Transport Policy 106 (2021) 249–261

Contents lists available at ScienceDirect

Transport Policy

journal homepage: http://www.elsevier.com/locate/tranpol

Making public transport irresistible? The introduction of a free public transport ticket for state employees and its effects on mode use

Annika Busch-Geertsema *, Martin Lanzendorf, Nora Klinner

Goethe University Frankfurt, Department of Human Geography, Theodor-W.-Adorno-Platz 6, 60629, Frankfurt a.M., Germany

ARTICLE INFO

Keywords:
Jobtickets
Public transport policy
Travel demand management
Free ticket
Zero-price effect
Multimodality hypothesis

ABSTRACT

To increase its attractiveness for employees, to save costs regarding parking supply and to foster modal shift away from the car, employers can offer sharply cost-reduced public transport tickets. In the state of Hesse/Germany, public authorities have gone one step further by introducing a cost-free public transport ticket for all state employees. We argue that the step from sharply cost-reduced to cost-free is more than just a monetary difference. The aim of this study is to assess whether the ticket is actually affecting employees and what changed their travel behaviour. Therefore, we have analysed a two-wave survey conducted at Goethe University in Frankfurt: one from before and one from after the introduction of the new ticket. The results show a substantial increase in the use of public transport (pt) for commuting and other trip purposes. Car use and availability, however, did not decrease. In particular, those who had no cost-reduced jobticket beforehand switched to public transport after the introduction. Furthermore, we identified increasing public transport use for low-income employees (inclusion hypothesis) and several indicators pointing towards a more multimodal behaviour (multimodal hypothesis).

1. Introduction

A high quality, attractive and frequently used public transport system is crucial for a sustainable and climate-friendly transport system (Schiller et al., 2010; Shaw and Docherty, 2014; Sims et al., 2014). Although the role of public transport systems in cities and regions worldwide may differ, at least in most European urban areas, public transport (pt) is already of high relevance for transport systems today and, in combination with non-motorized modes, offers alternatives to a car-centric transport system.

Thus, one strategy of European travel demand management (tdm) programmes is to increase the attractiveness and usage of pt. Against the background that a quarter to a third of all trips are work-related (e.g. Germany: 34% in 2017, Follmer and Gruschwitz, 2019; England: 24% in 2018, National Travel Survey statistics, 2019), commuters are a promising tdm target group. Many countries or regions support companies aiming to reduce the car use of their employees, for example, by improving bicycling facilities or offering reduced prices for pt tickets – known as jobtickets.

The latter are generally considered as being successful for all partners since employers, employees and public authorities benefit from these price reductions. Employees benefit from lower travel costs by pt and appreciate if their employers offer this additional benefit. Companies usually subsidize jobtickets with a limited amount of money, but frequently provide spare investments for additional parking spaces that are costly in urban environments. In addition, jobtickets may be used for local business trips and, thus, reduce the costs for that type of trip purpose. Ultimately, public authorities and society benefit from higher shares of pt users and reduced numbers of car commuters. Thus, this measure has the potential to reduce fossil energy use and CO_2 emission equivalents. Furthermore, the widespread use of jobtickets contributes to reducing the number of cars on the streets and, therefore, opens up opportunities for re-using car space (roads, parking) for other uses (Kirschner and Lanzendorf, 2019). Moreover, jobtickets may not only affect travel behaviour change and related ecological benefits, but also the social impact may be important. Affordable pt is a key condition for all low-income groups to participate in social activities and, therefore, for the mitigation of social exclusion.

However, since employees still have the deliberate choice either to buy a jobticket or not, the question arises as to whether a cost-free pt

* Corresponding author.
E-mail addresses: busch-geertsema@geo.uni-frankfurt.de (A. Busch-Geertsema), lanzendorf@geo.uni-frankfurt.de (M. Lanzendorf), klinner@geo.uni-frankfurt.de (N. Klinner).

https://doi.org/10.1016/j.tranpol.2021.04.007
Received 11 August 2020; Received in revised form 14 March 2021; Accepted 9 April 2021
Available online 14 April 2021

ticket would further increase usage. In the literature, it is argued that a zero price effect arises in this case, meaning that the employees will not further assess if it is rationale to buy the reduced season ticket or not for their specific purposes (Shampanier et al., 2007). Therefore, an additional share of pt users may be expected.

In the German state of Hesse, the state government introduced a zero-price pt ticket for all government employees amounting to approximately 145,000 persons, including university employees, as an additional supplement to their salary in January 2018 (Hessisches Ministerium des Innern und für Sport, 2017). To the best of our knowledge, it is the first time in Germany that a state government has introduced this policy. The question arises as to whether the ticket will lead to an increase in pt use on the commute and beyond, and, at the same time, if car use will decrease.

We aimed to assess the ticket's effects on employees' travel behaviour using a two-wave survey. Fortunately, we conducted a survey of Goethe University employees' travel in 2015 before the introduction of the ticket as part of a tdm programme. A jobticket already existed in 2015, meaning employees could deliberately choose to have the ticket with an approximately 60% discount. After the state-wide introduction of the zero-price ticket, we repeated the survey from 2015 with almost the same study design and survey questions in 2019 to compare the resulting behaviour changes.

It was our key ambition to improve the understanding of the impact of a zero-price ticket for employees. For that purpose, we compared commuting mode choice between 2015 and 2019. However, as our results are based on cross-sectional data and not on a panel survey, we were not able to identify behavioural changes on an individual level. Furthermore, we did not employ trip diaries in the survey, but asked about the frequency of mode use for commute trips. Furthermore, we asked about the underlying reasons for the observed changes and if some individual groups are more likely to change their behaviour. For that purpose, we considered work place accessibility (location of the campus site, commuting distance, subjective accessibilities by mode), car ownership, attitudes towards modes, biographical key events (children in household, duration of work with this employer) and socio-demographic characteristics. Furthermore, we analysed the effect of the zero-price ticket compared to the former jobticket by distinguishing between those people who already had the jobticket before 2018 and those who did not.

The remainder of this paper is organized as follows. Section 2 summarizes the related state of the art and section 3 describes Hesse's zero-price ticket in more detail, the case study of Goethe University Frankfurt, the survey methodology, data, representativeness and the factor analysis with the attitudinal items delivering six attitudinal factors. Subsequently, we describe and present mode changes by bivariate (section 4) and multivariate (section 5) analyses. Finally, we discuss the results of the case study in section 6 and transfer our findings against the background of transport policy options (section 7).

2. State-of-the-art: the introduction of a free ticket as key event

2.1. Key events and behavioural change: a window of opportunity

From the theoretical background of mobility biographies (Müggenburg et al., 2015; Scheiner, 2018), the introduction of free or flat-rate tickets are exogenous interventions and, thus, key events that have the potential to affect daily travel practices. Simultaneous key events, like residential relocations, starting a new job or new children in the household, may intervene and interact with these exogenous interventions and, thus, strengthen a behavioural change (Verplanken and Roy, 2016). Similarly, but from different theoretical angles, Garvill et al. (2003) and Cass and Faulconbridge (2016) maintain that pt flat-rate tickets are an option for reducing the habits and daily practices of car use. To be able to switch to pt, however, some preconditions are crucial, such as the accessibility of pt. Further aspects may intervene with the effectiveness of price reductions, such as socio-demographics, employment status, income, spatial factors and attitudes (Dijst et al., 2013).

Chng et al. (2018) emphasize the strong emotional ties connected with car use. Therefore, individual groups emotionally bounded or strongly convinced by the car might show no behavioural change concerning the introduction of a free ticket (similarly Haustein and Hunecke, 2007). These attitudes are considered to be relatively stable, especially if they are strong and salient and the context remains stable (Bohner and Dickel, 2011; Hogg and Vaughan, 2008). A causal effect in only one direction - from attitude to behaviour falls short. Rather, attitude has to be interpreted as one part of behaviour or, vice versa, executed behaviour as part of attitudes (Eagly and Chaiken, 1993; Ajzen, 2005; Busch-Geertsema et al., 2015).

2.2. Travel demand strategies supporting pt: free or flat-rate tickets

Free or flat-rate tickets for pt are frequently part of travel demand strategies for changing travel behaviour in urban areas. As one of the most famous examples, in 2012, the city of Vienna (Austria) lowered the price of its city-wide pt flat rate to 365€ per year financed by increased parking fees in the city (Sommer and Bieland, 2018) and they are increasing its use as part of a larger package of sustainable transport policies (Buehler et al., 2016). Other cities, like Tallinn (Estonia) and Hasselt (Belgium), and small countries (Luxembourg), have even made pt fare-free. For Tallinn, Cats et al. (2017) showed that the attitudes towards pt improved significantly in the course of the introduction and use of the ticket. Moreover, the share of pt trips increased. Contrary to the hope of more sustainable transport, they attributed some part of this modal shift to former walking trips. The overall amount of car distances, however, did not decrease (see Van Goeverden et al., 2006 for similar results in Hasselt). Similarly, Fujii and Kitamura (2003) found in an experimental study with a control group in Kyoto (Japan) that a temporary free bus ticket for car drivers increased pt use and improved attitudes towards travel by bus. Thøgersen (2009) confirmed these results with a study on the effects of a free monthly travel card for car owners in Copenhagen.

Moreover, it should be noted that most of the cities with full-fledged fare-free pt and discussed in the literature are small cities with less than 100.000 inhabitants (with the exception of Tallinn). In these cities, the absolute number of pt users was relatively low and, for example in Hasselt, the experiment ended with the introduction of new fares due to increasing operational costs (Cats et al., 2017).

