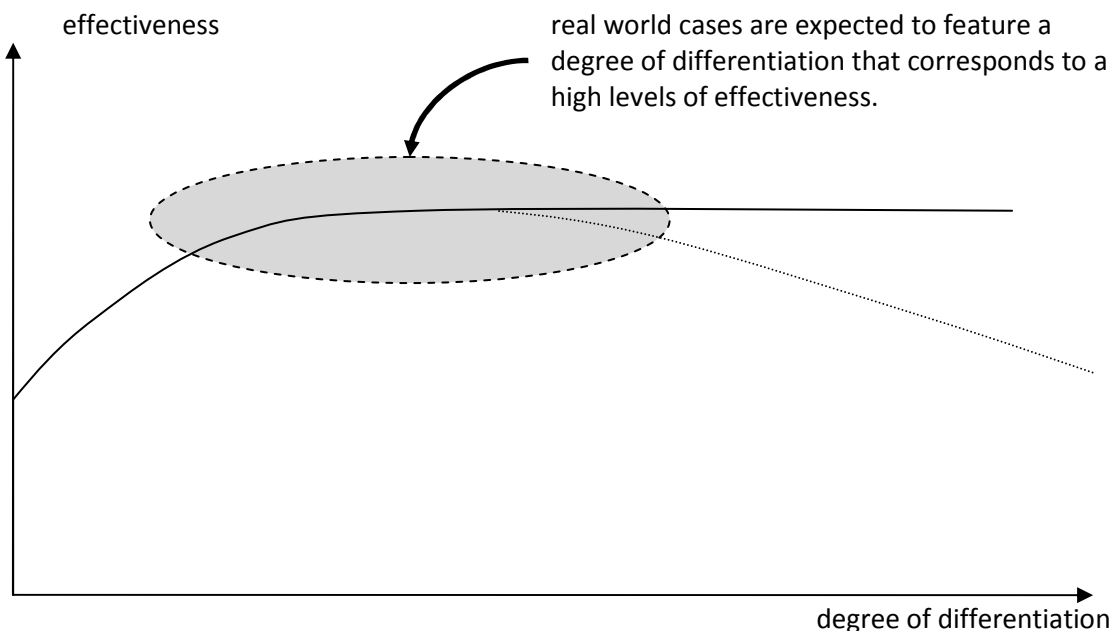


Figure 6: The relationship between degree of differentiation and effectiveness.

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 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. These decision making costs are 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 than infrequent users. Although there probably is some correlation between both categorisations, companies are likely to be more frequent users than individuals.

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

Considering the fact that most cases are real world pricing schemes, it seems safe to assume that they are designed to be (close to) optimal. As we have already seen in comparing the observed degree of ambition to the observed degree of differentiation, there seems to be a relation (figure 6). This relation indicates that a given degree of ambition corresponds to an optimal level of differentiation, which is basically what the hypothesis poses.

