Searching for the Rail Bonus

Results from a panel SP/RP study

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EJTIR, **1**, no. 4 (2001), pp. 353 - 369

Received: July 2001
Accepted: October 2001

The inherent superiority of rail-based public transport options over bus-based alternatives, all other things being equal, has been stipulated in the literature and in the public policy discussion for some time. The exact strength of any such rail bonus is important to a public transport operator which has to consider the replacement of rail-based services by bus services. The public transport operator of the city of Dresden (DVB), while generally upgrading its services, has to consider this option, in particular where the continuing tram operation would require a costly rehabilitation of the tracks.
The measurement of any such systematic preference for rail-based modes is difficult, as it requires either a before-and-after study of such a switch, controlled for the other relevant service attributes, e.g. frequency, speed, reliability, price, route, etc., or a study of a network, in which rail- and road-based modes offer comparable types of services, with bus services in particular not restricted to feeder services to rail/tram lines. Both are rare for obvious reasons.
A recent service change of the DVB offered the opportunity to look at the issue in detail. A series of surveys were undertaken for this purpose before and after:

- *A one-day travel diary (including a household questionnaire)*
- *A survey of the image of the services*
- *A between-mode* stated preference *exercise focusing on the choice between public transport and private motorised transport where public transport was provided by either bus or tram (7 choice situations)*

- *A within-mode* stated preference *exercise looking at the trade-offs between public transport modes, in particular levels of comfort, travel times and transfers (7 choice situations)*

The paper reports detailed results from this study addressing the differences in preferences between the waves (effects of familiarity with an alternative) from both separate and joint stated preference *and* stated preference/revealed preference *models. The modelling so far indicates a consistent, but weak preference for the rail option through a higher value-of-time for rail usage, higher valuation of new rail vehicles in comparison to new busses, although they are partially balanced by a higher transfer penalty.*

1. Introduction

The inherent superiority of rail-based public transport options over bus-based alternatives, all other things being equal, has been stipulated in the literature and in the public policy discussion for some time. See for example Arnold and Lohrmann, 1997 or Heimerl, Meier, Dobeschinsky, Mann and Götz, 1988. As a further example, the following statement by Monheim (1997) is typical in content and style for the German discussion: "Light rail and street cars have a markedly higher market acceptance than busses due to their better recognisability and their higher comfort" (page 46)[1]. The rail bonus is said to reflect, among other aspects, the stronger commitment of the operator to rail-based modes, as well as their higher reliability and better comfort. The exact strength of such a rail bonus is important to a public transport operator which has to consider the replacement of rail-based services by bus services. The public transport operator of the city of Dresden (DVB), while generally improving its services, has to consider this option, in particular where the continuing tram operation would require a costly rehabilitation of tracks. It was therefore prepared to undertake a study analysing the preferences of its ridership using both *revealed preference* (RP) and *stated preference* (SP) data.

The measurement of any such systematic preference for rail-based modes is difficult, as it requires either a before and after study of such a switch controlling for the other relevant service attributes, e.g. frequency, speed, reliability, price, route etc. or a study of a network, in which rail- and road-based modes offer comparable types of services, in particular bus services that are not restricted to feeder services to rail lines. Both are rare for obvious reasons. Recent results of a SP/RP analysis in Innsbruck, which operates diesel buses, trolley buses and trams (street cars) on comparable routes, showed no consistent rail bonus controlled for the other service attributes, but not for the different ages of the respective vehicle fleets (Axhausen, Köll and Bader, Forthcoming). Nielsen and Drivicic (1999)[2] report significant but small differences in the valuation of bus vs rail-based in-vehicle times, but it is unclear, if the SP-games on which the results are based offered busses as the trunk haul mode. An earlier paper by van der Waard (1988) was based on RP data and showed no differences

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[1] "Stadt- und Strassenbahnen finden am Verkehrsmarkt eine deutlich höhere Akzeptanz als Busse, wegen ihrer besseren Orientierbarkeit und ihrers höheren Komforts". The German "Orientierbarkeit", a word coined by Monheim, has the further connotation of a better understandability of the system during use, which the chosen "recognisability" does not capture.