Some free or flat-rate tickets are not provided for the whole population of a region but only for specific user groups. For example, the Netherlands, Flanders (Belgium) and Toronto (Canada) offer free or flat-rate tickets for university students (Cats et al., 2017; Butler and Sweet, 2020). Similarly, in Germany, many universities provide studenttickets (*Semesterticket*) for pt (Blees et al., 2001; Busch-Geertsema and Lanzendorf, 2017). This is a compulsory flat-rate ticket at the price of approximately only 15–30% of the cost of a regular season ticket for the city. Often, these tickets not only cover the urban but also the regional and sometimes statewide pt network. Although studenttickets are widespread in Germany, only a few studies have focused on the impact of these tickets and published the results internationally. Bamberg et al. (2003) showed in a case study in Giessen (Germany) that with the introduction of a studentticket the share of pt users almost doubled. The increase resulted from a shift away from car use (similar results published in German for Darmstadt by Blees et al., 2001 and North Rhine-Westphalia by Müller, 2011). During a panel study on habit stability with students from three universities, Klöckner and Matthies (2012) observed a remarkable decrease in car use and a weakening of habits by accident, as one university introduced a studentticket within the investigation period. Instead of habits, norms and situational constraints were shown to be more influential on mode choice when someone had a mandatory studentticket (Klöckner and Matthies, 2009).

Another specific group of flat-rate tickets targets company

employees. This type of pt ticket is frequently part of tdm company programmes (Busch-Geertsema and Lanzendorf, 2017). While the studentticket is usually mandatory for students, the prevalent jobticket is not for employees. Usually, it is part of a tdm programme and only available for companies with at least 50 employees (Blechschmidt et al., 2014), who have actively negotiated the price conditions with the local or regional pt suppliers. Thus, the discount offered is smaller in comparison to the studentticket. Case studies (Busch-Geertsema and Lanzendorf, 2017) show that the ticket is attractive for people commuting by pt though, but not purchased by the majority. In companies where a jobticket is offered, the use of pt is higher compared to companies without this offer. Using household travel survey data from the Atlanta Regional Household Travel Survey, Ghimire and Lancelin (2019) found that employees who were provided with a free or subsidized transit pass had higher odds of commuting on transit. Putting the focus on income with older data from the Atlanta region, Lachapelle (2018) identified an undersupply of employer subsidized pt passes for lower income workers. Interestingly, lower income individuals with access to a transit pass were less likely to use it than their wealthier counterparts.

2.3. Free is better than cheap: the zero price effect

This effect might change when the ticket is not only cheaper but without any costs. Cools et al. (2016) distinguish between the effects of reduced and zero prices on transport. With a zero price for a product or service, the demand increases significantly compared to a reduced price. The authors argue about mental transaction costs meaning that customers always ask if the price for a product or service is worth its financial value. Therefore, it is easier to convince customers of a free product, but, at the same time, they do not value such a free product as much as one they paid for (Shampanier et al., 2007; Szabo, 1999). Therefore, Cools et al. (2016) maintain a zero-price effect in their stated preferences study in Flanders. From several experiments to better understand the overreaction to zero-price conditions, Ariely and Shampanier (2006) attribute the zero-price effect to an affective response of individuals. Ariely and Shampanier (2006: 20) argue that "options with no downside (no cost) evoke a more positive affective response than options that involve both benefits and costs".

3. Methodology

3.1. Case study: public transport tickets for employees at Goethe University Frankfurt

In 2018, the federal state of Hesse (Germany) introduced a pt ticket for all state employees, known as the StateTicket (*Landesticket*) (RMV, 2017). The ticket is valid for unlimited trips by pt throughout Hesse, except for long-distance trains (ICE, IC), and it is not limited to work trips. Moreover, it is possible to take one adult and any number of children along free of charge on weekdays in the evening and all day at weekends and on bank holidays. As part of a negotiated wage agreement, the ticket is without charge for all state employees, which entitles all staff at Goethe University in Frankfurt to receive this ticket (Goethe-Universität Frankfurt, 2019a). Thereby, the introduction of the ticket reduces commuting costs to zero for pt. However, this may not be completely true for some specific employees, since long distance trains as well as local transport outside of Hesse are not included in this service.

Before the introduction of the StateTicket in 2018, most employees at Goethe University could purchase a jobticket. This jobticket, however, was only valid for use in the authorized fare zones between home and the workplace and employees had to pay a monthly rate themselves. For employees living in Frankfurt, the monthly jobticket price was 35.65€ in 2015 (compared to 86€ for a regular monthly ticket) and for people from a neighbouring fare zone (e.g. from Offenbach) the price was 52.05€ each month (compared to 129.80€), for both meaning a price reduction at about 60%. Many employees refused to buy the ticket and some, such as professors, were not even entitled to buy the ticket.

The university is located at five different campus sites (Fig. 1). The main campus is the Westend Campus, where 61% of all students and large parts of the administration are located (Goethe Universität Frankfurt, 2019b). 17% of the students are located at the Bockenheim Campus. Both sites are located in urban districts close to the city centre and are easily accessible by pt (rail, subway, tram, bus). The university also offers the possibility of using parking spaces on the sites for a small fee (Westend Campus, 30€/month; Bockenheim, 20€/month). The Riedberg Campus with natural sciences (11% of all students[1]) is part of a completely new district at the fringe of the city. It is connected to the metro network, but also easily accessible by car due to motorway access and parking. The Niederrad (9% of all students, medicine) and Ginnheim campuses (2% of all students, sports facilities) are not as centrally located as Bockenheim and Westend, but still urban and accessible by pt (tram, bus).

Car use in Frankfurt is the most frequent mode (in 2018: 33% car, 26% walking, 21% pt, 20% cycling; Stadt Frankfurt, 2020).[2] Besides the slight reduction in car use in recent years (35% in 2008), it is worth mentioning that the use of bicycles has nearly doubled within the last ten years (11.5% in 2008), walking decreased (33% in 2008) and pt remained stable (21% in 2008).

3.2. Survey description

For this paper, we analysed data from two quantitative online surveys at Goethe University regarding travel behaviour: one from May 2015, before the introduction of the StateTicket; and one from May 2019. We invited all staff from Goethe University by e-mail to participate with a personalized link to access the survey (for details, see Schubert, 2016 and Klinner, 2020).

The official statistics of the Goethe University report 5675 positions (full-time equivalent, December 2018, Goethe-Universität Frankfurt, 2018). However, that includes staff from the medical clinic, who are not state employees, and, thus, not provided with the StateTicket. Therefore, we drew on staffing information from the human resources department/academic organizational unit and calculate 4606 employees in 2015 and 4748 in 2019.

Taking the information from the computer centre of the Goethe University into account, which was in charge of distributing the invitation, the e-mail was sent out to 6652 e-mail addresses in 2015 and to 5600 in 2019. The number of e-mail addresses is higher than the number of employees because of the inclusion of functional e-mail addresses such as info@ …., which we were not able to exclude. From this, we saw a response rate between 19.5 and 28.2% in 2015 and between 30.1 and 35.5% in 2019 (Table 1). By collecting data using an online survey, we further expected to have a bias with respect to staff who do not work on a computer, such as employees from the maintenance service.

Filling out the questionnaire took about 20 min. The questionnaires are similar except for a slight adaptation regarding the introduction of the StateTicket. Both contain questions regarding (Ajzen, 2005) the general situation of working, living and residence (Ariely and Shampanier, 2006); mobility behaviour (Bamberg et al., 2003); mobility tools including the availability of a pt ticket (Blechschmidt et al., 2014); mobility attitudes; and (Blees et al., 2001) sociodemographics.

To check for representativeness, we drew on the staff groups

[1] The university does not collect the respective data for the allocation of staff to the different campuses (personal communication with university administration, e-mail 14 May 2020).

[2] Data for modal split refers to all journeys made within and outside the city on mid-week days by people living in Frankfurt (SrV data). Although we refer to the Frankfurt population, we have to bear in mind that not all staff working at Goethe University live within Frankfurt.

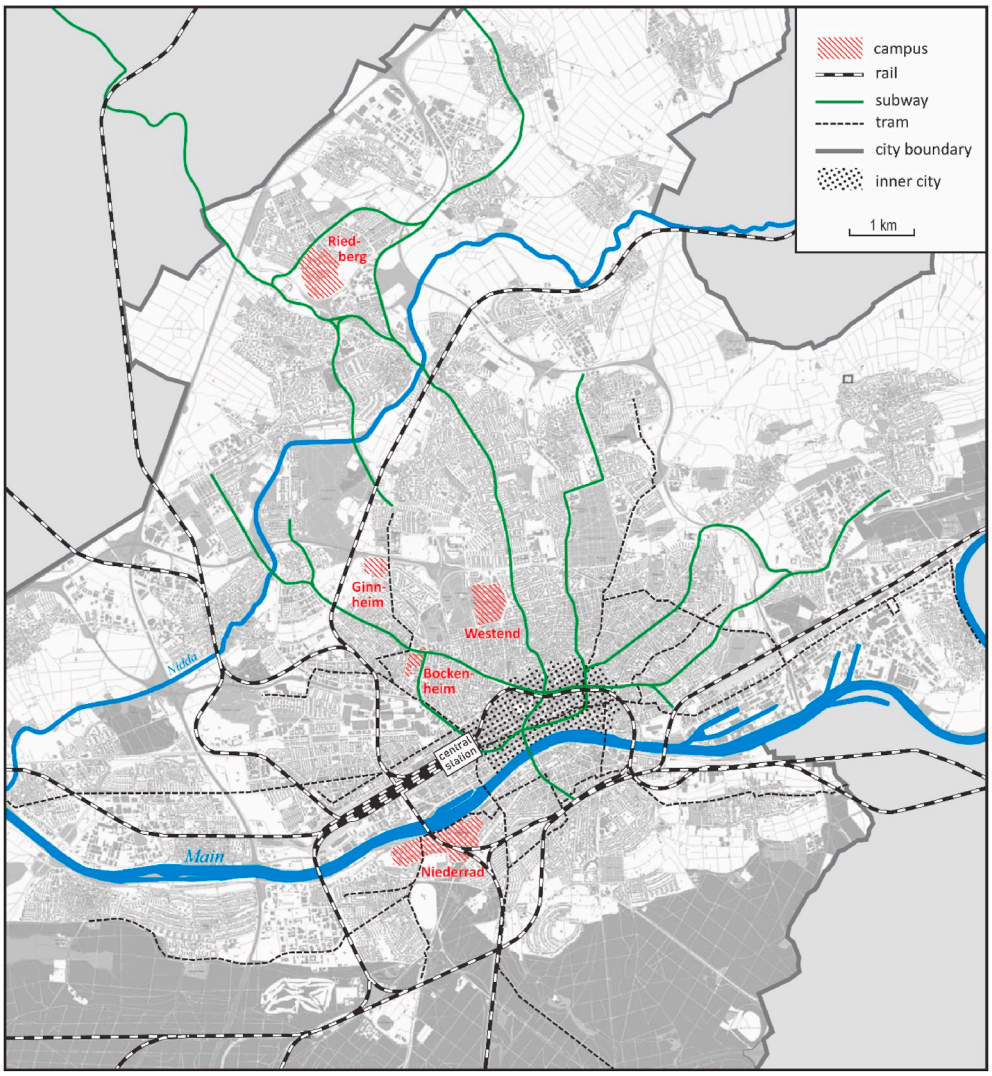

Fig. 1. Location of campus sites in Frankfurt (cartography: Elke Alban, Goethe University Frankfurt).