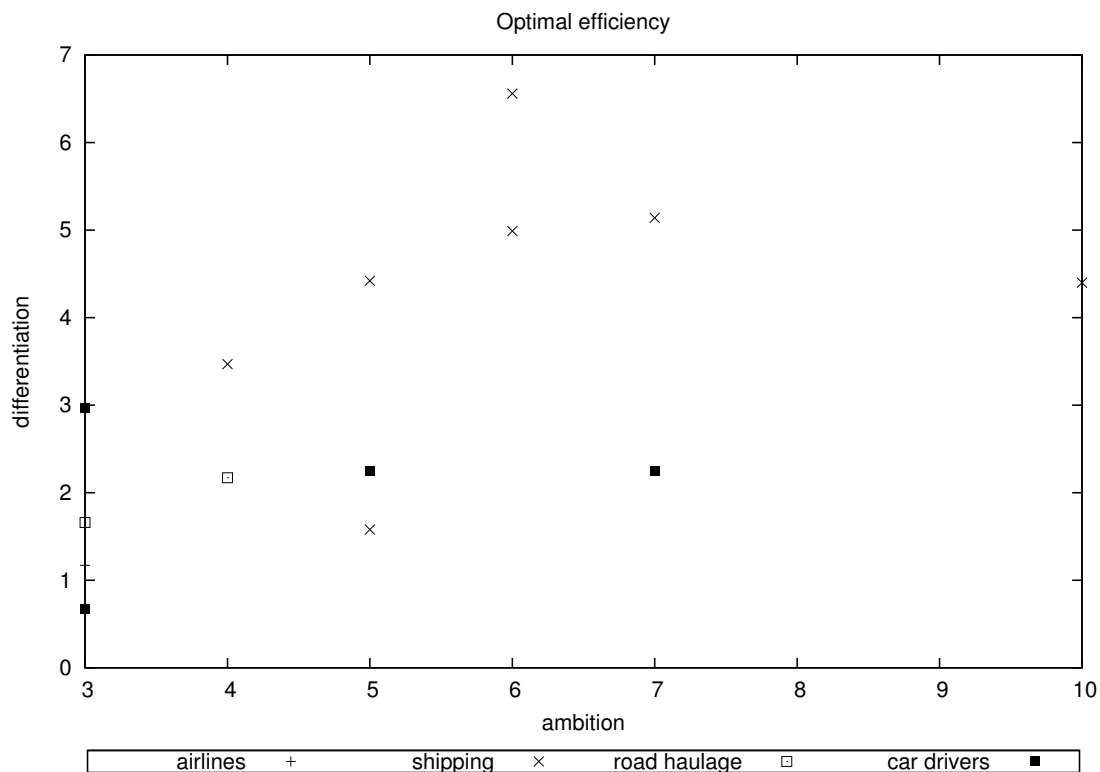


Figure 7: Case studies for which the impact of the charging scheme is reported to be in accordance with the aims set.

By redrawing the relationship between differentiation and ambition and limiting to the cases that have an impact in accordance to the aims set, the picture even becomes clearer (see figure 7). 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 costs play a role. And for a given level of ambition, the optimal level of differentiation is smaller for car drivers than for companies.

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

Specific hypothesis A-2 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 in such a way 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.

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.

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 price 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 the case studies, 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 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 considered relates to route changes of trips to infrastructure outside 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.

Abstracting from the route choice issue discussed above, we observe that the second most reported user response 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 considered (size, type, fuel) are heavily correlated. As such, the hypothesis seems to be 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.

Specific hypothesis B-3 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, this 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, which report on acceptability and in which a value is available for the degree of differentiation and ambition. The resulting subset consists of ten case studies, which we plotted in figure 8.