[2] See table reported in Nielsen (2000)

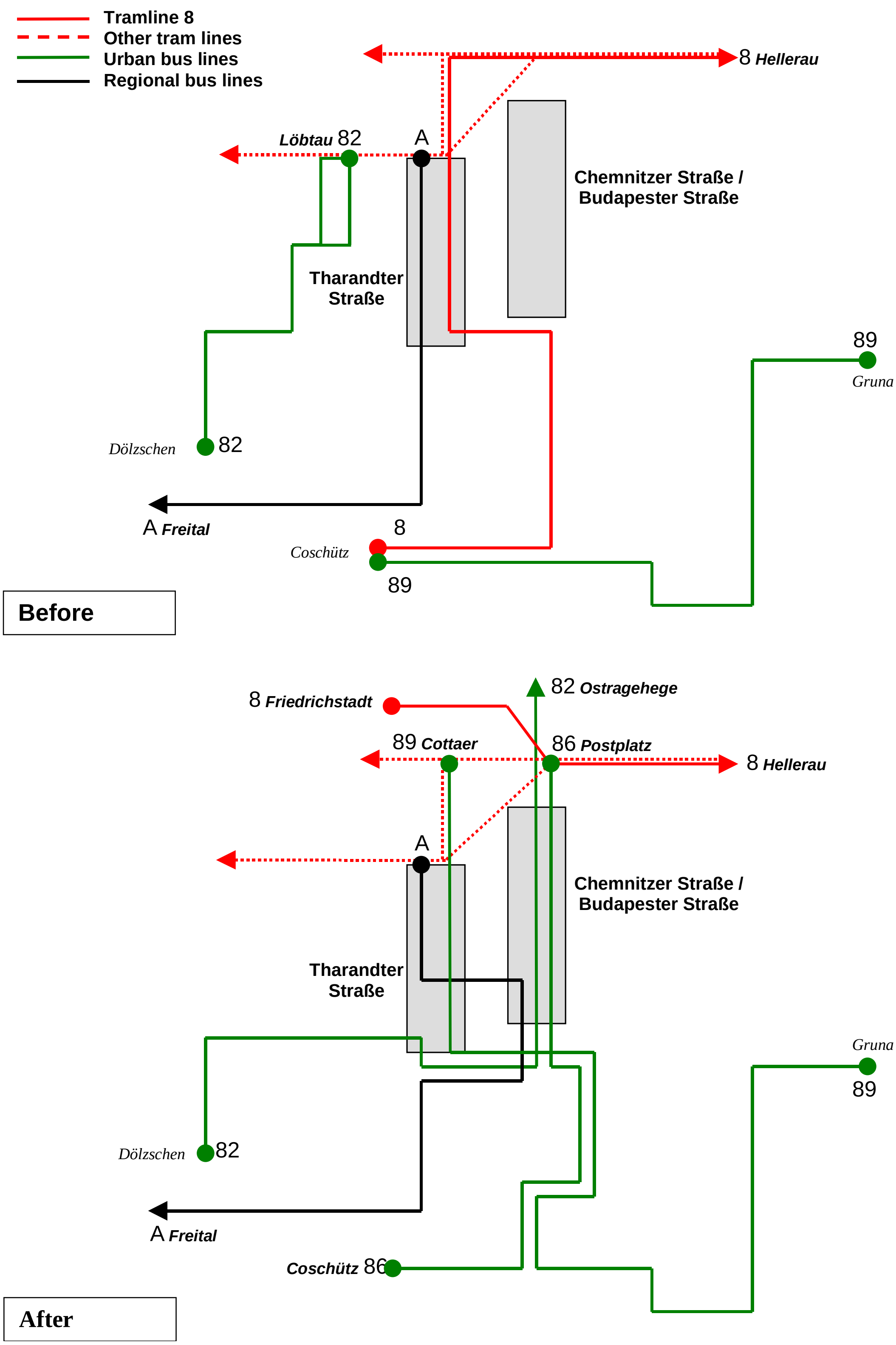

Figure 1. Network changes implemented

between bus and tram in-vehicle times. The other literature is equally inconclusive, when considering the details of the case studies reported. Equally, see the small valuations reported by Wardman and Whelan (2001) for different types of train sets in the UK.

The service changes implemented as part of the new Winter timetable 1998/99 in the Tharandter Strasse corridor and in the parallel corridor Chemnitzer Strasse and Budapester Strasse provided a unique opportunity to observe the reaction of the travellers to the decommissioning of a tram line and its replacement by bus services (see Figure 1). The southern branch of tram line 8, which used to serve the Tharandter Strasse, was realigned to serve the Friedrichstadt area of Dresden. The corridor is now being served by the urban bus line 89 and the regional bus line A. In parallel with these changes, the near-by radial corridor of Chemnitzer Strasse/Budapester Strasse received new services through the urban bus lines 82 and 86.

These changes motivated the DVB to implement a complex programme of survey research with the goal of measuring the behavioural changes and also to provide the data for suitable forecasting models for future service changes (see Fell, Haupt, Heidl, Wirth, Axhausen and Lohse, 1999).

This paper reports a further analysis of these data (see below), which focuses on a panel of respondents and merges the three available data types: travel diaries and two different stated preference surveys for a joint estimation exercise, which aims to identify any rail or street car bonus expressed by the travellers in Dresden.