Table 1
Basic population and response rate (source: own surveys).

	2015	2019
Staff (academic organizational unit)	4606	4748
Staff (e-mail addresses)	6652	5600 (−314 not deliverable)
Questionnaires filled out (corrected)	1297 (1264)	1686 (1680)
Response rate	28.2% of staff (19.5% of e-mail addresses)	35.5% of staff (30.1% of e-mail addresses)

(administrative staff, academic staff and professors) and sociodemographic aspects (Table 2). For both waves, we observed a higher response rate from women and slightly more middle-aged participants as well as a lower share of young respondents. Academic staff were less likely to have participated in the survey and administrative staff were more likely to have done so.

3.3. Variables in the analysis and data processing

Where data was missing for individual cases and variables, we applied the method of multiple imputation[3] to substitute missing values for bivariate and multivariate analysis. We excluded cases with more than 50% of relevant variables missing. Thus, we excluded 39 cases and processed 2944 (98.7%). Missing data usually referred to attitudinal question, but also to sensitive facts such as income.

As a dependent variable for most of our analysis, we constructed the binary variable "regular mode use to work", which was fulfilled if the respondent used the mode at least once a week to commute to university. In the case of independent variables, we structured them as follows (Ajzen, 2005): accessibility factors (Ariely and Shampanier, 2006); life situation and mode availability; and (Bamberg et al., 2003) attitudes towards mobility.

For the accessibility factors, we included the campus location to which the person commuted, the commuting distance (up to 3 km, 4–10 km and more than 10 km) and the subjectively perceived accessibility by modes. For the latter, we asked participants, how easily they could reach their workplace by each mode (very good, rather good, rather bad, very

[3] For the multiple imputation (see Urban et al., 2016; Enders, 2010), we applied the SPSS algorithm with 20 imputations.

Table 2
Representativeness (source: own surveys).

		Sample (2015)	Sample (2019)	Employees (2019) [a]
Gender	Female	58.5%	59.5%	53.6%
	Male	41.5%	40.0%	46.4%
	diverse [b]		0.5%	
Age	<20	0.1%	0.1%	0.3%[b]
	20–29	14.9%	13.5%	17.1%[b]
	30–39	27.2%	28.2%	32.0%[b]
	40–49	24.2%	21.5%	19.5%[b]
	50–59	25.3%	27.5%	22.0%[b]
	≥ 60	8.3%	9.2%	9.0%[b]
Employee group	Administrative and technical staff	49.8%	50.4%	41.6%[b]
	Academic staff	38.7%	39.2%	48.2%[b]
	Professors	11.5%	10.4%	10.3%[b]
Highest educational level	Primary/general secondary school certificate (Volks-/Hauptschulabschluss)	1.2%	1.1%	
	Secondary school certificate (Realschulabschluss)	7.3%	7.0%	
	General/subject-specific higher education entrance qualification (Fachabitur/Abitur)	12.0%	9.7%	
	Bachelor's degree	4.4%	5.2%	
	Diploma/Magister/Master's degree	42.2%	42.3%	
	PhD	18.9%	21.1%	
	Postdoctoral lecture qualification (Habilitation)	12.1%	12.7%	
	Other/no degree	1.9%	0.9%	
Own monthly net income	<500€	1.3%	0.2%	
	500 - < 1000€	4.6%	3.9%	
	1000 - < 2000€	40.8%	33.4%	
	2000 - < 3000€	24.8%	30.8%	
	3000 - < 4000€	9.3%	11.0%	
	≥4000€	8.1%	10.5%	

[a] Employees according to academic organizational unit (May 2019).
[b] In 2015, respondents were asked whether they were male or female (binary). In 2019, we added the option to select "diverse", which eight people did. For further statistical analysis, we worked with the binary variable "female/not female".

bad). As the smaller and highly specialized campuses only had low numbers of participants, we only went into details for the larger campuses of Westend, Bockenheim and Riedberg.

For the personal life situation and mode availability, we used socio-demographics (sex, age groups, income groups), employment group (academic staff, administrative staff, professors) and (permanent) car availability.

We also asked for the employment duration and categorized that information into three groups (Ajzen, 2005): employees who started working at the university after the introduction of the StateTicket (less than 17 months ago) (Ariely and Shampanier, 2006); employees who started working at Goethe University between 18 and 30 months ago and therefore might have weaker habits; and (Bamberg et al., 2003) employees who had already started working at the university more than 30 months ago. Besides the key event of starting a new job, we identified a second relevant event within our data set: the birth of a child. We operationalized this by using a category for those with small children in their household (less than 3 years old). We also formed a category for those with older children in their household (3–13 years old) assuming that those children might need assistance with their mobility. The questions regarding jobticket availability differ in both surveys. In 2015, we asked if the respondent purchased a jobticket, as this was on a voluntary basis and involved extra costs. In 2019, this variable differed because all staff held the StateTicket. We therefore asked who had a jobticket before the introduction of the StateTicket in the 2019 wave.

In the case of mobility attitudes, we asked the respondents to rate 24 statements on a five-point Likert scale. The statements relate to the four modes of walking, cycling, driving and using pt as well as to sharing modes and multimodality. For further analysis, we reduced the dimensions by applying a principal component analysis (pca). For this purpose, we combined both 2015 and 2019 data sets into one and calculated a pca with varimax rotation. This delivered six factors of employees' travel mode related attitudes (Table 3): (Ajzen, 2005) "a car is freedom, independence and fun" (Ariely and Shampanier, 2006); "a bike is independence, fun and great to combine with pt" (Bamberg et al., 2003); "non-car use is socially disadvantaging" (Blechschmidt et al., 2014); "open-minded and appreciation of pt and sharing options" (Blees et al., 2001); "joy of walking"; and (Bohner and Dickel, 2011) "car-free multi-optionality".

4. Changes in use of pt

As expected, the share of regular users of pt for commuting increased significantly with the availability of the StateTicket. In 2019, almost three quarters of employees accessed Goethe University regularly by pt (Table 4). In addition, the new ticket is frequently used for non-work purposes, even by employees not commuting by pt. Approximately one half of all employees use the ticket at least weekly for leisure (51%) and for shopping/maintenance activities (40%) and more than one fifth for accompanying other persons (e.g. children, elderly) to their destinations (22%).

Surprisingly, regular cycling and walking for commuting also increased between 2015 and 2019, although regular car travel did not decrease significantly. In the following, we will shed some light on the mode use changes by accessibility (4.1), socio-demographics, key events and mobility tools (4.2) and attitudes (4.3) before we explore the reasons for mode change by a regression analysis (Blees et al., 2001).

4.1. Changes in pt use by accessibility

The regular use of pt and walking significantly increased between 2015 and 2019 in almost all accessibility categories, albeit at different levels (Table 4). The increases were only insignificant for commuting distances shorter than 3 km, but there was still some increase tendency. The highest shares of regular pt users are in work-home distances above 3 km, in areas with subjectively good pt accessibility and at the inner-city campus sites of Bockenheim (84%) and Westend (73%). Although at Riedberg the pt share is only 64%, this is still relatively high for campus sites on the periphery of a city. Moreover, the pt increase from 2015 to 2019 is higher at Riedberg than at Bockenheim and Westend. Despite a relatively limited number of respondents and only a few significant differences, the campus sites of Niederad and Ginnheim show

Table 3
Differences between 2015 and 2019 in attitudes towards transport modes and sharing options with a factor analysis (source: own surveys).

