APPLYING MOBILITY PRICING INSTRUMENTS TO OPTIMIZE TRAFFIC AND TRANSPORT

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ABSTRACT

Among numerous, established instruments of Mobility Pricing, e.g. public transport tariffs or parking fees, new approaches for pricing the mobility can be found more and more. City toll systems, like the introduced ones in London and Stockholm, gain a lot of attention, also internationally. As a consequence, in many countries, the opportunities and risks of new instruments are going to be debated intensively. In order to support the upcoming discussions, this article looks into the requirements and the effects of the different mobility pricing instruments. The potential goals of mobility pricing are presented, and an overview of the different types of instruments is given. Mobility Pricing offers significant contributions to achieve political and planning goals and to optimize traffic and transport systems. An objective and substantiated discussion of new instruments appears to be not only desirable but absolute necessary, in terms of a sustainable design of our traffic and transport systems.

Introduction

Mobility Pricing comprises all the instruments by which a user must pay for his potential and realized spatial mobility in passenger and freight traffic.

Numerous mobility pricing instruments are already established worldwide, e.g. public transport tariffs, parking fees, or fuel taxes. Recently, some new approaches and applications of pricing schemes (such as the road pricing in London or Stockholm) gained a lot of attention, also internationally. As a consequence, in many countries, the opportunities and risks of new instruments are going to be debated intensively. However, e.g. in Germany the deployment of such new instruments was still politically resisted until now because the public acceptance level was estimated to be low. There the topic is increasingly discussed only lately. The discussion about application is supported by the positive experience in Germany with the freeway truck toll, by successes in international implementations as well as, by an intensified need for action in the finance and traffic management sectors. At the same time, it is generally accepted that the experiences in specific countries cannot directly be transferred to every other country and that the correlation between the different mobility pricing instruments must be considered.

In order to support the upcoming discussions regarding the opportunities and risks of an implementation of such instruments, this article looks into the requirements and the effects of the different mobility pricing instruments. The potential goals of mobility pricing will be presented, and an overview of the different types of instruments will be given. The potentials and the risks of individual instruments will be identified with special consideration of intermodal aspects. This includes a summary of some current international developments.

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Goals of Mobility Pricing

The goals of an application or alignment of mobility pricing instruments mostly lie in the scope of traffic management and financing. The question of acceptance plays a role in both scopes. Regardless of the intention an instrument is adopted with, it will affect both scopes.

The strategic goals of traffic management lie in the fulfillment of the mobility needs, an increase in traffic safety, an improved cost effectiveness, the protection of natural resources as well as, the reduction of the environmental impacts. From an operational point of view, the goals of traffic management may be classified as traffic avoidance, traffic shift (timely, spatially, modally), and traffic control. The goals are summarized in Figure 1.

The current report focuses on the areas of traffic management and acceptance. Finance has an undisputed high level of importance; however, it will not be the focus of this report.

Figure 3: Goals of Mobility Pricing (Summary)

CATEGORIZATION OF THE MOBILITY PRICING INSTRUMENTS

Despite the prevalent use of the same term, there can be essential differences between the applied instruments, which can, e.g., be seen in the term „City-Toll". This instrument was adopted by, e.g., the City of London in 2003 under the name „Congestion Charge", and the City of Stockholm introduced a time limited trial in 2005/2006 under the name „Trängelskatt". Since 1st of August 2007, the City-Toll system in Stockholm is permanently implemented. However, the two systems in London and Stockholm have quite different parameter values and consequently different effects.

This necessitates a detailed differentiation and categorization of the mobility pricing instruments, which is possible on the basis of four questions (Why are charges imposed? For what are charges imposed? On what basis are charges imposed? By which means are charges imposed?). The attributes and their characteristics defined via the questions are presented in Figure 2.