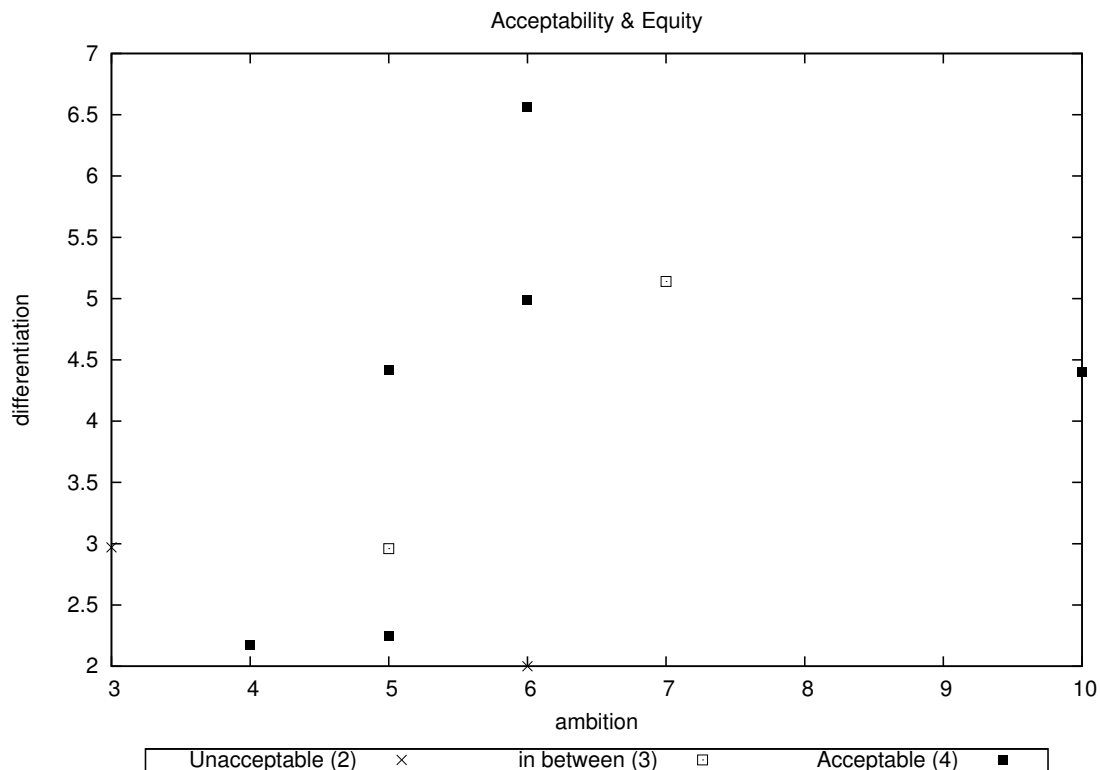


Figure 8: Acceptability in cases where equity is an objective (rated on a scale from 1 to 5, with 1 meaning very unacceptable and 5 meaning very acceptable).

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.

4.2. Positive economics

In the theoretical section, we formulated the conjecture that in reality transport prices are to a large extent the result of political compromises. In the following we shall try to show in more detail how the various pricing schemes that have been developed in

normative price theory can easily be manipulated by politicians and interest groups. We will now substantiate the discussion by means of empirical findings from the DIFFERENT project.

In our discussion of the topic we first elaborate on practical implications of the positive economics' theoretic framework. These findings will result in two hypotheses which will subsequently be tested by using the case study dataset.

Practical implications

We shall first start with cost based pricing structures (marginal cost pricing and fully distributed cost pricing) and then move on to demand based pricing structures (Ramsey pricing, multipart tariffs).

Starting with marginal cost pricing, it is clear that –when applied consistently- this pricing principle would result in very finely differentiated and very complex charges. It is this very postulate of maximum differentiation which opens the door for SIGs to intervene and manipulate the pricing structure. This assertion, however, is too coarse and needs to be refined. The finally implemented tariff structure will depend on the relative political power³ of the various SIGs. If a highly differentiated pricing scheme leads to substantial increases of expenses for the members of a certain (powerful) SIG, it will depend on its relative political power whether this pricing scheme will be implemented or not. A simple example of this case could be HGV tolls. A high degree of differentiation between private cars and heavy goods vehicles would most likely translate into higher bills for truckers. Private car drivers would favour a very differentiated pricing scheme for truckers and a less differentiated and lower price structure for themselves. (In Germany the current toll for private cars on motorways is even zero.) In that way they could shift the major part of infrastructure financing to hauliers. If, however, in this situation truckers are more effective in lobbying, or if the HGV manufacturing industry is important for policy-makers, the tariff structure which is finally implemented will be less differentiated than private car users would want it to be.

Fully distributed cost tariffs, once implemented, are (as shown by Laffont 2000) less amenable to political manipulation than marginal cost prices. On this basis one would expect that the activity of SIGs will be directed more towards manipulating the cost calculation method. It can be expected, for instance, that SIGs will debate the costing methodology (accounting based vs. pure economical methods), the allowed rate of return as well as the degree of detail of the cost calculation. This too can result in a higher degree of price differentiation.

A recent example are the developments of the German HGV toll: a more detailed cost calculation led to a marginally higher tolling level.⁴

Sometimes pricing schemes based on Fully Distributed Costs are amplified by incentive compatible pricing elements. Again, the German HGV toll may serve as an example. The charging structure incorporates reductions and penalties for the use of environmentally friendly vehicles.⁵ This led to a much higher degree of differentiation

³ Political power of an interest group can be defined first in terms of voting power (e.g. the number of members of the SIG), or in terms of financial power (e.g. the wealth of the single members of the SIG).

⁴ The new calculation method was developed by IWW/Infras. The calculation reports infrastructure costs of HGV at one cent higher than in the original calculation of 2002.

⁵ This calculation was made by means of a toxicity comparison method of the respective emission classes.

than the pure FDC methodology for the allocation of infrastructure cost would have implied. The winners of the new charging structure (effective from the beginning of January 2009) are the German hauliers, who in most of the cases use governmental subsidies to purchase environmental friendly vehicles and therefore pay a lower effective charge, which gives them a relative competitive advantage compared to foreign hauliers.

In contrast to cost based pricing schemes, demand based charging structures take differences in the behavioural patterns of the infrastructure users as a point of departure.