	2015	2019	diff[b]		Component[c]					
	mean[a] 2015	mean[a] 2019			1: a car is freedom, independence and fun	2: a bike is independence, fun and great to combine with pt	3: non-car use is socially disadvantaging	4: open-minded and appreciation of pt and sharing options	5: joy of walking	6: car-free multi-optionality
I don't just want to use a car, I want to own it.	2.12	1.95	−0.16	***	0.747	(-0.131)	(0.121)	(-0.063)	(-0.026)	(-0.145)
Driving a car is fun.	2.68	2.55	−0.13	***	**0.745**	(0.087)	(-0.060)	(-0.039)	(-0.095)	(0.031)
I think it is desirable to drive a great car.	1.60	1.51	−0.10	***	**0.733**	(-0.057)	(0.140)	(-0.019)	(-0.064)	(0.087)
When driving in a car, I appreciate that I can decide for myself who I take with me or with whom I drive.	2.65	2.55	−0.10	**	**0.702**	(-0.081)	(0.133)	(-0.008)	(0.022)	(-0.095)
I can live my life well without a car.	2.53	2.76	0.22	***	**−0.549**	(0.233)	(0.099)	(0.148)	(0.150)	0.503
I feel independent and free on a bike.	3.09	3.02	−0.07	**	(-0.090)	**0.868**	(-0.171)	(-0.063)	(0.010)	(0.027)
I ride a bike because I enjoy it.	3.19	3.09	−0.10	**	(-0.037)	**0.836**	(-0.200)	(-0.084)	(0.035)	(-0.044)
For me, it is important that I can easily combine pt and a bicycle.	2.56	2.74	0.18	***	(-0.191)	**0.724**	(0.081)	(0.161)	(-0.074)	(0.093)
For me, rental bikes are a great addition to the existing pt in everyday life.	2.00	2.00	0.00		(-0.018)	**0.447**	(0.130)	0.333	(-0.068)	(0.044)
When I walk, I often feel disadvantaged.	1.75	1.66	−0.09	***	(0.005)	(-0.001)	**0.752**	(0.004)	(-0.101)	(0.001)
When I travel by bus or train, I feel like a second-class person.	1.61	1.51	−0.10	***	(0.238)	(-0.052)	**0.664**	(-0.238)	(0.091)	(-0.119)
I find the use of a rental bike uncomfortable because I do not know who sat on it beforehand.	1.59	1.50	−0.09	***	0.334	(-0.135)	**0.524**	(-0.042)	(0.148)	(0.013)
I often feel cornered on a bike.	2.08	2.35	0.27	***	(-0.207)	(-0.113)	**0.419**	0.358	(0.101)	(-0.246)
When I travel/travelling by bus or train, I appreciate that there is always something interesting to observe.	2.16	2.20	0.05		(-0.048)	(0.024)	(0.005)	**0.660**	(0.225)	(0.088)
Relaxation is easy for me on pt.	2.39	2.48	0.09	***	(-0.128)	(-0.023)	(-0.291)	**0.619**	(0.038)	(0.144)
I think it's great that I can combine many means of transport in the Rhine-Main area.	3.06	3.32	0.26	***	(-0.003)	(0.248)	(-0.081)	**0.527**	(0.048)	0.341
The possibility in car-sharing that one can borrow different car models is lovely.	1.72	1.64	−0.08	***	(0.120)	0.314	(0.263)	**0.339**	(-0.018)	(0.094)
For me, the most beautiful way of getting around is to walk.	2.55	2.61	0.06	*	(-0.045)	(-0.055)	(-0.067)	(0.134)	**0.812**	(0.011)
Only on foot can I move in my rhythm.	2.10	2.15	0.05		(-0.065)	(-0.053)	(0.141)	(0.128)	**0.772**	(0.009)
I can do almost everything by walking in my everyday life.	2.13	2.22	0.09	***	(-0.133)	(0.183)	(0.021)	(-0.026)	**0.527**	0.518
I can reach all the destinations that are important to me with pt.	2.82	2.91	0.09	***	(-0.195)	(0.041)	(-0.050)	0.345	(0.111)	**0.633**
It is not easy to combine different transport modes.	2.72	2.60	−0.12	***	(-0.076)	(0.195)	0.335	(-0.093)	(0.055)	**−0.520**
I think cycling is part of a prevailing trend at the moment.	2.76	2.84	0.08	**	(0.002)	0.366	(-0.036)	0.337	(0.232)	**−0.380**

(*continued on next page*)

Table 3 (*continued*)

	2015	2019	diff[b]		Component[c]					
	mean[a] 2015	mean[a] 2019			1: a car is freedom, independence and fun	2: a bike is independence, fun and great to combine with pt	3: non-car use is socially disadvantaging	4: open-minded and appreciation of pt and sharing options	5: joy of walking	6: car-free multi-optionality
I am not determined to use only one specific transport mode.	2.87	2.96	0.08	**	(0.013)	(0.289)	(0.017)	(0.190)	(0.003)	**0.335**

[a] *n(2015) = 1264, n(2019) = 1680, all items achieve agreement rates between 1 (fully deny) and 4 (fully agree).*

[b] *t*-test (between 2015 and 2019): *p < 0.1 **p < 0.05 ***p < 0.01.

[c] PCA with varimax rotation (n = 2944); loadings ≤ 0.3 are shown in grey; Kaiser–Meyer–Olkin = .786; Bartlett's test of Sphericity: $\chi^2 = 17466$ df = 276 p = 0.000; Total variance explained: 53.5%.

Table 4
Travel modes to work by key factors before (2015) and after (2019) the introduction of the free ticket at Goethe University (source: own surveys).

	N		Regular mode use to work[a]											
			car			pt			cycling			walking		
	2015	*2019*	2015	2019		2015	2019		2015	2019		2015	2019	
Total	*1264*	*1680*	35%	34%		63%	72%	***	35%	39%	*	13%	21%	***
Accessibility														
Campus														
Bockenheim	*262*	*333*	27%	23%		73%	84%	***	35%	38%		13%	24%	***
Riedberg	*317*	*427*	50%	48%		51%	64%	***	32%	35%		8%	16%	***
Westend	*645*	*881*	30%	30%		68%	73%	**	37%	41%	*	15%	23%	***
[Niederad]	*51*	*60*	45%	37%		49%	60%		35%	47%		14%	22%	
[Ginnheim]	*20*	*27*	65%	56%		35%	67%	**	40%	33%		5%	0%	
Subjectively good accessibility														
by car	*756*	*938*	51%	49%		54%	64%	***	30%	34%	*	10%	15%	***
by pt	*895*	*1275*	26%	27%		76%	81%	***	36%	40%	**	15%	23%	***
by cycling	*621*	*872*	25%	22%		58%	69%	***	62%	63%		15%	22%	***
by walking	*337*	*520*	17%	15%		60%	66%	*	58%	54%		27%	35%	**
Commute distance														
up to 3 km	*187*	*259*	13%	10%		46%	48%		67%	69%		31%	34%	
4–10 km	*381*	*500*	25%	23%		65%	76%	***	52%	54%		7%	13%	***
more than 10 km	*696*	*921*	47%	45%		67%	77%	***	18%	23%	***	12%	22%	***
Socio-demographics, key events and mobility tools														
Gender														
Female	*735*	*977*	34%	31%		65%	75%	***	31%	37%	**	13%	21%	***
not female	*529*	*703*	38%	37%		61%	68%	***	41%	43%		13%	21%	***
Age														
younger than 30	*232*	*241*	25%	27%		74%	80%	*	33%	30%		13%	19%	**
between 30 and 49	*627*	*829*	36%	32%	*	64%	73%	***	35%	40%	*	12%	23%	***
50 and older	*405*	*610*	40%	39%		56%	68%	***	37%	42%		15%	20%	**
Income[b]														
less than 2000 €	*655*	*708*	31%	32%		67%	78%	***	31%	32%		12%	20%	***
2000 to 2999 €	*333*	*543*	34%	32%		63%	72%	***	38%	42%		13%	22%	***
3000 € and more	*276*	*429*	46%	37%	**	55%	63%	**	44%	48%		16%	22%	**
Employee group														
tech./admin. staff	*638*	*847*	37%	36%		65%	75%	***	29%	34%	*	13%	20%	***
academic staff	*486*	*656*	29%	29%		65%	73%	***	41%	44%		11%	22%	***
Professors	*140*	*177*	51%	37%	**	50%	58%		44%	49%		21%	20%	
Employment duration														
less than 17 months	*194*	*274*	23%	22%		74%	76%		29%	41%	**	10%	18%	**
17–29 months	*112*	*163*	30%	25%		65%	78%	**	37%	39%		13%	29%	***
30 months and more	*958*	*1243*	38%	37%		61%	71%	***	37%	39%		14%	21%	***
Children in household														
children aged <3 years	*85*	*133*	40%	27%	**	68%	77%		33%	47%	**	11%	28%	***
children aged 3–13 years	*231*	*331*	42%	36%		59%	67%	**	40%	49%	**	10%	21%	***
no children <14 years	*984*	*1269*	34%	33%		64%	73%	**	35%	37%		14%	21%	***
Car availability														
Always	*514*	*685*	66%	60%	**	45%	59%	***	25%	31%	**	8%	16%	***
not always	*750*	*995*	14%	15%		76%	81%	***	43%	45%		17%	25%	***
Jobticket[c]														
Yes	*582*	*699*	21%	23%		87%	90%		29%	35%	**	15%	26%	***
No	*682*	*981*	47%	41%	**	43%	60%	***	41%	42%		12%	17%	***

Pearson χ^2 (between 2015 and 2019): *p < 0.1 **p < 0.05 ***p < 0.01.

[a] All respondents who answered "(almost) daily" or "at least once a week" to the question "How frequently do you usually use the following means of transport in summer/winter to get from home to your workplace?"

[b] own monthly net income.

[c] different question in the surveys: 2015: at the moment; 2019: before the introduction of the StateTicket.

similar increases in pt use. In most cases, the walking shares increased simultaneously with the pt shares, probably because respondents used walking as the access and egress modes for their pt use.

For cycling, the user shares in 2019 are at least slightly higher in almost all accessibility dimensions than in 2015, but not all of them are statistically significant. Even under consideration of the three accessibility dimensions, regular car use did not change significantly between 2015 and 2019. However, the shares indicate a tendency for decreasing car use.

4.2. Changes in pt use by socio-demographics, key events and mobility tools

Subgroups of the university employees by socio-demographics, key events and mobility tools confirm that the significant growth of pt use and walking, a relatively small increase in cycling and an, albeit non-significant, tendency to reduced car use is visible in all categories (Table 4). Women commuted less often than men by car and bicycle, but used pt more often. In 2019, the lowest income group had the highest share (78%) and growth rate (from 67% in 2015) of pt use compared to higher income groups. Moreover, the highest income group reduced their car use more than others, but still had the highest share of car use (37% in 2019).

Regarding key events, the employees who had been working at Goethe University for less than 17 months had small but non-significant pt increases unlike employees who had been working there longer, who had higher and significant growth rates.

Furthermore, car use decreased significantly for households with small children below the age of 3 and, even if not significantly, for households with older children aged between 3 and 13. At the same time, all other mode uses increased above average for households with children, albeit not significantly for pt with small children.

The car availability of employees did not change between 2015 and 2019. In both years, 41% of employees always had a car available. However, employees with car availability used their car less often but all other modes more frequently for commuting in 2019. Compared to those with no car availability, the changes were greater for each mode of transport.