2. Survey programme

The advantages inherent in combinations of revealed and stated preference data are well established (see for example Ben-Akiva and Morikawa, 1990; Ben-Akiva, Morikawa and Shiroishi, 1992; or Bradley and Daly, 1993), in particular for situations, in which important variables correlate strongly in a study area, here for example travel costs and travel times, or where weak variables have to be assessed, here for example the type of public transport vehicle and the comfort of the vehicles. The substantial service changes planned invited the use of a panel approach to capture the changes in travel behaviour before and after them.

To keep the complexity of the stated preference element manageable it was decided to divide the survey tasks between two instruments: one looking at mode choice and price and the other looking at the type and comfort of the vehicles. The budget did not allow for the customisation of the SP instruments for each respondent, therefore reasonable ranges where chosen for the attribute values using local expertise.

Three surveys were conducted in each wave (early September 1998 and early November 1998):

- One-day travel diary using the well-tested KONTIV survey instrument and protocol, as adapted by the PTV AG in its previous studies.
- Between-mode choice stated preference experiment (6 or 7 decision situations)
- Within-mode choice stated preference experiment (6 or 7 decision situations)

2.1 Survey contents

The between-mode choice experiment described the car option with two variables (door-to-door travel time and parking fee) and the public transport option with four (type of vehicle (bus or tram), door-to-door travel time, transfer requirement[3], one-way fare) (see Figure 2). A fractional factorial design of 27 choice situations was divided into four blocks of three times seven situations and one time six situations.

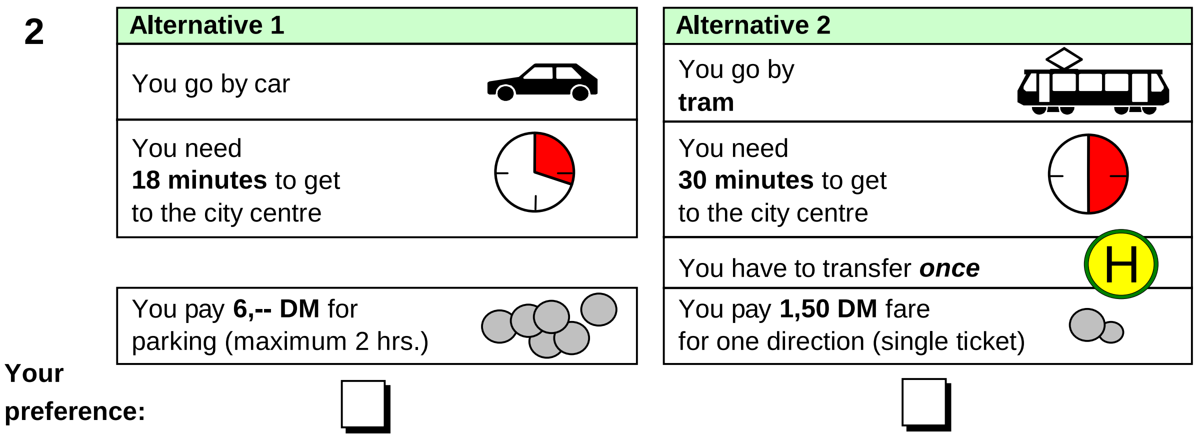

Figure 2. Example of the between-mode stated preference experiment

The within-mode choice experiment looked at the decision between bus and tram characterising each with egress times, in-vehicle times, transfer requirement and comfort of the vehicle (old or new) (see Figure 3). The four different vehicle types were shown on a separate page using photographs of locally used vehicles. Again 27 situations were divided into four blocks of up to seven situations.

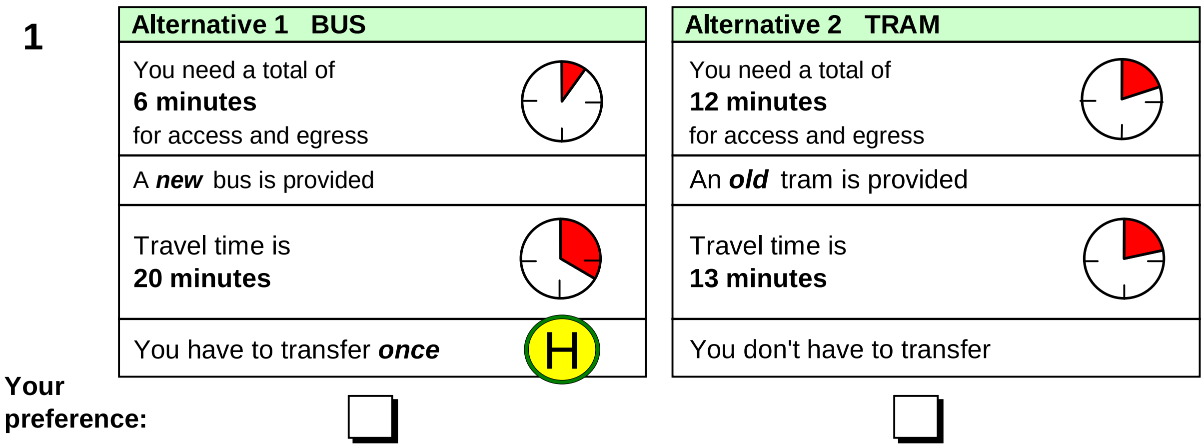

Figure 3. Example of the within-mode stated preference experiment

[3] Transfer is defined here as a change of vehicle or sub-mode, e.g. bus to bus, or bus to tram.

