Potential influence of city pricing (downtown toll) for private transport in Germany on travel behaviour

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Abstract: The impact on individual travel which the potential introduction of a city pricing system would have in a German city was the focus of a study conducted by the German Aerospace Center (DLR)-Institute of Transport Research (DLR-IVF) in the cities of Berlin and Stuttgart. The focus is on possible changes in the travel behaviour of car users. Our initial overview of the results of the study demonstrates that the introduction of a toll in German cities as well would tend to cause clear changes in travel behaviour. In general, the potential for diverting traffic through introduction of a downtown toll tends to vary widely depending on travel purpose. The clearest changes will be observed in shopping trips and trips for personal reasons.

Key Words: road pricing, transport costs, infrastructure pricing, travel behaviour

1 Introduction

Road pricing has been discussed since quite a long time as a political measure to shift transport costs directly to the infrastructure users thus also meeting the need for providing efficient transport infrastructures in the future. Other general objectives related to road pricing concern traffic management, in particular the support of an efficient handling of traffic. Ecological effects are more or less considered as welcome side effects. Only marginal data is available with respect to the actual impact of road pricing on traffic conditions. Nevertheless, road pricing is increasingly discussed as a traffic management measure. [1]

"Road pricing" is an umbrella term encompassing a wide variety of pricing concepts. Among these concepts, we can distinguish between mileage-based and non-mileage-based, asset-related, route-based and time-based pricing. Other characteristics of road pricing systems relate to the geographic delineation of the toll zone and technical implementation. The focus of this article is on city pricing (downtown toll), which is understood for our purposes to mean use-based pricing of urban road infrastructure.

Experiences in other European cities have demonstrated the traffic-reducing effects of downtown tolls. The impact on individual travel which the potential introduction of a city pricing system would have in a German city was the focus of a study conducted by the DLR Institute of Transport Research (DLR-IVF) in the cities of Berlin and Stutt-

gart. This paper gives a brief overview of the state of the art for downtown toll systems in Europe and cites selected results of the DLR-IVF study.

2 The State of the Art

There is a wide variety of pricing systems for municipal road infrastructure, of which Singapore and London are certainly the most significant examples. Analogies can be derived for German cities from similar political and societal structures, primarily from experiences in Europe. To this end, initial it will be provided a brief overview of the major downtown toll systems in Europe.

2.1 City pricing in Europe

The table below gives an overview of European cities with a downtown toll in place.

Table 1: Downtown toll systems in Europe

	London	**Bergen, Oslo, Trondheim**	**Stockholm**
Time of introduction	Feb. 2003	Bergen: Jan. 1986 Oslo: Feb. 1990 Trondheim: Oct. 1991	Jan. 2006 (Test)
Amount of toll[1]	11.60€ (15.50 €) per day	1.90 € - 2.50€ per each entry	1.10€ - 2.20€, per each entry and exit, staggered by time of day
Toll period	7:00 AM-6:30 PM on weekdays	Bergen: 6 AM-10 PM Oslo: all days Trondheim: 6 AM-5 PM	6:30 AM-6:30 PM on weekdays
Objectives	Reducing traffic, improving the environment	Primarily infrastructure financing	Reducing traffic, improving the environment
Impact	Travel into the zone down 18% from 2002 to 2004 Traffic in toll zone down by 30%	Travel to and from the zone down by about 4% (Bergen, Oslo)	Travel to and from the zone down about 25% in first few months
Framework conditions	- prior improvement in public transportation system	Definite term of about 15 years	- prior improvement in public transportation system
System	Video	Manual, microwave, video	Microwave, video
Acceptance	Mostly positive	Slightly positive (except for Trondheim)	About 50%-50%
Outlook	Expansion of the toll zone	Extension of terms in Oslo and Bergen, stronger focus on traffic management and environment, no extension in Trondheim (end of Dec. 2005)	Sept. 2006: referendum on operation of the system

(Source: London [2]; Bergen, Oslo, Trondheim [3]; Stockholm [4]) [1] exchange rate, July 2006

The London "congestion charge" is probably the best-known downtown toll system in Europe. London's "congestion charging zone", which was introduced at the start of 2003 due to massive traffic problems, encompasses an area of about 22 km² in the centre of the city [5] (see Table 1). The reduction in traffic congestion within the zone relative to the situation prior to introduction of the system has remained largely constant at 30%. [6] As a result, there has been a substantial improvement in the timeliness of public buses and an increase in general average speed.