The employment status was of particular interest in this study, since no jobticket was offered to professors in 2015 as was the case for the other employees. Thus, the StateTicket was an even larger price discount for professors than for other employees. The professors reduced their car use significantly unlike the other employment groups. In the case of using pt, the share of users was on a still remarkable but lower level compared to the others. The increase in 2019 was similar in numbers to the other employment groups but does not become significant due to the lower number of cases in the professor group.

Those with a jobticket in 2015 only increased their pt use insignificantly in 2019, but remained at a very high level (90%) and, additionally, increased cycling and walking for commuting. Those without a jobticket showed an important increase in pt use since 2015, but only reached a lower level (60% in 2019). They additionally reduced their car use and increased walking.

Finally, to compare the effects of the StateTicket with the jobticket in more detail, we limited our analysis to employees with at least 18 months' employment at Goethe University. These employees had the choice to buy a jobticket before the StateTicket was introduced if they were not professors (who were not entitled to the jobticket). The modal changes for professors working at least 18 months at Goethe University were similar to those for all professors (Tables 4 and 5). Nevertheless, the group of voluntary non-holders of a jobticket showed an important increase in pt use to 51% in 2019 (from 36% in 2015) and, thus, one of the most important increases in our analysis. In contrast, all other modes showed no significant changes, although car use tended to increase.

4.3. Attitudes and mode changes

In our previous analysis, we were able to show an increase in commuting by pt. However, our data reveals only a limited reduction in car use. Therefore, we wanted to know if the availability of the StateTicket had any effect on the mobility attitudes that might be a first indicator of ongoing and future behaviour changes.

For car attitudes, we identified two factors in our pca (section 3.3, Table 3): one combining emotional aspects (factor 1: "a car is freedom, independence and fun"); and the other the symbolic and status dimensions of the car (factor 3: "non-car use is socially disadvantaging"). Both factors decreased significantly between 2015 and 2019 for all respondents showing a reduced esteem for the car in 2019 (Table 6).

Furthermore, all respondents approved the attitudes "being open-minded and appreciation of pt and sharing options" (factor 4) as well as "car-free multi-optionality" (factor 6) significantly more in 2019 than in 2015. Both factors combine attitudinal items of pt and multimodality showing a relationship between these (Table 3). Focusing on pt attitudes, we see a significant increase in nearly all individual items. The

Table 6
Attitudinal factors in 2015 and 2019 by regular mode to work[1] (source: own surveys).

N	Total			
	2015	2019	diff[2]	
	1264	*1680*		
factor 1: a car is freedom, independence and fun	0.11	−0.08	−0.19	***
factor 2: a bike is independence, fun and great to combine with pt	0.02	−0.01	−0.03	
factor 3: non-car use is socially disadvantaging	0.05	−0.04	−0.10	**
factor 4: open-minded and appreciation of pt and sharing options	−0.13	0.10	0.22	***
factor 5: joy of walking	−0.03	0.02	0.05	
factor 6: car-free multi-optionality	−0.05	0.04	0.09	**

factor scores are z standardized for both joined waves with a mean = 0 and standard deviation = 1

[1] at least once a week [2] *t*-test (between 2015 and 2019): *p < 0.1 **p < 0.05 ***p < 0.01.

Table 5
Travel modes to work by jobticket ownership[a] before (2015) and after (2019) the introduction of the StateTicket (only persons working at least 18 months at the university, source: own surveys).

	N		Regular mode use to work										
			car			pt			cycling			walking		
	2015	*2019*	2015	2019		2015	2019		2015	2019		2015	2019	
Jobticket	*438*	*609*	22%	23%		87%	90%		32%	36%		15%	27%	***
no jobticket														
Professors	*120*	*152*	55%	39%	**	48%	57%		45%	49%		21%	20%	
Other	*400*	*482*	51%	54%		36%	51%	***	40%	40%		11%	13%	

Pearson $\chi 2$ (between 2015 and 2019): *p<0.1 **p<0.05 ***p<0.01.

[a] different question in the surveys: 2015: at the moment; 2019: before the introduction of the StateTicket.

remaining attitudinal factors, "joy of walking" (factor 5) and "a bike is independence, fun and great to combine with pt" (factor 2), did not show any significant changes after the introduction of the StateTicket.

5. Multivariate analyses – factors explaining the changing use of public transport

As we do not have panel data to observe intrapersonal changes, we identified and compared the influencing factors for regular pt use before and after the introduction of the StateTicket for all participants in the study (5.1). To gain a deeper insight into who had switched to pt, we limited further analysis to the 2019 sample and split it into persons who had a jobticket before the introduction of the StateTicket and those who did not (5.2).

5.1. Factors explaining the regular use of public transport in 2015 and 2019

Our logistic regression models comprise four categories of factors explaining differences in mode use between 2015 and 2019: (i) accessibility factors, (ii) mobility tools, (iii) attitudes and (iv) socio-demographics. The explained variances of the models are relatively high (see Table 7). We derived the independent variables in both multivariate models from theoretical considerations. Thus, we did not remove non-significant variables from the models to show these results as well.

Although the share of persons using pt regularly for commuting was different between the campuses and increased on a different scale after the introduction of the StateTicket, the work place location did not seem to be influential by itself. However, commuting distance as well as the perceived accessibility by different modes showed different influences on the probability of commuting by pt. In both waves, a commuting distance of less than 3 km reduced the chance of using pt whereas a distance of more than 10 km tripled the probability of using pt as a regular mode to work. Even more influential was the – subjectively perceived – accessibility by bus and train. If respondents rated accessibility by car in a positive manner, the probability of using pt decreased. Similar to a short commute, good walking accessibility reduced the use of pt, although this effect only became significant in 2019, but the odds ratios are similar. The case changes, however, for cycling accessibility. Good cycling accessibility in 2015 reduced the probability of using pt regularly for commuting. In 2019, this effect could not be observed anymore.

To overcome distance, households have different transport tools at their disposal. For both waves, a person's car availability and jobticket availability (as in 2015, before the StateTicket was introduced in 2019) appear to be influential. Despite a lower effect in the 2019 model, car availability has not decreased between 2015 and 2019 (both 41%).

In both regressions on a similar level, the attitudinal factors "open-minded and appreciation of pt and sharing options" and "car-free multi-optionality" increased regular pt use, whereas the factor "a bike is independence, fun and great to combine with pt" decreased the probability of using pt on a regular basis. The factor "a car is freedom, independence and fun" had no influence in 2015, but appeared negatively connected to the probability of pt use in 2019, meaning that employees with a positive car attitude used pt less often as their regular mode.

Finally, considering the life situation of employees, being old as well as being female reduced the likelihood of using pt in 2015. Interestingly, this relationship disappeared after the introduction of the StateTicket. Income and employment group had no effect on the use of pt in 2015, but people with low income used pt more in 2019. The probability of using pt increased especially for professors in 2019 and, if someone had just recently started his/her job, the probability of using pt for commuting was not higher than for others. In 2015 as well as in 2019, the probability of using pt decreased for employees in households with older children (aged 3–13). In the case of small children (aged 0–2), we observe no effect in 2015. This changed in 2019 when this factor increased the probability of commuting by pt.

Table 7
Regular use of pt (at least once a week) for the commute to work in 2015 and 2019 (logistic regression analysis).

	2015		2019	
	Exp(B)		Exp(B)	
ACCESSIBILITY FACTORS				
working location (ref. cat: Niederrad/Ginnheim)				
Bockenheim (b)	1.298		1.176	
Riedberg (b)	0.923		0.993	
Westend (b)	1.027		1.270	
commuting distance (ref.cat.: 4–10 km)				
up to 3 km	0.439	***	0.258	***
more than 10 km	2.960	***	3.009	***
subjectively good accessibility				
by car	0.448	***	0.570	***
by cycling	0.630	**	1.068	
by pt	3.890	***	4.388	***
by walking	0.698		0.662	**
MOBILITY TOOLS				
permanent car availability (b)	0.261	***	0.453	***
possession of a jobticket beforehand (b)	8.387	***	6.513	***
ATTITUDES				
factor 1: a car is freedom, independence and fun	0.996		0.839	**
factor 2: a bike is independence, fun and great to combine with pt	0.847	*	0.867	*
factor 3: non-car use is socially disadvantaging	1.004		1.104	
factor 4: open-minded and appreciation of pt and sharing options	1.386	***	1.311	***
factor 5: joy of walking	1.110		0.959	
factor 6: car-free multi-optionality	1.468	***	1.365	***
SOCIO-DEMOGRAPHICS				
employee group (ref.cat.: technical-administrative employees)				
academic staff	1.342		1.418	**
Professors	1.482		1.963	**
employment duration (ref.cat.: 30 months and more)				
less than 17 months	1.312		1.247	
17–29 months	0.887		1.203	
children in household				
children aged < 3 years (b)	1.163		1.705	*
children aged 3–13 years (b)	0.616	**	0.616	**
female (b)	0.707	*	1.061	
age (ref.cat.: 30–49 years old)				
up to 29 years old	1.333		1.365	
aged 50 and older	0.667	**	0.782	
income (ref.cat.: 2000–3000€/month)				
under 2000€/month	1.247		1.541	**
over 3000€/month	1.144		0.780	
Constant	*0.858*		*0.631*	
N (all)	*1264*		*1680*	
N (regular use of pt = no)	*463*		*464*	
	(63%)		*(72%)*	
Omnibus test	*0.000*		*0.000*	
−2 log-likelihood	*1011.825*		*1319.415*	
Cox & Snell R-Quadrat	*0.402*		*0.325*	
Nagelkerkes R-Quadrat	*0.549*		*0.470*	

(b) binary variable
each column represents one logistic regression model with the dependent variable of regular pt use
odds ratio values' (Exp(β)) significance: *p < 0.10 **p < 0 .05 ***p < 0.01

5.2. The regular use of public transport in 2019 by people with and without a former jobticket

Given that those who already had a jobticket before the introduction of the StateTicket and therefore probably use pt more often anyway (87% already regularly used pt in 2015, section 4.2), our interest especially concerns employees who had not previously had a ticket but

do use pt on a regular basis in 2019 (share increased from 36% to 51%). Therefore, we limited further analysis to employees who had already been working for Goethe University before January 2018 meaning an employment duration of at least 17 months at the time of the survey. The case is different for the group of professors, as they had no possibility to purchase a jobticket before. To avoid a bias by that circumstance, we excluded professors from further analysis and only conducted a logistic regression analysis for two other groups of employees already working at Goethe University before the introduction of the jobticket (Ajzen, 2005): those who purchased a jobticket and (Ariely and Shampanier, 2006) those who did not despite having that option available.