The travel diary was complemented with a household and person form. In addition to the SP experiments a series of ranking questions about system performance and perception were included in the questionnaire. The household was also sent a cover letter signed by the director of the DVB, an introductory letter, an explanatory leaflet (2 pages), a map showing the new route network and the associated new timetables for the urban bus lines. Only household members over 16 were asked to participate.

2.2 Samples

Two distinct samples were constructed to investigate different aspects of the service change. The first sample is a random sample of households drawn from those living in the wards affected by the change (RS), while a second choice-based sample was recruited from among the users of tram line 8 before the change (CB).

The affected wards, Plauen and Cotta, had 14,300 residents in 6,200 households at the time. Using the most up-to-date commercial database of addresses and phone numbers (last update was six month ago at the time of the sampling) a sampling frame of 4,886 households was constructed removing commercial and incomplete addresses. Of those households 506 were drawn as the sample.

For the choice-based sample trained personnel of the DVB approached passengers during one day in September 1998 (5:00 to 23:00) explaining the survey to them. If a willingness to participate was indicated, the potential respondents received a card to note down their address and telephone number, which they returned to the interviewers before alighting. Only persons over 16 years were included. After verification of address and telephone number a sample of 359 persons remained.

2.3 Survey administration

The sample households in the random sample received an announcement letter describing the nature of the survey, highlighting the voluntary nature of any participation and the possibility to phone in their refusal to participate. This procedure was not required for the choice-based sample, as these persons had already indicated their willingness to participate.

All households were called one or two day after their diary day to offer help, to answer questions and to motivate the households to participate. In addition, there was a service phone number available throughout the survey period.

All participating households received a thank-you letter a couple of days before the second wave.

The response rate was a satisfactory 53% of available households in the first wave and a very satisfactory 82% in the second wave (see Table 1). The SP was directed towards to person approached in the tram in the case of the choice-based sample and to the person over 16 years in the household with the first name starting with the letter closest to the letter “A”.

The quality neutral losses, which are a substantial 20.6% of the original sample in the first wave are due to deaths, household moves, some commercial addresses and some households included in both samples. These losses are particularly noticeable in the random sample, as the study area is experiencing rapid change due to new construction and renovation.

Table 1. Response rates

Wave (Reporting days)	**Random sample [Addresses]**	**Choice based sample [Addresses]**	**Total [N]***	**Persons [N]***	**SP [N]***
Before (14 to 18 and 23-9-1998)					
Sample	506	359	865		
Quality-neutral losses			179		
Available			687		
Returns			359 (52.1 %)	820	361(52.5 %)
After (2 to 4-11-1998)					
	170	**189**	**359**		
Quality-neutral losses			4		
Available			355		
Returns			290 (81.7 %)	654 (79.8 %)	286 (80.6%)

* Percentages are given where available

3. Data preparation

The data was weighted to reflect the household size distribution in the study area and the known age, gender and residential location distributions.

For the modelling, the trip weights for the observations from the choice based sample were calculated as the product of the person weight times a factor to adjust the market shares to those observed in the random sample. To account for the repeated observations, the weights of the SP observations were also divided by the number of available SP observations. This is an overly conservative weight, as it assumes that the SP observations are perfectly correlated with each other.

For the RP data travel times by car and by public transport were calculated using an available network model of Dresden. The public transport multiple path assignment gave the share of trips involving transfers and the share of movement using a tram or a bus. Movements with a share of more then 50% tram were classified as tram trips. The access times to the nearest stop were queried on the household questionnaire.

The travel times for the different times-of-the-day were estimated as multiples of the shortest-path assignments using appropriate average speeds. Equally, travel times for walking and cycling were based on multiples of the car-based travel times using age-dependent walking and cycling speeds.

No attempt was made to estimate trip costs for the RP-data, as information about the type of parking used, the vehicle driven and any season ticket owned was not available from the survey. As an indicator of parking cost, a variable was constructed indicating, if the trip had its destination in the commercial core or in the first ring around the commercial core. This correlates with the average parking costs, but does not identify them individually. Trips, for which not all variables could be constructed due to missing items, were removed from the dataset.

For the following analysis those mobile persons were identified which had participated in both waves. This reduced the number of persons and households by about a third in comparison to the numbers given above. All other entries were removed from the data set. This *panel subset* of the complete dataset allows us to concentrate on the changes in use and perception between the two waves.

