Germany's Newest Fare: The Deutschlandticket – First Insights on Funding and Travel Behavior

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ABSTRACT

German public transport has an entirely new fare policy: following the "9-Euro-Ticket", a nationwide season ticket for all local and regional public transport in second class for 9 Euro per month from June to August 2022, almost the entire nation demanded a permanent successor. This ticket, the "Deutschlandticket", started in May 2023 and is priced at 49 Euro per mont. The ticket simplifies the complex fare structures and has an attractive price.

In this paper, we report on the genesis of this fare innovation, first insights on ridership and funding, as well as travel behavior impacts using data from our study "Mobilität.Leben" with passive waypoint tracking and survey responses before and after the ticket introduction. We find that public transport operators have innovated further and now offer "upgrades" for personalization, e.g., for First-Class or bicycle transport. Nationwide data suggests that season-ticket ownership increased by around 10% and ridership increased to almost pre-pandemic levels. Nevertheless, given the ticket's introduction right before the summer period and some unsolved discount aspects, e.g., for low-income households, it is too early to assess funding impacts. In our study, 20% of new season-ticket customers reported less automobile and more public transport use, while 7% of existing customers do. Using our tracking data, we reveal that new and existing customers increase their public transport modal share by 5 and 7 percentage points, respectively. Daily savings in travel costs of 3-5 Euro result for ticket customers, but noteworthy carbon emissions savings are not yet observed.

Keywords: Public transport; Deutschlandticket; fare innovation; Survey; tracking; fare-free public transport; flat-fare public transport

INTRODUCTION

The German public transport system comprises local, regional, and long-distance services. Local services operate within cities or larger metropolitan areas, usually using buses, trams, subways, and trains; regional services connect villages, cities, and counties, usually using trains and buses; long-distance services connect large cities and metropolitan areas with only a few intermediate stops. There are more than 400 companies involved in operating all these services. Local and regional services typically operate within transit districts under the auspices of a single transit agency, which also sets the fare policy. There are around 70 such transit districts in Germany, which usually encompass areas around larger cities (read here for a detailed explanation of transit districts (*1*)). In each district, several companies are commonly working together. There are two critical differences between local and regional services on the one hand and long-distance services on the other hand. The former are public services that receive subsidies and are either state-owned utilities or operate following a tender, while the latter are private companies with a self-sufficient business model.

Travelers usually perceive all three services as one "public transport" system, as there is a natural hierarchy and interconnection between these services regarding operations. Nonetheless, from a regulatory perspective, there is a clear divide as aforementioned. Further, the organization in more than 70 transit districts with a further subdivision into multiple fare zones also divides the nation. Frustration for travelers then emerges regarding tickets: travelers can buy one-way tickets, return tickets, daily travel passes, and season tickets. If a traveler stays within a fare zone of a transit district, she or he usually has a complete set of tickets available to choose from. However, availability reduces the more zones or districts a person travels through. For example, for commuting between transit districts, usually, no season ticket exists. Then, travelers have to patch up tickets that is increasing travel costs and making commuting unattractive even though services would be available. Around Munich, for example, commuters would quickly have to pay around 400-500 Euros per month to commute from the lakes south of Munich to the city center. Hence, the fare policy "gap" mainly consists of season tickets encompassing several transit districts and fare zones at a price that is not seen as a non-offer.

The lately introduced fare innovation of the "Deutschlandticket" in Germany closes this fare policy gap. For the first time, a nationwide season ticket can be acquired, allowing for unlimited travel on all local and regional services within and between all transit districts and fare zones. It is priced at 49 Euro per month, is only available as a digital ticket, is initially limited to three years before facing an evaluation. It reduces the average cost for a season ticket, simplifies the complex structure of transit districts and fare zones, and provides more travel opportunities, e.g., for commuters between two districts. Note that the "Deutschlandticket" is not valid for long-distance services. Consequently, it is not the same as the Austrian "Klimaticket" or the Swiss "Generalabonnement", but the Deutsche Bahn, the largest operator of long-distance services, integrated the "Deutschlandticket" in its long-distance season ticket product, hence creating for the first time an identical product to the "Klimaticket" and the "Generalabonnement". The "Deutschlandticket" is a mobility tool and policy instrument. The mentioned advantages lead to the following hypotheses regarding mode shift. First, the price reduction, in some cases a drastic cut in travel costs, is expected to increase public transport use and decrease automobile use (*2*). Second, this unprecedented simplification of the German fare policy system is expected to attract public transport users too (*3*). The ticket's ability to encourage a shift from the automobile to public transport makes it a policy instrument. Its aim is clearly to reduce the externalities associated with automobile (*4, 5*),