Overall, about 50-60% of reduced traffic within the zone was transferred to public transportation (about 70,000 trips a day), and another 20%-30% consisted of through traffic, which now circumvents the toll zone. [7] Due to the clearly visible positive impact on traffic conditions, the system has relatively popular among the general population, and a westward expansion of the toll zone is being planned.

The experience in Stockholm has been similarly positive, where the recent introduction of a city pricing system contributed to a 25% reduction in travel to and from the toll zone.

2.2 Tolls in Germany

At the moment, Germany only has a distance- and route-based road pricing system in place for heavy vehicles on highways. Tolls are assessed based on kilometres travelled, which are measured using GPS and control stations. [8] Germany has practically no experience with respect to the impact of road pricing on individual travel, neither within nor outside of cities. Only in the case of a few public-private partnership (PPP) projects (e.g. the Warnow Tunnel in Rostock) an asset-related toll is charged. [9]

Thus far, data with respect to city pricing in German cities has been generated, for instance, as part of the EU's AFFORD project, by means of downtown toll acceptance studies, and in the form of dissertations [1]. Only one field test has been conducted, with about 400 study participants in Stuttgart in the mid-1990s (the MobilPASS field trial). In that study, the toll led to a reduction in weekday traffic volume of up to 20%. [10]

Despite the positive ‘signs’ from other European cities, the discussion about road pricing and congestion charging, however, remains controversial and sometimes becomes even emotional. At the time, the question if road pricing might be accepted by a considerable part of the road users is mostly ‘automatically’ denied.

Nevertheless, the public discussion and the clear professional interest demonstrate a need for further research in this regard in Germany. Therefore, the DLR Institute of Transport Research (IVF) has conducted an online survey in the cities of Berlin and Stuttgart in June 2006, in light of experiences in cities which have introduced downtown toll systems. Regardless of the political discussion, the DLR-IVF study focuses on the possible behavioural change by the introduction of a downtown toll. These outputs could be helpful for traffic management in German cities.

3 Study Concept

3.1 Objectives

The study seeks to determine to what extent introduction of a city pricing system would constitute an effective method of diverting traffic with the objective of ensuring mobility. The focus is on possible changes in the travel behaviour of car users, especially during work-related rush hour traffic. In particular, the intention is to determine the potential impact on traffic patterns of various toll models. Of interest in this regard are the factors which affect expected changes in travel behaviour. It was also analyzed whether the subjective perception of traffic noise, traffic jams and poor air quality has an impact on behaviour after introduction of a downtown toll. The study was also based on the assumption that expected behavioural changes correlate strongly with the relevant travel purpose.

3.2 Methods

The data was compiled from an online survey. The random sample was generated from an address data pool of Schober Information Services GmbH. The sole selection criterion was car availability. Therefore, the group of respondents consists exclusively of persons who have access to a car. There were a total of 911 respondents, including 469 from Stuttgart and the surrounding areas (with an additional area of 30 km) and 442 from Berlin and the surrounding areas (with an additional area of 15 km). The field work for the study was performed in June 2006.

The respondents were asked about their expected travel behaviour in the event of the introduction of a downtown toll by means of stated preferences. In each case, the respondents were given a fictional toll zone in downtown Stuttgart or Berlin, as well as three different methods of collection. In order to analyze behavioural changes as a result of the introduction of a downtown toll, respondents were also asked about their basic attitude towards a downtown toll and about their general travel behaviour.

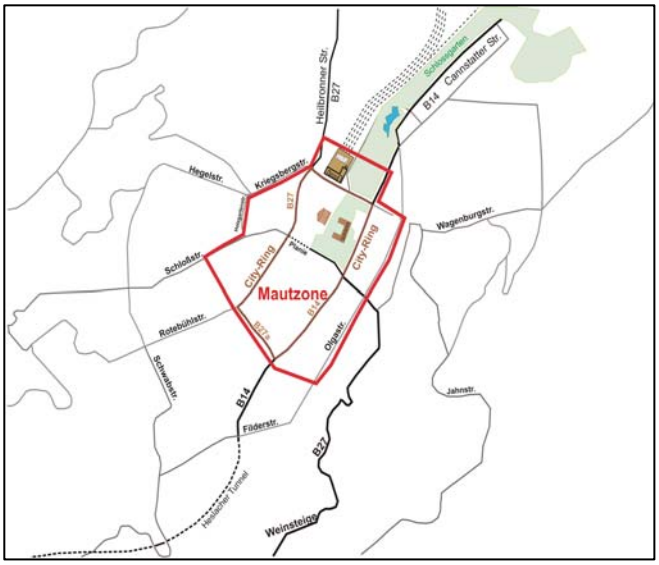
3.3 Fictional Toll Zones and Models

The fictional toll zones indicated in Figures 1 and 2 were chosen for the study in Berlin and Stuttgart:

Figure 1: The fictional Berlin toll zone

(Source: own data)

Figure 2: The fictional Stuttgart toll zone



(Source: own data)

The three different toll models chosen for the study are based primarily on experiences with downtown toll models in other European cities. The models differ based on cordon-based, distance-based and period-based pricing, and are defined as follows:

- the "cordon model": each entry and exit is subject to a toll;
- the "distance model": each kilometre travelled within the toll zone is subject to a toll;
- the "period model": the time spent within the toll zone is subject to a toll.

The following toll amounts and times were defined for the models:

Table 2: Toll amounts

	cordon-pricing	**distance-pricing**	**period-pricing**
12- 6 AM	free of charge	free of charge	free of charge
6- 7 AM	4 €	60 Ct. / km	10 Ct. / 5 min.
7-10 AM	5 €	80 Ct. / km	12 Ct. / 5 min.
10 AM-3 PM	4 €	60 Ct. / km	10 Ct. / 5 min.
3- 5 PM	5 €	80 Ct. / km	12 Ct. / 5 min.
5- 7 PM	4 €	60 Ct. / km	10 Ct. / 5 min.
7 PM – 12 AM	free of charge	free of charge	free of charge

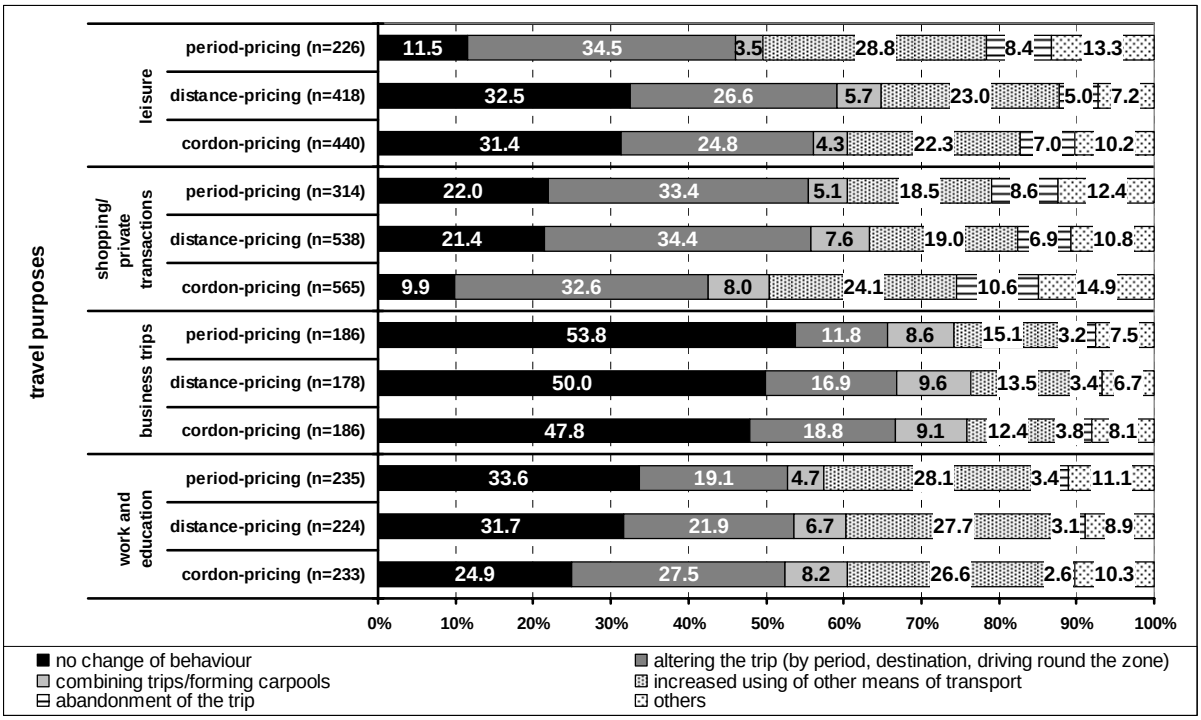
The fictional toll collection period for this study was limited to weekdays (Monday to Friday). Motorcycles, taxis, bicycles, public transportation (bus and subways), as well as ambulances, fire engines, etc., were considered to be exempt from the toll. Another condition of the study was that people residing within the toll zone only had to pay toll when they used their car on that day.