Let us begin with Ramsey pricing. Ramsey pricing takes price elasticities of user groups into account. The traditional principle of “value of service pricing” scheme of railroads may be interpreted in this way: by charging higher tariffs for high value goods, railroads exploit the lower elasticity of demand of the corresponding shippers. But Ramsey pricing is applied in other areas of transport too, although this may not be obvious at first glance. The reason for this apparent paradox lies in political influence. Political influence often results in the very opposite of the Ramsey principle that price should be higher for the inelastic demand. For example, in many European countries commuters can subtract a certain amount of money (based on the daily travelled distance) from their taxable income. Taking into account that commuters are in general less elastic in their travel behaviour than other travellers, this would seem to be more a case of inverse Ramsey pricing than of Ramsey pricing itself. Policy makers usually justify inverse Ramsey pricing with positive externalities (e.g. welfare effects of commuting mobility) as well as equity arguments. However commuters are also voters who are traditionally very well represented in the political process via automobile clubs and other organisations. Abolishing commuting subsidies would automatically decrease a politician’s re-election chances substantially. Germany, for instance, has just seen the re-introduction of commuting-subsidies after attempts to reduce them to a far lower level.

In this case it is clear, that SIGs have taken advantage of their political power and achieved to impose differentiation in line with their interests.

Examples like this seem to fit very well into the framework of positive economics. Since Ramsey pricing translates into different prices for different user groups it is very likely that the group paying the higher price will lobby in order to pay less. Keeping in mind that the policy-maker aims at re-election, politicians will try to avoid disadvantaging major SIGs. This means that, if disadvantaged user groups have high political power, policy makers will try to appease them in one way or another. The most likely way to do this is to create subgroups and impose additional price differentiation. From the perspective of positive economics, Ramsey pricing is therefore a policy which should be applied with caution, because it may invite interference of SIGs in the “wrong direction”.

Another useful pricing scheme for transport could be peak-load pricing in situations where travel demand fluctuates predictably. For SIGs it is much more difficult to manipulate peak-load pricing, since peaks are clearly recognizable and therefore not manipulable. For this pricing scheme it is therefore to be expected, that disadvantaged SIGs will centre their activities at first on avoiding peak-load pricing altogether. This seems to be the case in air transport. In the very few situations where peak-load pricing

on airports was implemented (Schank, 2005), legacy carriers engaged in heavy and successful lobbying to remove it.⁶

A further reaction of interest groups to peak-load pricing could be the attempt to influence the methodology of calculating marginal and capacity costs (see the case of FDC-pricing above). The peak-users would have an incentive to shift part of their capacity costs to the off-peak users. Commuters for instance would lobby in order to pay only the incremental infrastructure costs, or to exaggerate common costs with off-peak users.

Non-linear tariffs contain a fixed component (ideally reflecting the fixed costs) and at least one variable component (ideally reflecting marginal costs). Optional tariffs are a combination of at least two two-part tariffs, where the user can choose the one tariff fitting best to his/her preferences. Since users minimize their spending, they select a tariff according to their level of consumption. Therefore optional tariffs can also be seen as multipart tariffs. As stated in the theoretical section, Laffont's results show that there are cases where political distortions make linear tariffs superior to optional tariffs. The reason for this result lies basically in the self-selection possibilities of SIGs to consume more or less than they would do in the welfare optimum and in that way to shift the financial burden to other users. In addition, a higher degree of differentiation of the variable components of the charge will multiply the possibilities of decision-makers to burden particularly weaker user groups.⁷ Another additional possibility for political influence related to non-linear tariffs, is the possibility to change the proportions between the fixed and the variable proportions of the charge. Take for instance airport pricing: the typical charge on European airports consists of a fixed charge (determined by MTOW) and a variable charge (determined by the number of passengers). Legacy carriers favour a regime that contains only variable charges for two reasons: First, paying only a price per passenger implies that risks resulting from demand fluctuations are (partly) transferred to airports. Second, paying only a variable charge is in line with the business model of legacy carriers to capture the passenger's time sensitivity, which translates into a high service frequency and relative small aircraft size. In contrast, low-cost-carriers (LCC's) prefer to pay one price per take-off or landing, rather than a price per passenger, since they usually fly with high load factors. As a result, it is very likely that LCC's and legacy carriers will try to influence the pricing policy of airports with respect to the variable and fixed component of non-linear tariffs. The result again will depend upon the balance of political power.

Summarising this section so far leads to the formulation of the following conjecture:

General Hypothesis 1 The setting of infrastructure-tariffs is subject to a strong political element. The positive theory aspect of setting infrastructure charges is therefore

⁶ In just one case lobbying did not succeed to oppose peak-pricing efficiently. This case refers to La Guardia airport in year 1968, which experienced after the introduction of peak-pricing a massive exit of regional airlines to Teterboro airport.