but it does not reduce automobile dependence (*6*) and it must be part of a "*coordinated package*" (*7*) to become fully effective in reducing the share of automobile trips.

In this paper, we summarize the genesis of this fare innovation, starting from announcing the "9-Euro-Ticket" as a response to the cost-of-living crisis in early 2022, discuss first reports on ridership and funding impacts, and present first insights on travel behavior changes in the months before and after the introduction of the "Deutschlandticket" using data from our year-long panel study "Mobilität.Leben" with smartphone-based semi-passive travel diary (waypoint tracking) and questionnaires.

GENESIS OF A FARE INNOVATION

A response to the cost-of-living crisis

With the cost-of-living crises emerging from the geopolitical crisis in Ukraine in early 2022, several governments worldwide announced support packages that aimed at limiting the impact of inflation on households. In the European Union, a clear focus was on the support for energy bills (*8*); some countries also aimed at reducing transportation costs by reducing the cost of public transportation, e.g., Hungary (policy reference HU-2023-18/3201) and Spain (policy reference ES-2022-36/2799). However, one measure was clearly extraordinary, Germany's fare policy of the "9-Euro-Ticket". It was a monthly public transport season ticket for 9 Euro per month, approximately 10 US-Dollar, allowing unlimited travel in June, July, and August 2022 on all local and regional public transport lines. These services do not include long-distance and high-speed services like the ICE, TGV or railjet (*9*). It was extraordinary for two reasons. First, its price was less than the minimum hourly wage, making it almost fare-free public transport. Second, it drastically simplified the German fare system: one season ticket for the entire nation instead of season tickets limited to the zones and transit districts. Right from its announcement, the "9-Euro-Ticket" generated much public interest and led to public transport being discussed more positively.

A first assessment of the 9-Euro-Ticket

The dual nature of the "9-Euro-Ticket" of being almost flat-fare and having a nationwide validity led to the hypotheses that public transport ridership will increase during these three months (*10*–*13*), eventually re-activating some users to use public transport also after the ticket's validity period (*14*). At the end of the validity period, the "9-Euro-Ticket" has been sold more than 52 million times across the three months. Additionally, around ten million public transport season-ticket subscribers received the ticket automatically (*15*). Assuming each of the "9-Euro-Ticket" purchased the ticket for June, July, and August would lead to an estimated 27 million users, including existing season-ticket subscribers. Hence, almost one-third of the German population had the ticket once within the "9-Euro-Ticket" validity period. However, a survey revealed that respondents bought, on average, 1.9 tickets, i.e., not all three months (*16*). This estimate then leads to in total of 38 million users who had the ticket once within the "9-Euro-Ticket" validity period. In transit districts, ridership increased on average in June, July, and August by around 10-20% compared to May 2022, while regional trips, i.e., larger than 30 km, increased by 30-50% (*16*). Notably, the summer months of June, July, and August usually see less ridership due to the summer holidays, but 2022 reversed this trend (*17*).