The cost to each individual respondent was calculated based on his or her statements with respect to the time of entry to and exit from the toll zone on that day for each type of trip. The number of kilometres travelled and the time spent within the toll zone were also recorded as a basis for calculating the toll. The respondents were then introduced to the different toll models based only on the fees calculated based on their statements.

4 Initial Results

We will now discuss selected initial results of the study.

Figure 3: Potential change of travel behaviour by different pricing models and travel purposes



(Source: own data)

Each of the models presented to the respondents would lead to a clear change in travel behaviour (Figure 3), with the type and extent of the change differing based on the purpose of the trip. Excluding business trips, the study shows that only one third of respondents, at most, would not change their travel behaviour. For business trips, however, the percentage of people who would not change their travel behaviour is about 50% in all models. Clearly, the need to conduct business trips by car is particularly high. Accordingly, the potential change is lower for such trips than for other travel purposes.

The highest potential change was found for shopping/personal trips and leisure travel. Up to 90% of respondents, depending on the model, indicated that they would change their travel behaviour for shopping/personal trips, and up to 89% for leisure travel (Figure 3). The most frequent change indicated for those types of trips is altering the trip. Altering the trip includes the possibility of moving the trip to another time of day, choosing another destination (outside of the toll zone) and circumventing the toll zone. Changing the means of transport (to public transport, bicycle, by foot) is

the dominant change only for work/education trips, at about 27%. However, changing the means of transport still has importance for all other types of trips as well.

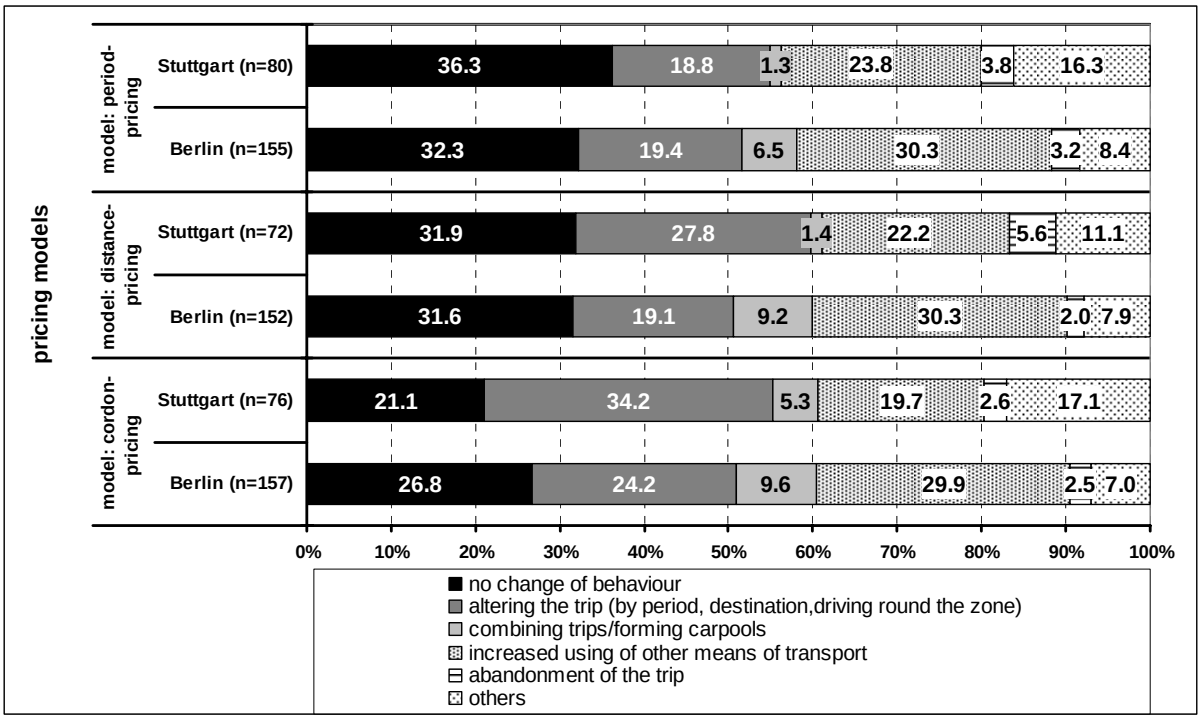
In a large number of cases, the change in travel behaviour takes the form of changing the starting time of the trip, changing the destination or shifting the route outside of the toll zone, while retaining the car as the means of transport.