⁷ Laffont's result applies to outputs which are end-products. In talking about infrastructure user charges we are, however, dealing with intermediate products. It is well known that for end-products non-linear tariffs are pareto-superior to linear tariffs (apart from marginal cost pricing). With respect to intermediate products this is not necessarily the case (Ordover and Panzar, 1982) Frequently economists overlook this difficulty and use the so called "Willig theorem" for intermediate goods too, such as transport infrastructure services. Nevertheless it is still an open question whether Laffont's result applies to intermediate goods in the strict sense too.

highly relevant. Lobbying activities will be a major explanatory variable for the tariff structure that will finally be implemented.

General Hypothesis 2 Policy makers will react to lobbying influences and implement a “SIG equilibrium” (“a compromise”). Infrastructure charges which correspond to such an equilibrium may be labelled as “politically acceptable”. This means that in reality cases where charges conform the “textbook model” of a certain pricing-scheme (like marginal cost pricing or Ramsey pricing) will be rare. 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 would be positive.

Specific Hypotheses

With respect to the finally implemented charging structure, our analysis shows that different pricing rules lead to different SIG behaviour regarding different transport modes. In order to generate testable hypotheses concerning the effects of SIG behaviour on the finally implemented tariff structure, a framework of very detailed and differentiated hypotheses would be necessary. For practical reasons however and due to the limited amount of existing data (see the previous section), we limit ourselves to the formulation of two rough hypotheses, which reflect the main ideas of the theoretical analysis above. As stated before, price differentiation plays an important role for SIGs and policy makers in most pricing rules. In almost all pricing rules the number of SIGs as well as the distribution of their political power will be decisive for the final policy outcome:

Specific Hypothesis 1 The higher the number of participating SIGs and the more balanced the distribution of their political power, the higher the degree of differentiation of the charge. If the number of SIGs becomes very high, however, the situation will approximate a regime of polypolistic competition where no SIG will be able to wield a decisive influence on the political process. Therefore, in this case the predictions of positive theory will be identical with the predictions of normative theory.

Corollary The smaller the number of participating SIGs and the more unbalanced the distribution of their political power, the lower the degree of differentiation of the charge.

In the following we will present the empirical results from the case studies in order to test these two hypotheses. The first major finding is that in almost none of the case studies a clear “textbook” pricing rule can be found. Most charging structures mix cost and demand elements in an opaque way, without recognizing the initial pricing rule. But this is only a first hint of the influence of SIGs. To deal with this issue more deeply a type of Delphi study was conducted within the DIFFERENT group with the various partners of the project acting as experts for their country.

The first goal was to identify the political dimensions of the pricing scheme. From the answers obtained, it is clearly recognisable that the political dimension plays a decisive role. In 87 percent of all case studies the political factor is recognised as a crucial factor in pricing issues. The range of the political dimensions covers all transport modes and all countries concerned. There is only one case in which there is clearly no political

dimension at all, namely the Spitsmijden case. However, this case is based on experimental design and therefore cannot give evidence of any political dimensions at all. The large share of case studies indicating political dimensions supports General Hypothesis 1 above.

Turning to the issue of political acceptability, the picture obtained by the case studies is very similar to the one with respect to the relevance of the political dimensions. The vast majority of all case studies (77 percent) showed evidence of the relevance of political acceptability. It was also clearly observable 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. Additionally, both findings conform to Corollary 1. A majority of cases shows the relevance of the political dimension in infrastructure charging. At the same time a vast majority of cases detects politically accepted charges (little complaints and therefore little ex post lobby activities). One may assume therefore, that these charges represent a SIG equilibrium.