Goal of Pricing

Traffic management	not considered	traffic avoidance	traffic shift: timely	traffic shift: spatially (destination)	traffic shift: modally	traffic control: route choice	traffic control: product choice				
Financing	not consid-ered	adjustment: to tax financing	adjustment: to premium or fee financing	adjustment: to user financing	adjustment: to private financing	shifting: cost neutral	shifting: for an increase of public revenues	shifting: with over-charging	charging: of route costs	charging: of traffic infrastructure costs	charging: of external costs

Purpose of Pricing

Cause	traffic opportunities	flowing traffic	parked vehicles							
Means of transportation	air traffic	rail traffic	shipping traffic	heavy vehicle traffic	passenger car traffic	other motorized street traffic	public transport (Bus, Rail, Taxi)	bicycle traffic	pedestrian traffic	other
Utilization area	Europe	Country	State	City	Subarea					

Differentiation of the Pricing (Tariff)

Situation dependent	not considered	time of usage	area	environmental impact	traffic volume	booking time	payment time	
User dependent	not considered	vehicle type	emission standard	user group	occupancy (level)	traffic type	driving style	
Usage dependent	not considered	entrance/exit/transit	mileage	utilized zones	duration of use	other		
Temporal util. contingency	continuous utilization	utilization limited for a time span	unique use					
Spatial utilization conting.	network	area / zone	cordon	object / route				

Other Aspects (organizational / financial)

Traffic system operator	public organisation	private organisation	private organisation, publicly influenced		
Principle of price formation	incremental costs	full costs	demand based price determination	subsidies	other
Utilization of revenues	for the charged system	for other traffic means/systems	earmarked utilization for other areas	return payments	not earmarked for any purpose
Price determination	before the utilization (plan)	after utilization (best price)			

Other Aspects (technical)

Analysis of Effects and Requirements

The consideration of the different design possibilities of the mobility pricing instruments as well as the closer examination of current case studies and reports, and some analyses of the mobility budget serve to describe the effects and requirements of the different instruments. Thereby, direct (modal) effects, intermodal effects and financial dependant effects must be considered.

The following analysis of effects and requirements is carried out based on these six evaluation areas which are derived from the goals: traffic situation, economy, environment, acceptance, financing and system design. The following core predicates have been elaborated to focus the results of this analysis. Comprehensive literature and case study references proving the individual predicates are contained in the unabridged version of this study (Boltze et al., 2007).

Traffic Situation

Mobility Pricing can change mobility behaviour.

→ The traffic volume can be influenced according to the set goals.

Traffic avoidance is possible e.g. via a more efficient use of traffic means. For instance, this effect can be observed in the implemented systems in Singapore (cf. Steininger et al., 2005) and the truck toll in Germany (cf. Bundesamt für Güterverkehr, 2006). Furthermore, the local traffic volume can be altered by changing the destination choice and reducing the travel distance. A change in the choice of the travel time arises primarily when temporally differentiated fees are introduced. A good example of this is the City-Toll trial in Stockholm, where an appreciable relief during the rush hours was observed (cf. Stad Stockholm, 2006a). An influence on the destination choice is possible through modal, intermodal and financial dependant effects. This influence is particularly boosted when sufficient alternatives are available, which can be observed e.g. within the London city toll (cf. Bell et al., 2004). A change to the route selection could be observed in the implemented system in Trondheim (cf. Progress, 2007). Thereby, a targeted influence is possible through a spatially differentiated charging model. Financial dependant and intermodal effects play one of the main roles in changing the choice of the traffic means. This is shown e.g. through the city toll systems in Stockholm and London, which lead to an appreciable change in the traffic behaviour (cf. Stad Stockholm, 2006b; Transport for London, 2006). A decision between qualitatively different offers of the same traffic means is made at the changing of the product choice. Product choice adaption by the traffic participants can also be influenced through differing price levels.

→ A range of potential improvements of the traffic situation and traffic quality arise from these opportunities to influence traffic volumes.

Mobility Pricing instruments can lead to a more efficient utilization of the traffic means and infrastructure through the produced traffic shift. Capacity overload in motorized traffic and public transport can be reduced. A considerable reduction in traffic jams could be observed in London as well as in Stockholm (cf. Steininger et al., 2005; Stad Stockholm, 2006a). Due to the reduced congestion, it is possible to increase the travel speed in turn, and thus to reduce the travel time. Above all, the intermodal effects are important here. Through the enabling of better and faster service, public transit also benefits from the motorized traffic charges and its associated improvements. The effects on the traffic safety through mobility pricing must be considered differentiated because positive and negative effects may emerge. However, overall positive effects were observed in London and Stockholm (cf. Transport for London, 2006; Stad Stockholm, 2006b).