The logistic regression models for both subsamples are similar to the composition in the previous section (Table 8). However, the pseudo R squared values are lower compared to the former analysis (Table 7), since we do not have the explanatory variable "possession of a jobticket" anymore, which obviously is a strong predictor for mode use. Furthermore, we used fewer cases for the regressions in Table 8 by excluding professors and new employees for the above-mentioned reasons.

As in the general model (5.1), the location of the campus was not significant in explaining the regular use of pt. Furthermore, the commuting distances again showed a decrease in the probability of pt use for short distances and an increase for longer ones. Good accessibility by car decreased the probability of pt use whereas good accessibility by pt increased the probability of pt use. Both effects, however, were stronger for those who already had a jobticket before the introduction of the StateTicket. In addition, walking accessibility only reduced pt probability for those who had previously had a jobticket.

The attitude "open-minded and appreciating pt and sharing option" increased the probability of pt use in both models. However, the impact of attitudes is different, since people who did not have a jobticket before 2019 used pt more regularly if they perceived "car-free multi-optionality" or disagreed with the "joy of walking".

For employees who already had a jobticket, no socio-demographic variable turned out to be influential, except the presence of children in the household. Older children in the household reduced and younger children, in contrast, increased the likelihood of using pt. It should be noted that the influence of socio-demographics is different for those who had no jobticket beforehand. For them, the probability of using pt for commuting was lower for older employees and higher for people with a low salary.

Table 8
Regular use of pt (at least once a week) for the commute to work in 2019 for employees who had a jobticket before the introduction of the StateTicket compared to those who had none (logistic regression analysis).

	jobticket		no jobticket	
	Exp(B)		Exp(B)	
ACCESSIBILITY FACTORS				
working location				
Bockenheim (b)	1.402		1.434	
Riedberg (b)	1.406		1.114	
Westend (b)	0.933		1.216	
commute distance (Ref.cat.: 4–10 km)				
up to 3 km	0.312	***	0.205	***
more than 10 km	3.497	***	2.265	***
subjectively good accessibility				
by car (b)	0.480	**	0.611	*
by cycling (b)	0.775		1.340	
by pt (b)	6.319	***	2.862	***
by walking (b)	0.497	*	0.954	
MOBILITY TOOLS				
permanent car availability (b)	0.399	***	0.551	***
ATTITUDES				
factor 1: a car is freedom, independence and fun	1.042		0.908	
factor 2: a bike is independence, fun and great to combine with pt	0.753		0.887	
factor 3: non-car use is socially disadvantaging	1.144		1.165	
factor 4: open-minded and appreciation of pt and sharing options	1.438	**	1.380	***
factor 5: joy of walking	1.237		0.800	**
factor 6: car-free multi-optionality	1.188		1.551	***
SOCIO-DEMOGRAPHICS				
employment duration 17–29 months (b)	0.661		1.399	
academic staff (in contrast to technical administrative staff) (b)	1.419		1.540	*
children in household				
children aged < 3 years (b)	4.638	**	1.789	
children aged 3–13 years (b)	0.511	*	0.756	
female (b)	0.918		1.392	
age (ref.cat.: 30–49 years old)				
up to 29 years old	1.975		1.361	
aged 50 and older	1.266		0.601	*
income (ref.cat.: 2000–3000€/month)				
under 2000€/month	0.963		1.764	**
over 3000€/month	0.724		0.984	
Constant	*5.473*		*0.448*	
N (all)	*680*		*566*	
N (regular use of pt = no)	*69*		*262*	
	(10%)		*(46%)*	
Omnibus test	*0.000*		*0.000*	
−2 log-likelihood	*316.875*		*589.492*	
Cox & Snell R-Quadrat	*0.174*		*0.288*	
Nagelkerkes R-Quadrat	*0.361*		*0.384*	

(b) binary variable
each column represents one logistic regression model with the dependent variable of regular pt use limited to respondents who had worked at the university before the introduction of the StateTicket (employment duration of at least 17 months*); excluded: professors*
lowest number of cases (field): persons with small child(ren)&no jobticket before: n = 52
*odds ratio values' (Exp(β)) significance: *p < 0.10 **p < 0.05 ***p < 0.01*

6. Discussion

Our analyses confirm that the Hessian policymakers increased the regular use of pt with the introduction of the StateTicket. Despite the former jobticket already having high shares of regular pt commuters compared to other employers, the cost-free StateTicket increased these rates further. This observation is not only true for commuting and business but also for private trip purposes. This may change travel related attitudes and improve the overall appreciation of non-car modes for daily travel (4.3). However, car use did not decrease at the same time and car accessibility persists at the same level. Therefore, some effects of the StateTicket on traffic and the environment might remain limited in the short run. For cycling, we assume that the observed increases are closely related to the overall increase in cycling in Frankfurt due to related policy changes and efforts (Lanzendorf and Busch-Geertsema, 2014).

An important question is whether the StateTicket with the impacts described above mainly threatens non-motorized modes, since users, but not car users, might change to pt. Our analyses deliver some results pointing in this direction, for example, that the negative impact of good bicycle accessibility towards regular pt use in 2015 disappeared in 2019. On the contrary, we argue that the most important effect of the StateTicket is the strengthening of a non-car dependent, multimodal transport system and, thus, one step away from the automobile dependence we often have today. Our assumption is that more people can either abandon or even decide not to purchase their own car, if they get used to a set of available and attractive alternatives for different trip purposes, situations and related requirements (*multimodality hypothesis*). Therefore, if people can easily cover most trips without their own car, the disadvantages of owning a car may prevail. Hints for a development in this direction are a weakening negative effect of car availability for pt use (5.1), although car availability is still unchallenged for many employees today. Moreover, the StateTicket increased the share of regular pt commuter distances above 10 km, a distance highly suitable for the car. Furthermore, the decreasing appreciation of car related attitudes

and the increasing appreciation of non-car and multimodality attitudes point in this direction, in particular for car commuters (4.3). Therefore, the StateTicket is similar to the promotion of cycling and sharing, parking restrictions and other mobility management tools, an important component of policy packages for building a more sustainable, multimodal transport system. We maintain that with these types of policies, travel patterns will change in the future and they have the potential to increase the number of people and households that abandon their private car. However, our conclusions are limited to people who are not emotionally bound to their car. The StateTicket shows no behavioural effect for those with a strong car use attitude (5.1), which underpins previous results in this direction (Ariely and Shampanier, 2006).

Although we see no decrease in car use, we observe attitudinal changes pointing to a more sustainable mode choice. Therefore, we assume the intervention to be relevant not only for direct behavioural mode shift, but in the longer run and as part of a variety of mobility management tools to soften car-dependent thinking. Building upon other data regarding the hessian StateTicket, Langhagen-Rohrbach et al., 2020 could show that the increase of pt use was accompanied by a decrease in car use for several trip purposes.

It was a surprise in our analyses that the workplace location of employees showed only limited effect regarding the pt increase. Despite the campus of Riedberg being located on the periphery of Frankfurt with lower frequencies of pt supply, longer travel times to the inner city (3.1) and people commuting regularly by car more often than at other sites (4.1), pt increased a similar amount there as at other sites. However, all university sites in Frankfurt are located within the central city of the metropolitan area, have high quality pt accessibility and, thus, the effects might be different for other, more rural locations of universities, institutions or companies.

Furthermore, the increase in pt use does not apply to all employees in the same manner. Employees with no jobticket before 2018 in particular tended to increase pt use in 2019. We observed three important results. Firstly, the StateTicket improves social inclusion and options for lower income groups (*inclusion hypothesis*). After the introduction of the StateTicket, being female or old was no longer related to using less pt as was the case in 2015. Instead, in 2019 low income groups used pt more frequently for commuting than other employees (5.1). This is especially true for those who had no jobticket before the StateTicket was introduced (5.2). As the ticket is free of charge, low-income employees value having the ticket without additional costs. For them, the purchase of an already cost-reduced jobticket (section 3) was still a barrier to using pt, a result also found in the literature (Ariely and Shampanier, 2006). However, the step from paying little to paying nothing seems to be crucial.

Secondly, being a professor nearly doubles the likelihood of using pt for commuting compared to the technical-administrative staff. For professors, the StateTicket is a more pronounced price reduction than for other employees, since they did not have the option of buying a jobticket before 2018. Since professors have a higher income than others, we understand the effects of the StateTicket primarily as a psychological effect by getting a service for free as was reported in the literature (*zero price hypothesis*, section 2).

Thirdly, being an academic staff member also increases the likelihood of using pt regularly compared to technical-administrative staff. At German universities, most academic staff members who are not professors only have several, successive fixed-term contracts with a maximum of twelve years in total and with some exceptions for care responsibilities or other reasons. In contrast, technical-administrative staff members usually have permanent contracts and are, thus, employed for longer than academic staff members. From this, we conclude that the technical-administrative staff members have developed *stronger travel habits* than the academic staff members. In combination with less flexible office hours, this may explain that the StateTicket reveals a weaker effect for the technical-administrative staff.