This natural experiment has been observed by many. The official study has been organized by the Association of Public Transport Companies (VDV) with more than 70,000 respondents (*18*). Their study reports that 17% of all "9-Euro-Ticket" users shifted from other modes of transport to

public transport, reducing the number of automobile trips by around 1 billion trips per month. 29% of trips of previous non-season-ticket owners and 23% of trips of previous season-ticket owners took place outside the home location's transit district. Overall, 16% of trips were induced. In one nationwide survey with around 2,500 respondents, others reported that out of all public transport trips, 6% were induced and 11% were shifted from other modes of transport, leading to a reduction of 53 million automobile trips per month (*16*). Similarly, a passenger survey in the Frankfurt metropolitan area with around 2,300 respondents revealed that out of all public transport trips made, 5% were induced, and 14% were shifted from other modes of transport (*17*). Two studies combined a mobility tracking panel with surveys, a nationwide approach using around 2,100 tracking respondents with around 1,200 survey responses (*19*), and a study with a focus on the Munich metropolitan area with around 1,000 tracking responses and around 2,200 survey responses (*20*). Both studies reported a similar pattern: a general increase in public transport use in the first weeks of June, around 20% compared to May, followed by a decline to 80% of May levels until mid-August, before increasing again until the end of August, to around 90% of May levels, before dropping substantially after the ticket ended, to around 70% of May levels (*19*). This pattern might be intuitive given the usually less busy summer months (*17*). During the "9-Euro-Ticket" ticket period, a five percent shift in the modal share from the automobile to public transport was observed in the Munich metropolitan area (*20*). However, both studies note that no major change in daily mobility, e.g., for commuting or shopping, was observed. Overall, several studies concluded that carbon savings were made, which were somewhere in the order of magnitude of 300,000 to 600,000 t CO_2 per month; when considering the ticket's costs of 2.5 billion Euro, this leads to carbon abatement costs of around 1,500 (*21*) to 2,000 Euro per t CO_2 (*16*).

Finding a successor ticket

The "9-Euro-Ticket" was a public success. It achieved its primary cost-saving objective and it attracted people to use public transport, at least for some trips. Nevertheless, people also liked its simplicity compared to the previous complex fare policies (*18*). This success prompted an immediate public debate about a successor: most politicians agreed that such a product should be permanently introduced; however, there was disagreement about the price. Prices from one Euro per day to 70 Euro per month were discussed. Finally, in September, the federal government announced that the price would be between 49 and 69 Euro per month.

The pricing discussion was accompanied by the discussion on funding public transport in general and how to subsidize the expected revenue losses, given that many season tickets would become cheaper. However, in this discussion, it appears that the price elasticity of demand has not been publicly considered. Clearly, the question of whether revenue losses occur or not depends on the uptake of the "Deutschlandticket" in the population, here various estimates exist: an increase in season ticket ownership of around 10% based on data from August 2022 (*16*), 20% based on data from September 2022 (*22*), and 40-50% based on data from April 2023 (*21*). Ultimately, this discussion and the requirement to find a finical agreement between the federal government and state governments to fund the expected revenue losses before the start of the "Deutschlandticket" the led to a step-wise postponement of the starting date from 1 January 2023 to 1 May 2023.

Introduction of the "Deutschlandticket" and further fare innovation

The "Deutschlandticket" went on sale on 3 April 2023, and its validity started on 1 May 2023. The ticket could be further subsidized by employers, leading to a price of 34.30 Euro per month.

As aforementioned, the "Deutschlandticket" was also integrated without a premium in Germany's long-distance season ticket, called "BahnCard 100" (*23*). Additionally, in some states or transit districts, the "Deutschlandticket" was also introduced for low-income people, pupils, or students for around 20-30 Euro per month (*24*).

Analyses show that two third of the German population can save money with the "Deutschlandticket" compared to the basic season ticket offered before and get an increased travel range. In addition, the commuter tax allowance in the German income tax systems generates additional benefits: for full-time employees who commute 40 km per day, the total ticket costs can be claimed, while when commuting 60 km per day, the entire allowance can be claimed that substantially exceeds the costs of the "Deutschlandticket", i.e., taxpayers can claim more than they paid (*24*). Nevertheless, this cost analysis lacks the fact that previous season tickets usually came with features that the "Deutschlandticket" does not include, at least not yet.