➔ Obstructing the traffic flow through technical processing can be nearly completely avoided.

In all the recently realized case study examples (e.g. German truck toll, performance related-heavy traffic charge in Switzerland (LSVA), city toll in London, city toll in Stockholm), obstructions arising from the technical payment and enforcement systems could be avoided through modern systems.

➔ The effectiveness of mobility pricing instruments depends strongly on their design and on the circumstances of application.

A targeted influence of the effectiveness is possible via the price. At the same time, the concern about the price and price assessment play a role along with the price knowledge (cf. Bauer, 2007). But prices are effective only if they are the greater deciding factor, in the face of other contrary affecting circumstances. Thus, the German truck toll leads only to a small traffic adaption, because the extra effort and lost time of the adaption strategies were estimated to be more negative than the toll costs (cf. Clausen et al., 2005). The user costs must therefore be clearly noticeable, if the behaviour should be influenced. In addition, the effectiveness is influenced through the trip purpose and other circumstances. This shows itself also through different price elasticities. In the case studies, different responses were observed dependant on the trip purpose. Above all, a differentiation is reasonable between the work/school traffic and the shopping/free time traffic. The more conscious the payments are, the more influential the pricing scheme is. Thus, the influence of „Out-of-Pocket" costs on traffic behaviour is stronger than indirect payments. Moreover, the efficiency is not only dependant on the absolute price, but rather also on the relative price level of the alternatives.

➔ Available possibilities to avoid the pricing will be used.

Not only desired effects need to be observed. Depending on the system design, undesired effects may arise along with the desired effects. This is particularly the case where the charges are limited. Thus, the case studies display spatial, temporal and vehicle related evasive behaviour. As an example, the use of non-charged vehicles increased through the German truck toll as well as through the city toll in London (cf. N.N., 2007; Transport for London, 2006). Undesired effects can be extensively prevented through an integrated system design. The performance-based heavy traffic charge in Switzerland is an example for an implemented system that at least eliminates domestic, undesired evasions.

➔ Mobility obstructions can (and should be) avoided.

The avoidance of mobility obstructions is a basic requirement of mobility pricing, which can be fulfilled. The mobility of affected traffic participants will still be enabled by providing adequate alternatives. Thus, especially important is the targeted adjustment of the public transport capacity during the implementation of instruments affecting individual motor vehicle traffic. For example, improved public transport was realized in both city tolls in Stockholm and London (cf. Transport for London, 2006; Stad Stockholm, 2006a).

➔ Holistic Solutions are important.

In terms of an holistic solution, the obstacles affecting behavioural adjustments need to be known. For example, these could be due to life circumstances or to the attitudes of the users. When multiple different mobility pricing instruments with variable characteristics are implemented, the interaction between them must be considered. In addition, financial dependant effects play a large role at this. Furthermore, the interplay with other planning parties and decision areas, e.g. regional and urban planning, as well as the traffic quality must be considered.

➔ Gathered information can be used for other purposes, subject to privacy regulations.

➔ The requirements of a goal-oriented price design arise from the above described effects.

Economy

Mobility Pricing can affect the economy positively as well as negatively.

➔ The traffic sector can be significantly influenced.

Higher transport costs can result from fee changes and particularly from additional charges. It is estimated that the German truck toll leads to an increase to the overall road transport costs between 4 and 6% (cf. Doll and Schaffer, 2007). On the other hand, increases in efficiency are possible due to mobility pricing instruments in terms of an improved planning of commercial traffic, in particular through more reliable travel times, through shorter driving times and through an improved infrastructure as a financial dependant effect. As an example, the industry in Stockholm commended the optimization possibilities in connection with the improved accessibility gained through the city toll (cf. Stad Stockholm, 2006a). Through traffic shifts, above all through changes of the Modal split, specific sectors and their revenue situations may be positively or negatively affected. The city toll in London led to an increase of 20% in taxi and bus rides, which significantly increased the revenue of the public transit sector, for example (cf. Transport for London, 2006). Although the revenue situations of different instruments are interactive. As an example, one can see the inter-play between city toll and parking charges or between one-way tickets and season tickets in the field of public transport. Also, innovation processes can be triggered through the design of the instruments. For example, the increased acquisition of more environmental-friendly vehicles as a result of the truck toll in Germany can have a positive impact on developments in this area (cf. Bundesamt für Güterverkehr, 2006).