4. Descriptive statistics of the panel members

Table 2 gives an overview of the most important socio-demographic characteristics of the sample. Noticeable is the larger than normal share of female respondents. The large share of persons in education is to some extent due to the presence of a large technical university in Dresden, which is close to the study area.

Table 2. Socio-demographic characteristics of the mobile panel members

Attribute	Value	Share [%]
Gender		
	Female	58.0
	Male	42.0
Age		
	Below 20 years	25.3
	20 –30 years	9.4
	30 – 40 years	15.3
	40 –50 years	17.5
	50 – 60 years	14.6
	60 years and older	18.9
Licence holding (persons over 18 years)		
	Females	65.7
	Males	85.0
	All	73.7
Employment status		
	Not working	31.2
	In education	27.0
	Part time	9.4
	Full time	32.4

The mobility behaviour is the topic of the following two tables (Table 3 and Table 4): the first looking at the socio-demographics and the next at the modal choices. The two samples do not differ in the overall trip making, but have the expected differences in the modal shares. There is a small drop off in trip making between the waves, but it is not statistically significant.

Table 3. Average number of trips by socio-demographic variables [trips/day]

Attribute	Value	Wave Before	After	Both
Gender				
	Female	3.47	3.46	3.47
	Male	3.89	3.69	3.79
	All	3.65	3.55	3.60
Employment status				
	Not working	3.68	3.70	3.69
	In education	3.70	3.46	3.60
	Part time	4.25	3.65	3.95
	Full time	3.40	3.46	3.43
	All	3.65	3.55	3.60

Table 4. Average number of trips by mode, sample and wave [trips/day]

Sample	Wave	----- Mode ----- Walk	Cycle	Passenger	Car driver	Public transport	All
Random sample							
	Before	0.81	0.30	0.28	1.13	1.13	3.65
	After	0.71	0.11	0.25	1.15	1.30	3.52
	Both	0.76	0.21	0.27	1.14	1.22	3.58
Choice-based sample							
	Before	0.58	0.19	0.28	0.55	2.01	3.61
	After	0.70	0.13	0.22	0.53	1.97	3.55
	Both	0.64	0.16	0.25	0.54	1.99	3.58

The differences between Table 3 and Table 4 are due to trips with no indication of the mode, which were excluded for this table.

5. Utility maximising choice models

The joint estimation of data from different sources allows the merging of information to enrich as well as to restrain the parameter estimates. This section will report two sets of results: one focussing on the merger of the two SP experiments and the other of the merger of three types of data available.

The paper follows the approach suggested originally by Ben-Akiva and Morikawa (1990) for this task, as translated into generally available estimation software by Bradley and Daly (1993). This approach uses the nested logit approach to identify the differences in the error variances of the respective data sources, while constraining the respective parameters to be equal across the different data sources. For details see the references above, Econometric Software (1998) or Ortuzar and Willumsen (1995). The estimations were performed using Limdep 7.0 (Econometric Software, 1998). Alternative approaches, such as allowing for heteroscedastic error variances or error variance structures consistent with the probit model, were considered, but rejected for this first stage of analysis due to their complexity. No explicit attempt was made to account for the possible serial correlation between the stated – preference observations. This was left to future work.

Table 5. Joint SP-experiments: Nested Logit-estimates

Mode	**Attribute**				----- **Sample** -----								
		All	**1)**	**2)**	**3)**	**Random sample**	**1)**	**2)**	**3)**	**Choice based**	**1)**	**2)**	**3)**
Private car													
	Travel time	-0.0520		*	*	-0.0406			*	-0.0551			*
	Cost	-0.4083	*	*	*	-0.3858	*	*	*	-0.4169	*	*	*
	Ln (VMT)	0.0526		*	*	0.0311			*	0.0670		*	*
	After wave	0.0787				0.1364				0.0825			
	Choice-based sample	-0.3202			*								
Bus													
	Travel time	-0.0674	*	*	*	-0.0838		*	*	-0.0565		*	*
	Access time	-0.0591		*	*	-0.0629			*	-0.0512			*
	In-vehicle time	-0.0549		*	*	-0.0691			*	-0.0422			*
	Cost	-0.6742	*	*	*	-0.6584		*	*	-0.6903		*	*
	Transfer	-0.4700		*	*	-0.5316			*	-0.3882			*
	New vehicle	0.0969			*	0.1295			*	0.0714			*
	Inertia	0.6007		*	*	0.5743			*	0.7219			*
Tram													
	Travel time	-0.0646	*	*	*	-0.0806	*	*	*	-0.0550		*	*
	Access time	-0.0738		*	*	-0.0920			*	-0.0560			*
	In-vehicle time	-0.0426		*	*	-0.0348			*	-0.0401			*
	Cost	-0.6040	*	*	*	-0.6646		*	*	-0.6048	*	*	*
	Transfer	-0.5080		*	*	-0.6256			*	-0.3922			*
	New vehicle	0.1359			*	0.1872			*	0.1017			*
	Inertia	0.7609		*	*	0.7743		*	*	0.8506		*	*
Lambda[4)]		3.9119		*	*	3.5670			*	4.6959		*	*
L (0)		12,353				5,291				7,062			
L (Constants)		5,269				2,192				2,925			
L (B)		3,627				1,424				2,115			
N		4,895				2,036				2,859			
K		24				23				23			
adj. Rho squared (0)		0.7044				0.7265				0.6973			
adj. Rho squared (Constants)		0.3071				0.3399				0.2691			