The "Deutschlandticket" can be considered a "core ticket" as it offers no additional features or benefits, which are typical for German season tickets, e.g., bringing additional passengers on weekends, transporting bicycles off-peak, and handing over the ticket to another traveler (portability). It had been announced that additional features were not included because there was not enough time to harmonize all terms and conditions for all of these features in all transit districts. Nevertheless, the Association of Public Transport Companies (VDV) announced that they are working on harmonization and expect this progress to end within two years after the introduction of the "Deutschlandticket". Consequently, to offer "Deutschlandticket" customers these features, some companies and transit districts responded by offering additional services or "upgrades" to the "Deutschlandticket". Table 1 summarizes the most common upgrades. Importantly, these upgrades are only valid within the issuing transit district or even state. Nevertheless, when buying these upgrades, the savings from the "Deutschlandticket" compared to the season ticket can be neutralized; costs can even increase.

TABLE 1 : List of upgrades to the "Deutschlandticket". Values taken from (*24*).

Upgrade	Typical additional costs
First-Class travel	40-50 Euro per month
Bicycle transport	20-40 Euro per month
Portability	10-15 Euro per month
Additional travelers on weekends /offpeak	10-15 Euro per month

RIDERSHIP AND FUNDING

The "Deutschlandticket" is not only expected to increase season ticket ownership and ridership but also forces public transport companies to agree on a new approach for revenue sharing (*25*). While many public transport companies and agencies set up studies to observe the impact of the "Deutschlandticket" on ridership and travel behavior, many funding aspects are still unsolved, in particular as many federal states and transit districts are still working on providing a further subsidized "Deutschlandticket" to low-income people, students, and pupils, which strongly interferes with funding.

The German Association of Public Transport companies (VDV) reported that around 11 million "Deutschlandticket" subscriptions had been sold in the first two months, of which around 8%

are customers who did not use much public transport before; around 20% of customers reported that they want to reduce automobile usage due to the availability of the "Deutschlandticket" (*26*). So far, official results on travel behavior and ridership are only available for the Hamburg metropolitan area (*27*): season-ticket ownership increased by 22% and ridership increased from 89.3% to 95.4% of the pre-pandemic levels from April to May 2023. Using a survey with around 1,000 respondents, they find that out of all new trips made with the "Deutschlandticket", 53% were previously also made by public transport, but without a season ticket, 24% would have otherwise been made by the automobile, 2% would have otherwise been made by walking and 3% by cycling, while 6% are shifted from usually more expensive long-distance public transport services and the remaining more than ten percent of trips are induced demand. Using mobile phone data, Germany's Department of Transport announced the number of regional train trips increased by 25% since the introduction of the "Deutschlandticket" (*28*).

In 2018, local and regional public transport companies had revenues of around 14.2 billion Euro which constitute ticket sales, subsidies, and further surrogate payments (*29*). In comparison, with 11 million subscriptions, an annual revenue of around 6 billion Euro can be expected, and with 12 million subscriptions, an annual revenue of around 7 billion Euro. However, given the unknown development of season-ticket ownership in the course of the year as well as the unclear situation of further subsidized tickets and how transit companies are getting compensated for that, it is just speculation at this point whether this level of ownership suffices to avoid revenue losses. To reduce uncertainty, the federal government and all state governments agreed that each will provide 1.5 billion Euro, i.e., in total, 3 billion euro p.a., for the years 2023 to 2025, to compensate losses. In addition, the federal government also covers 50% of the additional costs related to the introduction of the ticket in 2023 (*30*). Nevertheless, the uncertainty of cash flow, in addition to the requirement of investing in digital hardware for ticket checking, can put in particular smaller companies at risk of bankruptcy.

BEHAVIORAL RESPONSE

Data

The data for the analysis of travel behavior in the months before and after the introduction of the "Deutschlandticket" has been collected as part of our "Mobilität.Leben"-study (German for mobility+life). Initially designed to observe the travel behavior impacts of the "9-Euro-Ticket", we extended the study to also include the first weeks of the introduction of the "Deutschlandticket" (*31*).