Complete abandonment of the trip reaches up to 4% of responses, at most, for work/education and business trips. For shopping trips, on the other hand, there is much greater flexibility to abandon the trip altogether (up to 11%). There are sharp differences between the changes in travel behaviour in the various models, presumably due to differences in toll amount in the various models. In the cordon-pricing model, for example, abandonment of the trip was chosen in about 11% of cases for shopping/personal trips (n=565), but in the distance-pricing model only 7% (n=538). The average cost of shopping/personal trips, based on the travel behaviour reported by respondents, is € 7.20 for the cordon-pricing model and € 3.20 for the distance-pricing model, which explains the differences between the models with respect to the number of respondents willing to abandon shopping trips.

We will now examine the work/education and shopping/private errands in somewhat greater detail in a comparison between Stuttgart and Berlin.

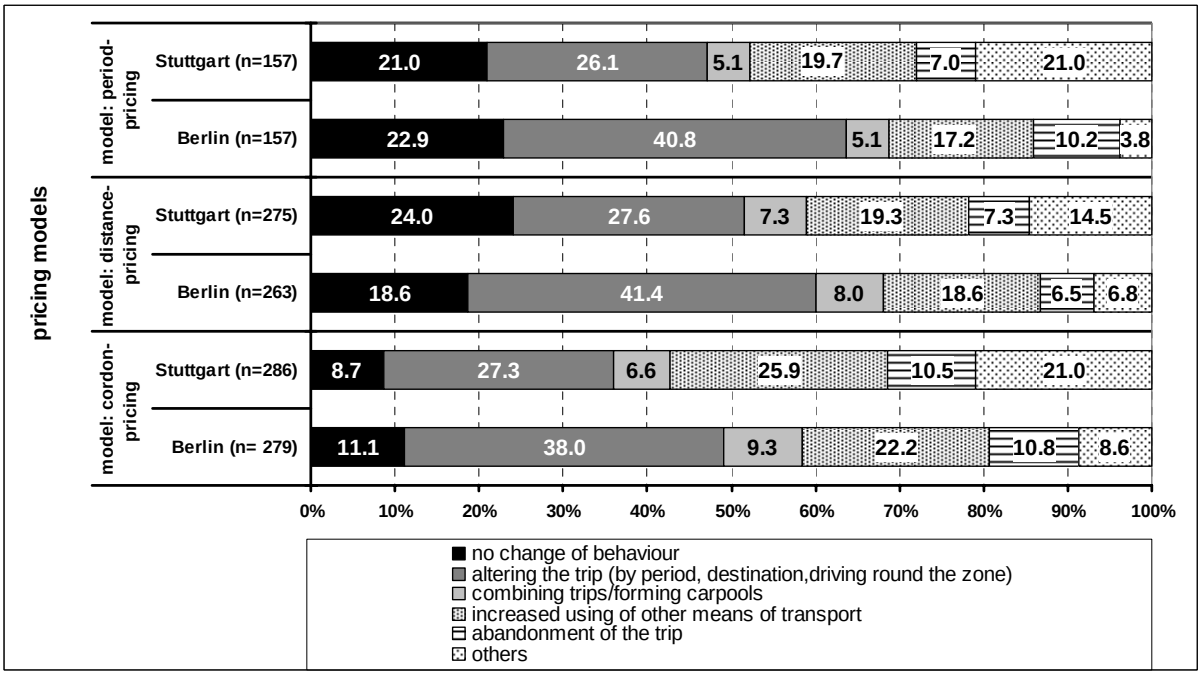
Figures 4 and 5 clearly show how great the difference in behavioural changes between the different travel purposes is. Retention of current travel behaviour (up to 36%) and change of the means of transportation (up to 30%) are more frequent for work/education trips than for shopping/personal trips. With respect to the data for rescheduling the trip and abandoning the trip, however, the situation is reversed. Abandoning the trip was chosen by up to 11% of respondents for shopping/personal trips, and by up to 6% for work/education trips. The trip to work/education tends to be regarded as less interchangeable. In this respect, the results confirm the thesis that the willingness of people to change their travel behaviour due to introduction of a downtown toll tends to be lower for work-related travel than for other types of travel.