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. The results were as expected. Infrastructure companies seem to be unambiguously the “losers” of the political game of setting infrastructure charges. In most of the cases (12 out of 22) users were recognized as the beneficiaries of the charging structure. This result was expected, since in almost all European countries infrastructure users have well organized interest groups. For instance car drivers are organised in automobile clubs which do not only provide technical assistance but also intervene with transport policy. Their political influence seems to be very high due to campaigns and printed media. Also, particular shippers (mostly oil-industry related, like in the case studies on ports) are favoured by the price structure. Some shippers managed to form small but very effective interest groups and therefore are in the position to keep the free rider problem under control. This means that shippers also have incentives to contribute to their lobby group in financial terms. With respect to the rest of the cases, results depend on the type of infrastructure analysed. Airport charges for instance are relevant for airlines and tour operators (as the major users). An interesting finding is that infrastructure companies do not seem to be able to establish their favoured tariff structure (see above). As privatisation progresses, infrastructure companies are expected to be the “winners” of the tariff-setting process (Betancor and Rendeiro, 2000) in more and more cases. Therefore, lobbying is expected to rise in the future. For the rest of the cases the picture was not clear enough since the researchers could not answer who benefits from the current tariff structure. Apparently, in these cases the political power was not clearly distributed and therefore no SIG could exclusively benefit from the tariff structure. This is an additional hint that the political balance of power is decisive for differentiation. In nine cases shifting of financial burden to other users was observed.

Summarizing the empirical evidence so far, we conclude that lobby activities play a key role when designing tariff structures. In the vast majority of the cases concerned users of infrastructure facilities are favoured by the tariff structure.

The next step is to link the degree of differentiation (as defined before) with lobbying activities and the political power of SIGs. Figure 9 depicts the first relation. The abscissa in this figure depicts the existence of lobbying activities (Yes/No) and the

ordinate depicts the degree of differentiation as defined above. The trend in this figure is clear: the degree of differentiation increases when lobby activities take place. However, the degree of differentiation has a relatively wide range. Hence, we can not safely conclude that the degree of differentiation increases with increasing lobbying activity per se. It is apparent that also other factors, such as voting power of the participating SIGs, play a key role.