For the key event of childbirth, we observed, as expected (Ariely and Shampanier, 2006), that employees with small children (0–2 years old) used pt significantly more often after the introduction of the StateTicket than before and also compared to other groups. A more detailed analysis reveals (5.2) that this effect is strong for those employees who already had a jobticket before 2018, but not for the others. Since the birth of a child changes the mobility patterns of the parents (Lanzendorf, 2010; Müggenburg et al., 2015) and is often accompanied by less pt use (Scheiner and Holz-Rau, 2013) and more car use (Oakil et al., 2011), we conclude that having a cheap or even cost-free option to proceed using pt helped these young parents to stick with pt and to avoid creating car-dependent structures.

However, for the key event of "starting a new job", we were not able to prove an effect of the StateTicket for those working at Goethe University for less than 17 months. We had to systematically exclude this group from the more detailed regression models analysing the effect of prior jobticket ownership (5.2), which can also be interpreted as a proxy for prior pt use. Those working at Goethe University for between 17 and 30 months showed a notable difference in their odds ratio hinting at an increase in pt commuting for those who had not purchased a jobticket before. This, however, is not statistically significant and requires further analysis with more specific data.

Regular commuting by pt is less likely for parents with older children (3–12 years old) and even the StateTicket does not change this (5.1). Also, parents with older children who previously had a jobticket commute below average by pt (5.2). Since habits formed for this group of employees without a StateTicket, the time schedules and activities of their children evolved under different circumstances. Evidently, pt is a less attractive option for this group of employees. From the impact of the StateTicket for parents of small children but not for older children, the question arises as to how the pt use of parents with small children will develop in the future. Will they develop pt related travel habits and activities in the future or will they also reduce their pt use as the children get older?

Finally, we were surprised by the sharp increase in walking in our 2019 survey. Langhagen-Rohrbach et al. (2020) did not observe an increasing amount of walking commutes for state of Hesse employees with the landesticket (by measuring the main transport mode instead of the regular mode use). As Table 4 suggests, mainly employees at the Goethe university with a jobticket before 2018 increased their regular use of walking for commuting. Moreover, in many cases, the walking shares increased simultaneously with the pt shares, possibly because respondents used the access and egress mode of walking for their pt use. A similar result was reported by Lachapelle and Frank (2009) who observed in a study in metropolitan Atlanta (US) that employer-sponsored transit pass holders not only increased pt use but also walking distances. However, attitudes towards walking in our study remained stable and further research is necessary to understand these observations better.

7. Conclusion

The Hessian state government introduced the StateTicket as a cost-free component and to "honour the commitment of state employees" (Hessisches Ministerium des Innern und für Sport, 2019) as part of the 2018 wage agreement. Before this, a huge share of Goethe University employees had already subscribed to a jobticket for which they had to pay a reduced monthly subscription price. Due to the introduction of the new ticket, its area of validity is larger compared to the jobticket and, additionally, accompanying persons are allowed, which was not the case for the jobticket.

Although commuting by pt with the jobticket was already very common, it substantially increased with the StateTicket. We conclude that in metropolitan areas with a developed pt system, this type of ticket helps to open up further pt potential. Therefore, the state government was successful in its objective to mitigate climate change by increasing the use of pt. Yet, however, we do not see a significant reduction in car

use in general. This objective was only reached for some subgroups (e.g. persons who did not subscribe to the jobticket before the introduction of the StateTicket).

Furthermore, several indicators point to an increasing multimodality as a consequence of the StateTicket, a result which was also mirrored in an evaluation study published recently (Kellerhoff and Gruschwitz, 2019). The results of our study suggest that people only abandon their private car if they can fall back on a set of transport options which satisfy their varied mobility requirements. Thus, it is a key task of transport policy to promote and provide a set of alternatives to the private car, by strengthening pt and non- or low-motorized modes and sustainable sharing systems, but also by restricting car subsidies (e.g. parking management, road charges, access restrictions, speed limits). For the moment, the behavioural change of using more pt might be fragile and there is still the opportunity to fall back on the car, which is still available for many.

Our analyses show the impact of the zero price effect and, thereby, the opening up of an increased potential for pt. Beyond our analysis, a discussion is needed regarding to which target groups such tickets should be tailored by transport policy. Our data suggest that some individual groups increased pt more than others and above average compared to their use beforehand. Especially employees with a low income benefit from the ticket and increased pt use. Thus, in a next step, it could be reasonable to provide a similar ticket to target groups with more severe financial constraints, such as people with a household income clearly below average ("social ticket"). Thereby, not only would the environment and climate benefit from such a measure, but we might also see an inclusive effect and potentials in the reduction of transport poverty (Lucas, 2012).

To the best of our knowledge, the Hessian StateTicket is unique to Germany so far. Considering the substantial increase in pt users and in recognition of related literature on free or sharply reduced flat rate tickets, such as the job- or studentticket, we believe that the potential of this policy measure has not been realized, yet. Evidently, local and national governments worldwide might benefit from this policy in combination with more car-restrictive policies to shift car traffic to pt and, ultimately, to improve quality of life in cities and to mitigate climate change.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

Author contributions (CRediT roles)

Annika Busch-Geertsema: Conceptualization, formal analysis, project administration, software, validation, Writing - original draft; Writing - review & editing.

Martin Lanzendorf: Conceptualization, investigation, methodology, project administration, supervision, validation, Writing - original draft; Writing - review & editing.

Nora Klinner: data curation, formal analysis, investigation, methodology, software.

Acknowledgements

The authors would like to thank all participants in the survey at Goethe University and especially Monika Kraus for her support in data collection. We are grateful to Elke Alban for contributing the respective map. Furthermore, we would like to thank Alison Hindley Chatterjee for the language check.

References

Ajzen, I., 2005. Attitudes, Personality and Behavior, second ed. McGraw-Hill Education, Berkshire.

Ariely, D., Shampanier, K., 2006. How small is zero price? The true value of free products. https://doi.org/10.2139/ssrn.951742.

Bamberg, S., Ajzen, I., Schmidt, P., 2003. Choice of travel mode in the theory of planned behavior: the roles of past behavior, habit, and reasoned action. Basic Appl. Soc. Psychol. 25 (3), 175–187. https://doi.org/10.1207/S15324834BASP2503_01.

Blechschmidt, A., Hoormann, J., Lanzendorf, M., 2014. Kleinbetrieb - Barriere für ein Jobticket?: Modell für Nutzungsmöglichkeiten von Jobtickets für Beschäftigte von kleinen und Kleinstbetrieben - am Beispiel der Metropolregion Frankfurt-RheinMain, Geisenheim, Rheingau, Reymann. Detlev.

Blees, V., Boltze, M., Stanek, G., 2001. Wirkungen des Semestertickets Analyse am Beispiel des Hochschulstandorts Darmstadt. Nahverkehr 19 (3), 30–41.

Bohner, G., Dickel, N., 2011. Attitudes and attitude change. Annu. Rev. Psychol. 62, 391–417. https://doi.org/10.1146/annurev.psych.121208.131609.

Buehler, R., Pucher, J., Altshuler, A., 2016. Vienna's path to sustainable transport. Int. J. Sustain. Transport. 11 (4), 257–271. https://doi.org/10.1080/15568318.2016.1251997.

Busch-Geertsema, A., Lanzendorf, M., 2015. 'Mode decisions and context change – what about the attitudes? A conceptual framework'. In: Attard, M., Shiftan, Y. (Eds.), Sustainable Urban Transport, pp. 23–42. https://doi.org/10.1108/S2044-994120150000007012. Bingley, U.K, Emerald.

Busch-Geertsema, A., Lanzendorf, M., 2017. 'From university to work life – jumping behind the wheel? Explaining mode change of students making the transition to professional life'. Transport. Res. Pol. Pract. 106, 181–196. https://doi.org/10.1016/j.tra.2017.09.016.

Butler, A., Sweet, M., 2020. No free rides: winners and losers of the proposed Toronto Transit Commission U-Pass program. Transport Pol. 96, 15–28. https://doi.org/10.1016/j.tranpol.2020.05.019.

Cass, N., Faulconbridge, J., 2016. Commuting practices: new insights into modal shift from theories of social practice. Transport Pol. 45, 1–14. https://doi.org/10.1016/j.tranpol.2015.08.002.

Cats, O., Susilo, Y.O., Reimal, T., 2017. The prospects of fare-free public transport: evidence from Tallinn. Transportation 44 (5), 1083–1104. https://doi.org/10.1007/s11116-016-9695-5.

Chng, S., Abraham, C., White, M.P., Hoffmann, C., Skippon, S., 2018. Psychological theories of car use: an integrative review and conceptual framework. J. Environ. Psychol. 55, 23–33. https://doi.org/10.1016/j.jenvp.2017.10.009.

Cools, M., Fabbro, Y., Bellemans, T., 2016. Free public transport: a socio-cognitive analysis. Transport. Res. Pol. Pract. 86, 96–107. https://doi.org/10.1016/j.tra.2016.02.010.

Dijist, M., Rietveld, P., Steg, L., 2013. Individual needs, opportunities and travel behaviour: a multidisciplinary perspective based on psychology, economics and geography. Cheltenham, Elgar. In: van Wee, B., Annema, J.A., Banister, D. (Eds.), The Transport System and Transport Policy: an Introduction, pp. 19–50.

Eagly, A.H., Chaiken, S., 1993. The Psychology of Attitudes, Forth Worth. Harcourt Brace College Publishers, Philadelphia, San Diego a.o.. https://psycnet.apa.org/record/1992-98849-000. Accessed 17 July 2020.

Enders, C.K., 2010. Applied Missing Data Analysis. Guilford Press, New York.

Follmer, R., Gruschwitz, D., 2019. Mobility in Germany: Short Report, fourth ed. Bonn, Berlin. www.mobilitaet-in-deutschland.de Accessed 17 July 2020.

Fujii, S., Kitamura, R., 2003. What does a one-month free bus ticket do to habitual drivers?: An experimental analysis of habit and attitude change. Transportation 30 (1), 81–95. https://doi.org/10.1023/A:1021234607980.

Garvill, J., Marell, A., Nordlund, A., 2003. Effects of increased awareness on choice of travel mode. Transportation 30 (1), 63–79. https://doi.org/10.1023/A:1021286608889.