➔ The location quality for industry can be influenced.

Through the improvement of the traffic situation, company workflows, which include commercial traffic, can be improved. For instance, the economy in London stated the simplification of the processing of business trips as a benefit of the city toll (cf. Campaigns Team and London Chamber of Commerce and Industry, 2005). The effects of the transport price changes on the overall economy are generally small. It is estimated that the German truck toll led to less than a 0.1% increase to overall costs within the better part of all the industry branches (cf. Doll and Schaffer, 2007). The competition with other regions can be influenced through the mobility pricing instruments because the quality of the mobility offering of a region is a decisive factor of the location quality. A problem arises when this is not economically sustainable. The case studies highlight different effects in this area.

Environment

Mobility Pricing can contribute to an improvement to the environmental quality.

➔ Noise and pollution can be influenced.

For one thing the total load can be reduced. For example, according to projections of the Swiss Department of Environment (Schweizer Bundesamt für Umwelt), the emissions of CO2, NOx and PM10 in 2007 will be 6 to 8% lower due to the implementation of the LSVA and the enhancement of the weight limits, compared with the case if the above measures would not have been implemented (cf. Balmer et al., 2007). For another thing, a targeted influence on the spatial and temporal dispersal is possible with a corresponding system design. To achieve a targeted temporal influence, e.g. staggered charges due to the emissions could be adopted, as is partially the case with landing fees at airports.

➔ The cityscape and living quality can be influenced.

The positive influences to the quality of life are supported by case studies. For example, in Oslo, due to the introduction of the city toll an originally traffic intensive square could be completely closed for road traffic (cf. Aring, 1993). Distinct financial dependant effects in connection with the revenue use are also possible. Negative effects on the cityscape, mainly through the installations of monitoring, registration and payment systems, can be minimized through appropriate system design.

➔ The spatial utilization can be influenced.

Even when basic influences on the spatial utilization must be assumed, these have scarcely been investigated and documented. Effects can arise in the private realm (changes to the location of employment and/or dwelling) as well as in industry. Increased segregation trends can develop particularly through the charging of specific zones. Financial dependant effects are possible if, for example, the connection of specific areas to the public transit network are improved through the investment of the gained means. Through this, also undesirable direct effects can be decreased or offset.

Acceptance

Mobility Pricing needs sufficient acceptance.

➔ A sufficient acceptance can be reached for drastic measures, as well.

The experience with up to now implemented measures generally exhibit a high level of acceptance. This is the case with a number of examples, such as, e.g. the systems in London and Stockholm or the German truck toll (cf. Steiniger et al., 2005; Commission for Integrated Transport, 2006; TollCollect 2006). Thereby, the acceptance increases with a tangible decision and with the implementation of the measure respectively. For example, the share of citizens in Trondheim, who were against the implemented toll, dropped from 72% to 48% two months after the commissioning of the toll (cf. Steininger et al., 2005).

→ The acceptance by the general public is influenced by different stakeholder groups.
The realization and effects of the instruments can be jeopordized by problems on the political level. Therefore, a political agreement at all levels is necessary (cf. e.g. Marner, 2007). Current policies regarding mobility pricing instruments are rather conservative. The acceptance by associations is also an important factor. It appears to be very important to have intensive dialogs with the associations about the advantages and disadvantages of the different mobility pricing instruments, and, if necessary, about their detailed design. The media can influence the public opinion. For example, the acceptance of the city toll system in Stockholm was also boosted through a broad media campaign (cf. Commission for Integrated Transport, 2006). Also in Singapore, the implementation of the electronic system was aided by the media (cf. Steininger et al., 2005).