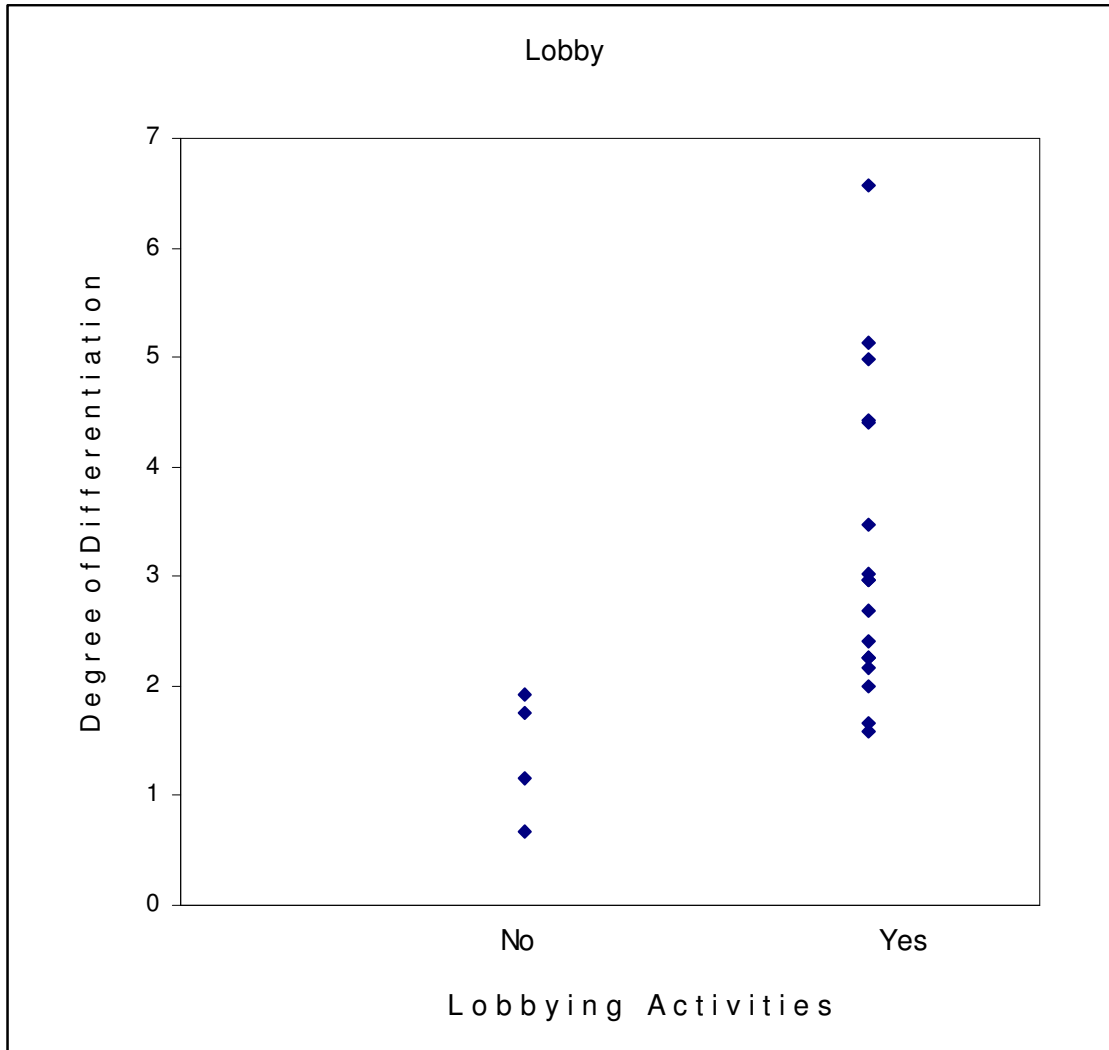


Figure 9: Degree of differentiation and lobbying activities. Source: Author’s own calculations.

In order to account for at least one of these factors we included voting power in the analysis. To do this we plot the degree of differentiation against the three possible levels of political power (as indicated by the case study leaders). Figure 10 shows a differentiated picture: first, the low number of cases (two cases) with low political power of the respective SIG does not allow for drawing safe conclusions; second, if political power of the dominant SIG is high, 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 welfare of the members of this particular SIG; third, if political power of SIGs is medium, it can be safely stated that more than one SIG is active. In this case, decision makers will take into account the welfare of the

most powerful ones. Thus, the degree of differentiation tends to be higher than in all other cases.

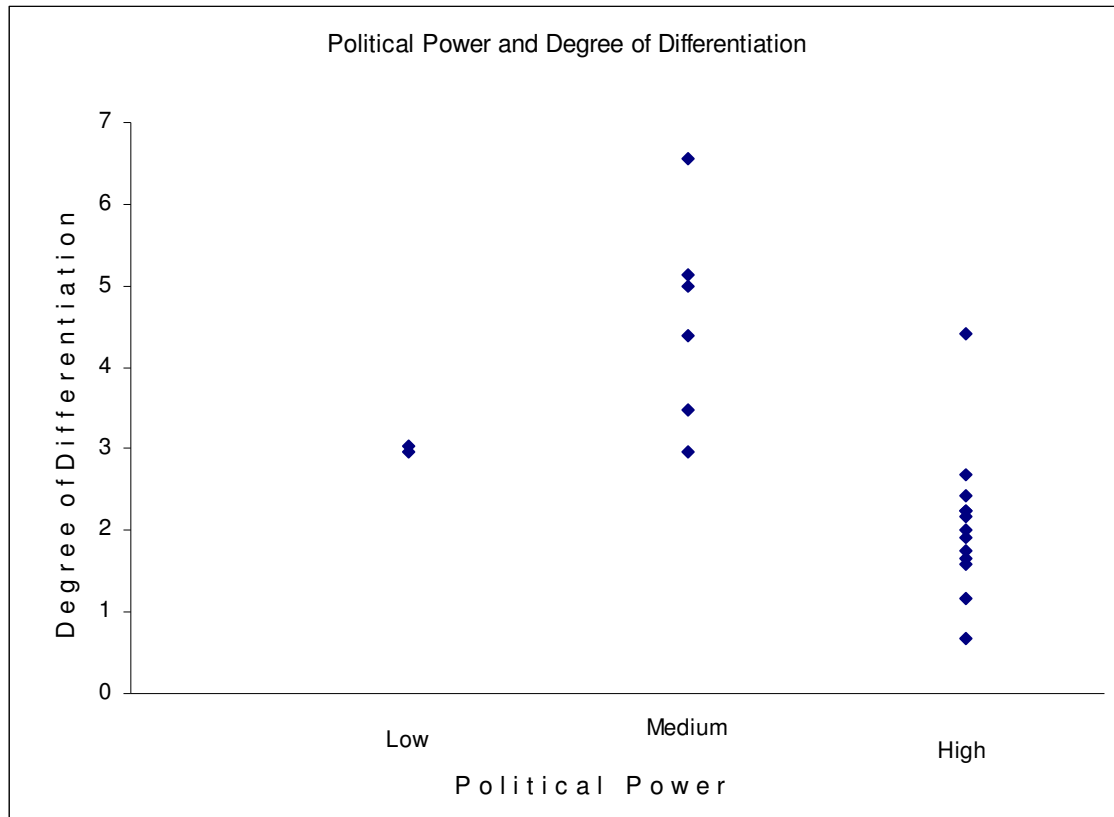


Figure 10: Degree of differentiation and political power.
Source: Author's own calculations.