Ghimire, R., Lancelin, C., 2019. The relationship between financial incentives provided by employers and commuters' decision to use transit: results from the Atlanta Regional Household Travel Survey. Transport Pol. 74, 103–113. https://doi.org/10.1016/j.tranpol.2018.11.005.

Goethe-Universität Frankfurt, 2018. Zahlen und Fakten [Online]. https://www.uni-frankfurt.de/38072376/zahlen_fakten. Accessed 17 July 2020.

Goethe-Universität Frankfurt, 2019a. *Information on the travel pass (LandesTicket Hessen/ Hesse StateTicket)* [online]. https://www.uni-frankfurt.de/83137637/FAQs_englisch_Freifahrtberechtigung_Stand_13_12_2019.pdf. Accessed 17 July 2020.

Goethe Universität Frankfurt, 2019b. *Studierendenstatistik: Sommersemester 2019* [online]. https://www.uni-frankfurt.de/85165919/Studierendenstatistik_SoSe_2019.pdf. Accessed 17 July 2020.

Haustein, S., Hunecke, M., 2007. Reduced use of environmentally friendly modes of transportation caused by perceived mobility necessities: an extension of the theory of planned behavior. J. Appl. Soc. Psychol. 37 (8), 1856–1883. https://doi.org/10.1111/j.1559-1816.2007.00241.x.

Hessisches Ministerium des Innern und für Sport, 2017. *Das LandesTicket – Für Hessen unterwegs: Ab dem 1. Januar 2018 fahren 145.000 Landesbedienstete kostenlos im ÖPNV* [Online]. https://innen.hessen.de/pressearchiv/pressemitteilung/das-landesticket-fuer-hessen-unterwegs. Accessed 17 July 2020.

Hessisches Ministerium des Innern und für Sport, 2019. *Landesticket - für Hessen unterwegs* [online]. https://innen.hessen.de/buerger-staat/personalwesen/landesticket-fuer-hessen-unterwegs. Accessed 17 July 2020.

Hogg, M.A., Vaughan, G.M., 2008. Social Psychology, fifth ed. Pearson/Prentice Hall, Harlow, England.

Kellerhoff, J., Gruschwitz, D., 2019. Begleitbefragung zum LandesTicket hessen: bericht [online]. https://wirtschaft.hessen.de/sites/default/files/media/hmwvl/infas_bericht_7091_evaluation_landesticket_hessen_20190828.pdf.

Kirschner, F., Lanzendorf, M., 2019. Parking management for promoting sustainable transport in urban neighbourhoods. A review of existing policies and challenges from a German perspective. Transport Rev. 40 (1), 54–75. https://doi.org/10.1080/01441647.2019.1666929.

Klinner, N., 2020. Methodenbericht zur Beschäftigtenbefragung der Goethe-Universität Frankfurt am Main zum hessischen Landesticket. Arbeitspapiere zur Mobilitätsforschung 21.

Klöckner, C.A., Matthies, E., 2009. Structural modeling of car use on the way to the university in different settings: interplay of norms, habits, situational restraints, and perceived behavioral control. J. Appl. Soc. Psychol. 39 (8), 1807–1834. https://doi.org/10.1111/j.1559-1816.2009.00505.x.

Klöckner, C.A., Matthies, E., 2012. Two pieces of the same puzzle? Script-based car choice habits between the influence of socialization and past behavior. J. Appl. Soc. Psychol. 42 (4), 793–821. https://doi.org/10.1111/j.1559-1816.2011.00817.x.

Lachapelle, U., 2018. Employer subsidized public transit pass: assessing disparities in access, use, and latent demand. Case Stud. Transport Pol. 6 (3), 353–363. https://doi.org/10.1016/j.cstp.2017.08.006.

Lachapelle, U., Frank, L., 2009. Transit and health: mode of transport, employer-sponsored public transit pass programs, and physical activity. J. Publ. Health Pol. 30, 73–94. https://doi.org/10.1057/jphp.2008.52.

Langhagen-Rohrbach, C., Gruschwitz, D., Kellerhoff, J., 2020. Wie wirkt das LandesTicket Hessen? Evaluierung des Jobtickets der Landesbediensteten in Hessen. Nahverkehr 9/2020, 48–52.

Lanzendorf, M., 2010. Key events and their effect on mobility biographies: the case of childbirth. Int. J. Sustain. Transport. 4 (5), 272–292. https://doi.org/10.1080/15568310903145188.

Lanzendorf, M., Busch-Geertsema, A., 2014. 'The cycling boom in large German cities—empirical evidence for successful cycling campaigns'. Transport Pol. 36, 26–33. https://doi.org/10.1016/j.tranpol.2014.07.003.

Lucas, K., 2012. Transport and social exclusion: where are we now? Transport Pol. 20, 105–113. https://doi.org/10.1016/j.tranpol.2012.01.013.

Müggenburg, H., Busch-Geertsema, A., Lanzendorf, M., 2015. A review of achievements and challenges of the mobility biographies approach and a framework for further research. J. Transport Geogr. 46, 151–163. https://doi.org/10.1016/j.jtrangeo.2015.06.004.

Müller, M., 2011. Das NRW-Semesterticket: Akzeptanz, Nutzung und Wirkungen dargestellt am Fallbeispiel der Universität Bielefeld. Wuppertal, Wuppertal Institut für Klima, Umwelt, Energie GmbH. https://epub.wupperinst.org/files/3936/wsa1_mueller.pdf. Accessed 17 July 2020.

National Travel Survey statistics, 2019. *Purpose of travel: Statistical data set* [Online]. https://www.gov.uk/government/statistical-data-sets/nts04-purpose-of-trips. Accessed 17 July 2020.

Oakil, A.M., Ettema, D., Arentze, T.A., Timmermans, H.J., 2011. A longitudinal analysis of the dependence of the commute mode switching decision on mobility decisions and life cycle events. In: Proceedings of the 16th International Conference of Hong Kong Society for Transportation Studies (HKSTS) (Hong Kong).

Hesse StateTicket [online]. In: RMV - Rhein-Main-Verkehrsverbund GmbH (Ed.), 2017. https://www.rmv.de/c/en/tickets/your-ticket/tickets-overview/tickets-for-specific-passenger-groups/hesse-stateticket. Accessed 17 July 2020.

Scheiner, J., 2018. Why is there change in travel behaviour?: in search of a theoretical framework for mobility biographies. Erdkunde 72 (1), 41–62. https://doi.org/10.3112/erdkunde.2018.01.03.

Scheiner, J., Holz-Rau, C., 2013. A comprehensive study of life course, cohort, and period effects on changes in travel mode use. Transport. Res. Pol. Pract. 47, 167–181. https://doi.org/10.1016/j.tra.2012.10.019.

Schiller, P.L., Bruun, E.C., Kenworthy, J.R., 2010. An Introduction to Sustainable Transportation: Policy, Planning and Implementation. London, Washington, Earthscan.

Schubert, S., 2016. Universität in Bewegung: bestandsanalyse des Verkehrsverhaltens und der Mobilitätseinstellungen der Studierenden und Beschäftigten der Goethe-Universität. Arbeitspapiere zur Mobilitätsforschung 11.

Shampanier, K., Mazar, N., Ariely, D., 2007. Zero as a special price: the true value of free products. Market. Sci. 26 (6), 742–757. https://doi.org/10.1287/mksc.1060.0254.

Shaw, J., Docherty, I., 2014. The Transport Debate. Policy Press, Bristol. https://doi.org/10.2307/j.ctt1t6p706.

Sims, R., Schaeffer, R., Creutzig, F., Cruz-Núñez, X., D'Agosto, M., Dimitriu, D., Figueroa Meza, M.J., Fulton, L., Kobayashi, S., Lah, O., McKinnon, A., Newman, P., Ouyang, M., Schauer, J.J., Sperling, D., Tiwari, G., 2014. Transport. Cambridge, United Kingdom and New York, NY, USA. In: Edenhofer, O., Pichs-Madruga, R., Sokona, Y., Farahani, E., Kadner, S., Seyboth, K., Adler, A., Baum, I., Brunner, S., Eickemeier, P., Kriemann, B., Savolainen, J., Schlömer, S., von Stechow, C., Zwickel, T., Minx, J.C. (Eds.), Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Sommer, C., Bieland, D., 2018. Analysis of the effects of establishing affordable annual tickets in Vienna. In: Proceedings of 7th Transport Research Arena TRA 2018, pp. 16–19. https://doi.org/10.5281/zenodo.1441113. April 2018, Vienna, Austria.

Stadt Frankfurt am Main, 2020. *Frankfurt in Bewegung: Neue empirische Befunde zum Verkehr in der wachsenden Stadt* [Online]. https://frankfurt.de/-/media/frankfurtde/service-und-rathaus/verwaltung/aemter-und-institutionen/strassenverkehrsamt/pdf/36_10-srv-2018-ergebnis.ashx. Accessed 17 July 2020.

Szabo, N., 1999. Micropayments and mental transaction costs. In: 2nd Berlin Internet Economics Workshop.

Thøgersen, J., 2009. Promoting public transport as a subscription service: effects of a free month travel card. Transport Pol. 16 (6), 335–343. https://doi.org/10.1016/j.tranpol.2009.10.008.

Urban, D., Mayerl, J., Wahl, A., 2016. Regressionsanalyse bei fehlenden Variablenwerten (missing values): Imputation oder Nicht-Imputation?: Eine Anleitung für die Regressionspraxis mit SPSS, vol. 44. SISS – Schriftenreihe des Instituts für Sozialwissenschaften der Universität Stuttgart, p. 57. https://doi.org/10.18419/opus-9112.

Van Goeverden, C., Rietveld, P., Koelemeijer, J., Peeters, P., 2006. Subsidies in public transport. Eur. Transport 32, 5–25.

Verplanken, B., Roy, D., 2016. Empowering interventions to promote sustainable lifestyles: testing the habit discontinuity hypothesis in a field experiment. J. Environ. Psychol. 45, 127–134. https://doi.org/10.1016/j.jenvp.2015.11.008.