1) Significant, if corrected with square root (number of observations/person)
2) Significant, if corrected with third root (number of observations/person)
3) Significant, uncorrected
4) Scaling parameter of the error variance of within-mode SP relative to between-mode SP

Both the final RP/SP and the final SP only models the set of explanatory variables included the modal attributes and a surprisingly small number of socio-demographic and trip related variables. The general usage of the different modes measured as the annual mileage by bicycle or private car dominated all other socio-demographic variables in the RP and SP context. Age, gender, number of hours worked were marginally significant, but were dropped from the final analysis as they did not influence the parameters of the modal attributes. In the

SP context a further inertia variable was added: the share of trips undertaken by public transport on the respective travel diary day, as the best available estimate of general public transport usage. For the private car the annual mileage remained the preferred variable, as it had a higher explanatory power then the alternative: share of trips by private car, also available from the diaries. This experience clearly shows that an equivalent indicator should be established for public transport. The obvious one in the European context is the ownership of a local season ticket or less so the ownership of a national rail discount card. Alternatively or additionally, one could establish the usage of public transport over a longer period, say one month or three months depending on average usage. See Simma and Axhausen (2001), Axhausen, Simma and Golob (2001) or Massot, Madre and Armoguum (2000) for the precision of such approaches and their usefulness in modelling behaviour.
The only relevant trip-derived variable in the joint estimation is the destination of the trip coded as into the core, the inner ring around the core or outside both (see above).

Table 6. Joint SP-experiment estimation: Derived ratios

Mode	Ratio	Unit	----Sample----		
			All	Random sample	Choice based
Bus					
	Transfer/Travel time	[min]	6.98	6.35	6.87
	New vehicle/Travel time	[min]	-1.44	-1.55	-1.26
	Transfer/In vehicle time	[min]	8.56	7.69	9.21
	Access/In vehicle time	[]	1.08	0.91	1.22
Tram					
	Transfer/Travel time	[min]	7.86	7.76	7.14
	New vehicle/Travel time	[min]	-2.10	-2.32	-1.85
	Transfer/In vehicle time	[min]	11.91	17.98	9.78
	Access/In vehicle time	[]	1.73	2.64	1.40
VOT					
	Car	[DM/min]	0.13	0.11	0.13
	Bus (Travel time)	[DM/min]	0.10	0.13	0.08
	Tram (Travel time)	[DM/min]	0.11	0.12	0.09
	Bus (In-vehicle time)	[DM/min]	0.08	0.10	0.06
	Tram (In-vehicle time)	[DM/min]	0.07	0.05	0.07

Table 5 and Table 6 present the results for the joint estimation of the two SP-experiments, which show a high goodness-of-fit[4]. The model was estimated with mode specific variables for the pooled data set and for the two samples separately. With the exception of the in-vehicle-time of bus and tram for the random sample none of parameter pairs are significantly different. There were no noticeable differences between the results of the before and after wave. Of the differences between the random and the choice-based sample only the parameters of the bus travel time were significant at the 0.05 level.
The assessment of the significance of the parameter estimates used the available rule of thumbs, but this seems overly conservative in this case, where on average 33 observations (14 + 14 + 5) are available for each respondent. Explicit models of the repeated measurement could be adopted to address this issue at a later stage.

[4] The estimated constants are not reported, as they reflect the artificial market shares of the SP experiments.