Figure 4: Potential change of travel behaviour for travel purpose work/ education



(Source: own data)

Figure 5: Potential change of travel behaviour for travel purpose shopping / private errands



(Source: own data)

The necessity of *travel to work/education* means, as explained above, that people are less likely to abandon those trips as they are to abandon shopping trips. On the other hand, they are more likely to change their means of transport, an option which was chosen by about 30% of respondents in Berlin. One reason for this difference may be the well-developed public transportation system in Berlin, which makes a change of this nature relatively easy. Another reason may be the composition of the

sample: while only 8 of the 442 respondents in the Berlin sample resided beyond the city limits, 341 of the 469 Stuttgart respondents lived outside of the city. Access to the public transportation system tends to be more difficult for those residing beyond the city limits, and this circumstance may account for the lower willingness of Stuttgart respondents to change their means of transportation. The specific features of the toll zones chosen in Stuttgart and Berlin may also be responsible in part for the different responses with respect to altering the trip, combining trips/forming car pools and the higher percentage of respondents in Stuttgart who chose "other behavioural changes".

Altering work/education trips was chosen more frequently in Stuttgart (19%-34%) than in Berlin (19%-24%), depending on the model.

Circumventing the toll zone was most frequently specified as the mode of altering the trip, by between 14% and 28% of all respondents. Due to the smaller toll zone in that city, circumvention seems to be chosen more often in Stuttgart as an alternative than in the case of the larger toll zone in Berlin (between 14% and 16%). An exception applies for the period-pricing model, where the lower price of traversing the zone seems to offer less of an incentive to reschedule the trip than in other models. The responses with respect to the formation of car pools and combination of trips can be explained in the same manner: the larger Berlin toll zone (with a diverse functional structure) offers greater incentive to combine different travel purposes (6%) than is the case in Stuttgart (2%). The "other" category includes the alternative of parking the vehicle outside of the toll zone and entering the toll zone on foot. About 10% of Stuttgart respondents chose this option, regardless of the model, and only 4% of Berlin respondents. This difference can once again be explained by the unique circumstances of the two toll zones, as the Stuttgart toll zone consists in its central part of a pedestrian zone.

The number of Stuttgart respondents who chose parking outside of the toll zone and walking for shopping/personal trips was even higher in the cordon-pricing model, up to 21%. The willingness of Stuttgart respondents to alter the trip is practically independent of the model for shopping/personal trips (about 26%-28%). In Berlin, however, this number rises up to 41% (distance-pricing model, n=263). The reason for this high figure is that respondents on shopping trips are substantially more flexible in the choice of their destination and the timing of their trip than would be the case for trips to work. This indicates that a potential exists for measures to influence traffic with the objective of limiting rush hour traffic, especially with respect to work/education travel.

5 Conclusions and Outlook

Our first view of the results of the study demonstrates that the introduction of a city pricing system in German cities would tend to cause clear changes in travel behaviour. The clearest changes will be observed in shopping trips and trips for personal reasons, where the flexibility of travel behaviour is greater than for work- and education-related trips. But in the latter case as well, a downtown toll may contribute to limiting individual car traffic in peak hours. In general, the potential for diverting traffic through introduction of a downtown toll tends to vary widely depending on travel purpose.

It is also clear that the results must always be seen in the context of local and regional structures. The impact of a downtown toll depends to a great extent on the selection of the area subject to the toll and the amount of the toll.

The results, described here, are only a part of the intended analysis of this survey. Further analyses of our data will be focused on the following:

- analysis of factors which may affect a potential change in travel behaviour as a result of a downtown toll
- analysis of socio-demographic factors
- analysis of geographical differences between the cities of Stuttgart and Berlin
- analysis of the impact on expected changes in travel behaviour of the subjective perception of traffic jams, noise and air pollution

Analogies to the expected change in actual travel behaviour as a result of the introduction of city pricing can be drawn with the changes in actual travel behaviour as a result of the rising gas prices in recent years.

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