→ The acceptance depends largely on the design of the mobility pricing scheme.
The system must be felt to be fair, in order to achieve a high level of acceptance. This is supported when good alternatives are available. The users expect a noticeable improvement to the problems. The acceptance level is supported by a clear reference to the problem, tangible considerations and the perception of the measures as effectively and efficiently solving the problem. In Stockholm e.g., this caused a higher acceptance level of the direct benefactors of the system as compared to the general public who benefited less and were outside of the charged area (cf. Commission for Integrated Transport, 2006). The earmarking of the revenues can increase the acceptance. The revenue use and its disclosure is very important. The earmarking for the German truck toll was also a much debated theme and was also deemed important for the acceptance level (cf. Ruidisch et al., 2005). The implementation of measures as a package can cultivate a high acceptance level. For instance, the Road Pricing System in Singapore was successful, for one because it was part of the traffic management, which additionally included measures that boosted the public transit and P+R grounds (cf. Steininger et al., 2005). In the same way, compensation measures can increase the acceptance. People show the preference to make decisions based on simple information, which allows them to be able to calculate the different prices and work better with the tariffs. This simplicity supports the acceptance. Sufficient information and communication also reinforces a high acceptance (cf. e.g. Weigele et al., 2007). The problem history, necessity, costs, measures and goals must be transparently illustrated. Sufficient social and political understanding of the economical correlations is important for mobility pricing. Known instruments are better accepted than unknown instruments. Thus, experience with already implemented instruments is another important factor for the acceptance.

Financing

Mobility Pricing needs an integrated financial consideration.

→ Next to the business effects, overall economic effects also emerge.
As a result, the following requirement arises within the overall economic consideration: the different costs and uses of the instruments are to be viewed at a higher-level context. Therefore, high charging costs must also be considered within the complete context. Otherwise, they can lead wrongly to the rejection of new instruments (cf. e.g. Becker ser al., 2007). The charges can be based on different approaches (route cost calculation, marginal cost calculation, price standard approach etc.). The approach choice depends on the set goal, amongst others. Mobility pricing instruments can impact different user groups differently.

Group differentiation is here possible according to e.g., income level, place of residence or social class.

→ There is an overall correlation between all the instruments of mobility pricing.

For example, there is the correlation between the city toll and the parking fees in the tolled zone, or the correlation between the public transit fees and the costs of private motorized traffic. The realization of compensation measures for the mobility pricing instruments is possible. Economic decisions are only made by traffic participants if the comparable costs of alternatives are known to them.

→ Revenue situations and finance systems can be changed considerably.

System Design

Mobility Pricing needs instruments designed in a goal-oriented way.

→ Principle decisions for mobility pricing should be directed towards the pursued goals as opposed to modifying the goals to fit within current technology.

→ The starting point for the technical system design must be the overall goals and requirements.

The design of the instruments must be discrimination free. Attention must be given to avoid disadvantaging particular user groups. Safety aspects must be considered during the implementation. In particular, the information reception by the traffic users needs to be thoroughly considered. The systems should be reliable. This is also important for the building of trust by the traffic users in the system. Systems should be interoperable. The definition and use of standardized systems is desired. There still exists some need for action here. A positive example can be seen in Scandinavia, where clients can use toll systems of different operators with the same on-board unit since March 2007 (cf. Schwarz 2007). The systems are to be integrated in a overall architecture, in which the structure and interaction of all the system elements are characterized on an organizational, functional and technical level. Organizational-institutional qualifications must be created because a central institution is appropriate for the coordination. The system design must be legally possible. If necessary, legal adjustments are to be implemented. At the same time, national policies as well as international guidelines must be considered.

Conclusions

The comprehensive analysis of the effects and requirements clearly shows that mobility pricing offers significant contributions to achieve political and planning goals and to optimize traffic and transport. The instruments are very effective when they are carefully designed. These results are shown and supported through the conducted literature review, the case studies, and the analysis.

The primary goals can lie in the areas of traffic management and financing; the effects must always be considered in both areas. In detail, the modal, intermodal, and financial dependent effects in the realms of the traffic situation, economy, environment, acceptance and finance must always be considered fully and as a whole. From an economic view, a comparison of the overall benefits and overall costs should underlie the decisions of the mobility pricing instruments.

The choice and design of the mobility pricing instruments requires prudence and an integrated approach. Negative effects can be largely avoided through the careful design of the individual instruments and through bundling instruments together. The case studies clearly prove that a high acceptance level, even for drastic new instruments, is achievable if they noticeably alleviate significant problems.

Mobility pricing instruments clearly offer more chances than risks. An objective and substantiated discussion of new instruments appears to be not only desirable but absolutely necessary, in terms of a sustainable design of our traffic and transport systems.

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