The values of time derived are within the ranges presented elsewhere for German conditions (Pauluβen, 1992). The valuation of the transfer requirement with about 8-9 min is sensible, but did change, when the data were pooled with the RP data (see below).
Ignoring the issue of the statistical significance for the moment, most of the results indicate some preference of the respondents for the rail-based mode: smaller parameter values for the in-vehicle, respectively travel time, larger bonus for a new tram in comparison to a new bus. On the other hand, the users are less willing to walk to the tram and are less willing to change in comparison to a bus only trip.
The significant scaling parameters indicates that the two SP experiments have unequal variances. This will be even more pronounced in the case, when the SP data are merged with the RP observations. Still, this further merger is necessary to scale the parameters properly against the observed behaviour.
The non-significant parameter for wave indicates that there are no differences between the waves, as measured by such a dummy variable. A more detailed analysis of the joint SP-experiment data using generic parameters for the public transport modes revealed a more complex picture.
There were indeed no significant differences between the waves for the parameters of the modal attributes in the choice-based sample-based data. The inertia parameters showed differences, but their pattern indicated no internal logic and were therefore ignored in the further analysis.
The differences between the before and after wave in the random sample-based data were interpreted as effects of experiencing local public transport services for the first time in the Chemnitzer Strasse/Budapester Strasse corridor and the larger awareness of public transport issues in the corridor from which the tram was removed. The relative valuations of the random sample moved closer to the valuations of the choice-based sample.
The results of the joint estimation of all three data sources show some systematic changes in comparison with the joint SP experiments estimation, but also continuity (Table 7 and Table 8). The SP and RP observations are linked through two variables: the transfer likelihood, which is available for both and the travel times. For the RP public transport observations the total travel time (see between-mode SP experiment) is calculated as the sum of the assignment derived in-vehicle-time, the assignment derived average waiting time and the distance to the nearest public transport stop. Car passenger observations are included as private car observations.
The observed cycling and walking choices were modelled as part of the RP data. The parameters are not shown here due to the focus of this paper.
The derived ratios remain mostly unchanged, which is no surprise as they are mostly estimated from the SP data. The main exceptions are those values involving a transfer requirement, where the valuations in the course of a bus trip and in the course of a tram trip move apart.
In terms of the parameter values one notes the differences between the parameters for the choice-based and the random sample. While the ratios are maintained, the parameters for the choice-based sample now indicate a near complete lack of sensitivity to the service variables. The pre-commitment to the modes actually used dominates the choices. This is not as pronounced for the random-sample, where the elasticities, evaluated at the sample means, are in the normal ranges (not shown here).

Table 7. Joint RP and SP estimation: NL-model

Mode	Attribute	----- Sample ----- All	1)	2)	3)	Random sample	1)	2)	3)	Choice based	1)	2)	3)
Car													
	Travel time	-0.0139			*	-0.0122			*	-0.0029			
	Cost	-0.1101		*	*	-0.0768			*	-0.0243			
	Ln (VMT)	0.0193		*	*	0.0102			*	0.0045			
	Trip into the core	-0.2228			*	-0.1156				-0.4522		*	*
	Wave 1	-0.2073			*	-0.1357				-0.3827			*
	Choice-based sample	-0.1622			*								
Bus													
	Travel time	-0.0132		*	*	-0.0168			*	-0.0030			
	Access time	-0.0133			*	-0.0141			*	-0.0033			
	In-vehicle time	-0.0125			*	-0.0155			*	-0.0027			
	Cost	-0.1762			*	-0.1290			*	-0.0403			
	Transfer	-0.1062			*	-0.1220			*	-0.0245			
	New vehicle	0.0215			*	0.0287			*	0.0043			
	Trip into the core	0.4960		*	*	1.0086	*	*	*	-0.1728			
	Wave 1	-0.0777											
	Choice-based sample	0.9056	*	*	*								
	Inertia	0.0901											
Tram													
	Travel time	-0.0127		*	*	-0.0126			*	-0.0033			
	Access time	-0.0133			*	-0.0141			*	-0.0033			
	In-vehicle time	-0.0095			*	-0.0075			*	-0.0026			
	Cost	-0.1645		*	*	-0.1243			*	-0.0352			
	Transfer	-0.1148			*	-0.1348			*	-0.0252			
	New vehicle	0.0310			*	0.0406			*	0.0066			
	Trip into the core	0.3429		*	*	0.7062	*	*	*	-0.0587			
	Wave 1	0.1822			*								
	Choice-based sample	1.0168	*	*	*								
	Inertia	0.1663			*	0.1705			*	0.0364			
Lambda[4]	Between-mode SP	3.6534		*	*	4.9912			*	17.2051			
Lambda[4]	Within-mode SP	17.1673			*	15.9116			*	72.8210			
L (0)		61,249				27,963				33,285			
L (Constants)		18,276											
L (B)		13,764				6,352				7,274			
N		15,189				6,684				8,505			
K		35				26				26			
adj. Rho squared (0)		0.7747				0.7719				0.7807			
adj. Rho squared (Constants)		0.2450											

1) Significant, if corrected with square root (number of observations/person)
2) Significant, if corrected with third root (number of observations/person)
3) Significant, uncorrected
4) Scaling parameter of the error variance of the respective SP relative to the RP data

Again, there is no significant difference between the first and second wave. The bundling of these possible differences into a dummy variable is a weak test, but models estimated

separately for the before and after case confirmed these conclusions in the sense of little change of the relative valuations (see above).
There are no significant differences between the parameters for the two public transport modes with the exception of in-vehicle time, where the time in the tram is valued significantly less negatively. The parameters for the two samples are not significantly different.