At this point it has to be stated that the limited number of cases does not allow a test for each single pricing rule as described above. Additionally, the balance of political power is different in each single transport mode. In air transport for instance legacy carriers traditionally have much more political power than low cost carriers. Finally, in each transport mode there are different parameters defining the activities of interest groups. The degree of competition in the market, or the nature of regulation are two prominent examples of this. However, these first results give a safe impression on the outcome of the political process, when designing infrastructure charges.

With respect to the impact of lobbying in terms of overall welfare effects, it is difficult at this stage to draw safe conclusions. If only one major SIG prevails (as figure 10 shows), the degree of differentiation of the charge decreases, apparently below the optimal level. In contrary, if more than one SIG interacts in the political game, the degree of differentiation increases, apparently above the optimal level. In both cases welfare losses take place (see also specific hypothesis B-1 of the normative economics framework). These welfare losses are increased by transaction costs of organizing and running an SIG. Safe conclusions can however only be drawn if the optimal level of price differentiation is clearly defined. Defining this optimal level needs further research.

5. Conclusions

In our analysis we covered a broad range of topics on infrastructure charge differentiation. Two strands of economic theory were explored: the positive and the normative economics approach. It was argued that both theoretical frameworks are not mutually exclusive: positive theory describes how policy makers maximise their personal utility but at the same time take into account normative elements such as general welfare.

An analysis of the practise of differentiated infrastructure pricing was conducted on a set of case studies. The case studies covered an extended scope of infrastructure and user types and hence carried much heterogeneity. To allow for a cross case analysis, it was necessary to somehow control for this heterogeneity. Two generic indicators were introduced. The first one captured the degree of ambition and was used in the analysis as a variable to control for heterogeneity in the aims of price setting actors. A second indicator captured the degree of price differentiation and proved to be useful as a dependent variable in our analysis of the charging schemes.

As for the impact of the aims of price setting actors, we revealed that a higher level of ambition relates to a higher degree of differentiation. While the described relationship is straightforward, it supports our use of the degree of ambition as a proxy for case study heterogeneity.

Furthermore we showed that the actual charging mechanisms may pose a practical barrier towards more differentiation where a degree of differentiation is observed that is lower than expected for a given level of ambition.

If we look at the relationship of the degree of differentiation and effectiveness, we observe that in practise the decision costs play a role in reducing the optimal level of differentiation for higher levels of ambition. This effect is stronger for car drivers than for companies paying the charge.

The cross case study analysis made clear that user reactions are expected to occur in behavioural domains that directly correspond to the dimensions of the pricing differentiation. While again this may sound trivial, this has important practical implications with respect to potential effectiveness and efficiency of pricing schemes that focus on charge differentiation across dimensions that depart from the intended behavioural change.

The analysis revealed that equity objectives can influence differentiated pricing schemes in many ways. The impact of the normative theoretical framework is confirmed by the observation that a higher value given to equity considerations (by price setting actors) results in lower charges for private car users that deserve support from an equity point of view. But in cases where companies are paying the infrastructure charge, protectionist tendencies seem to have a larger explanatory power for the distinction between the favoured users and the non-favoured ones. In this case, the positive theoretical framework describes how a powerful SIG can manipulate a scheme that is based on equity objectives.

Furthermore, we observe that a higher degree of differentiation increases the acceptability in equity oriented cases. While again the relationship can be explained from a normative point of view, relating a higher level of political acceptability to lobbying of SIGs which result in a higher degree of differentiation can also be explained by the positive theory.

The positive economics framework implies that different pricing schemes result in different manipulation possibilities by SIGs. 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.

The case studies further indicate that lobby activities are a major explanatory variable for the differentiated charging structure. Moreover, political acceptability of a certain pricing scheme can only be achieved if the most powerful SIGs do not object. As a result, the actual tariff structure reflects the political power of the SIGs. Whereas the presence of a larger number of SIGs (with a smaller amount of political power each) necessitates for a brokered compromise that carries much differentiation, a single powerful SIG may overrule the other SIGs in the lobbying process and hence allow for a political compromise on a less differentiated scheme.

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