Table 8. Joint RP and SP estimation: Derived ratios

Mode	Ratio	Unit	----- Sample -----		
			All	Random sample	Choice based
Bus					
	Transfer/Travel time	[min]	8.05	7.26	8.09
	New vehicle/Travel time	[min]	-1.63	-1.71	-1.42
	Transfer/In vehicle time	[min]	8.51	7.86	9.04
	Access/In vehicle time	[]	1.06	0.91	1.21
Tram					
	Transfer/Travel time	[min]	9.01	10.66	7.55
	New vehicle/Travel time	[min]	-2.44	-3.21	-1.98
	Transfer/In vehicle time	[min]	12.06	17.92	9.61
	Access/In vehicle time	[]	1.74	2.69	1.37
VOT					
	Car	[DM/min]	0.13	0.16	0.12
	Bus (Travel time)	[DM/min]	0.07	0.13	0.08
	Tram (Travel time)	[DM/min]	0.08	0.10	0.09
	Bus (In-vehicle time)	[DM/min]	0.07	0.12	0.07
	Tram (In-vehicle time)	[DM/min]	0.06	0.06	0.07

6. Conclusions and outlook

The work reported here has tried answer the question, if there is a systematic rail bonus in mode choice in Dresden. The data source available is rich, in particular offering a panel spanning a relevant service change, but it is not perfect, as the RP data lack price information and make use of network model derived estimates for the modal attributes.
The models estimated so far indicate mostly no significant changes in preferences over the three month period observed. The period might be too short, but it is still a useful indication of the stability of preference structures (see below). While the differences in the estimated parameters between the two samples (choice-based and random sample) are not significant for the SP experiments (pooled before and after data), they are significant for the RP and joint RP/SP estimates. This indicates that choice-based samples should only be used, if they include users of all modes. In this case, only users of one mode were selected and the self-selection inherent in this case will bias the parameter estimates; a bias which cannot be corrected by weighting for market share alone.
The results indicate, that there is a weak, but consistent preference for the rail-based tram in the sample analysed: lower willingness-to-pay for travel time improvements, lower disutility of in-vehicle-time, higher valuation of new and improved vehicles, but also a higher transfer

penalty, which indicates higher expectations for the service quality of rail-based types of public transport. It is also interesting to note, that the preference for the tram is larger for more frequent public transport users (see parameter estimates of the inertia variables for bus and tram above).

The respondents from the choice based sample show a strong preference for public transport, but they favour the tram slightly more. Still, there is no significant difference in the respective dummy variables in the joint SP/RP models. In the context of this particular service change, old trams on old track were replaced by new and modern busses. This might explain the small difference, but there is actually no need to expect a difference unless we assume the existence of a strong rail bonus.

The influence of prior commitments was noticeable throughout for both the individual and the public transport modes. These effects stabilize choices and lock travellers into habits. Unlearning of such habits is required, which slows down the acceptance of new services by new users, but also maintains usage of changed services by old users, in particular in the case of service reductions or service deterioration. These effects indicate the need for public transport operators to have their services in place early on in the life cycle of an area or household, as these transitions are typically the time periods with largest openness to behavioural change.

The influence of these prior commitments needs to be studied further. Especially, why persons commitment themselves to specific residential location – modal resource combinations. This obviously requires more then daily mobility data, but the approaches of Massot et al. (2000) or of Mobiplan (2000)[5] might make such data more easily available. See also Axhausen and König (2001) for SP-based work on this topic.

The results reported add evidence to the contention that there is a rail bonus, but they also indicate that it might be small; smaller than some advocates of public transport claim. The importance of the inertia variables in the modelling of SP data and the variables describing pre-commitments to a particular mode in general was confirmed in this analysis. They overshadowed the rail bonus in this study and might do so in general. The untangling of the effects of those pre-commitments and of a rail-bonus should be the topic of future work.

Acknowledgements

The authors wish to thank their colleagues in Dresden, which conducted the fieldwork of the survey, as well as the sponsor, the Dresdner Verkehrsbetriebe (DVB), which made the study possible. The comments of the anonymous referees helped us to improve the paper. The results and views expressed in this paper are those of the authors and not of the sponsor. Any errors are our own.

Results from these studies were presented at the 9th IATBR conference at Goldcoast, Australia (July 2000) and the 81th Annual Meeting of the Transportation Research Board, Washington D.C. (January 2001).

[5] The Mobiplan project undertaken by the ISB - RWTH Aachen, PTV AG, IVT – ETH Zürich and the IfS – Universität Karlsruhe is collecting activity frequency and activity space data from retrospective surveys (see www.rwth-aachen.de/mobiplan for details).

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