The "Mobilität.Leben"-study comprises two elements: a smartphone-based travel diary app with passive waypoint tracking that generates semi-passive travel diaries and multiple questionnaires. The smartphone app collects waypoints and sends them to the server that identifies trip-legs or stages, including mode detection and stays, which are returned to the user, who can edit and validate the entries in her or his travel diary. In this analysis, we focus on the time period of April and May 2023, i.e., the month before and after the introduction of the "Deutschlandticket". In this period, we distributed a questionnaire before the introduction and after the introduction of the "Deutschlandticket". The duration of each questionnaire is about ten minutes; the questionnaires collect information on stated travel behavior, season-ticket ownership, and attitudinal questions. Socio-demographic information has already been obtained through previous questionnaires of the "Mobilität.Leben" study.

The "Mobilität.Leben" study combines one panel with questionnaires and passive waypoint tracking and one panel with only questionnaires. The first panel was recruited via a media

campaign in two steps, one in May 2022 and one in March/April 2023. The second panel was recruited through a professional agency; recruitment was only in May 2022. Out of the more than 2,500 total study participants, we consider in this analysis the survey responses of 991 respondents who completed both questionnaires (571 from the media campaign recruitment, 420 from the professional agency recruitment). For the analysis of the waypoint tracking, we use data from 578 respondents who provided at least one tracking point and who completed the questionnaire after the introduction of the "Deutschlandticket", where they provided the information on whether they have bought the "Deutschlandticket".

Regarding our sample's representativeness, the media campaign in the Munich metropolitan area led to a sample biased towards this region with higher incomes and higher education levels. The recruiting via a professional agency aimed at a representative sample. Consequently, we can conclude that the survey results are more representative of the entire nation than the results from the tracking panel. Nevertheless, the sample covers all ages and genders from 18 to 70 years, and sample weighting can be done to make the findings more representative. This sample weighting is ongoing as data collection has only recently finished.

Results

Survey

From the 991 respondents who completed the two questionnaires, 25.5% are existing season-ticket customers, i.e., they already have season tickets in April, May, and June, while 11.7% are new season-ticket customers in May and June, i.e., they did not have a season ticket in April. To better understand the effects of related travel behavior variables on the choice of becoming a new season-ticket customer (*32, 33*), we estimate a Probit choice model for all those respondents who had no season ticket in April, i.e. before the introduction of the "Deutschlandticket". As covariates, we use age (categorical variable), being male (binary variable), monthly household net income (categorical variable), the household has at least one automobile (binary variable), Regional statistical spatial typology of the household location (categorical variable), public transport usage frequency in April (categorical variable). We also control for the recruitment strategy using a binary variable. Table 2 provides the levels of each variable as well as the model estimates. Due to missing data in the household income variable, only 717 out of 738 available observations are used for the parameter estimation.

The model estimates presented in Table 2 result from testing various model specifications and interaction effects and comparing their performance using the Likelihood-ratio test. We find that being older than 30 years, having no automobile in the household, and not living in a metropolitan center as well as using public transport only 1 to 3 days per week significantly increases the probability of becoming a new customer. Note that all respondents with a season ticket are not included in this model. Using the results from Table 2, we can calculate some predictions of interest. For example, people living in rural areas, being older than 30 years, having no automobile in their household, but using public transport 1-3 days per week have a probability of becoming a new customer of around 43%, which is reduced to 27% if the household owns at least one automobile. Contrary, people younger than 30 years and living in a metropolitan center, using public transport 1-3 days per week, and having no automobile have only a probability of 13% of becoming a new customer.

In each of the two questionnaires, respondents indicated their automobile (including motorbike and similar vehicles) and public transport mode use frequencies. In Figure 1, we show

TABLE 2 : Model estimates of a Probit choice model of becoming a new season-ticket customer.

	Dependent variable:	
	new season-ticket customer	
Age category		
Younger than 30 years (base)	-	(-)
30-50 years	0.416*	(1.95)
Older than 50 years	0.464**	(2.21)
Gender		
Non-male (base)	-	(-)
Male	0.0442	(0.34)
Net household income		
1499 Euro per month or less (base)	-	(-)
1500-2499 Euro per month	0.260	(1.07)
2500-3999 Euro per month	-0.0628	(-0.26)
4000 per month or more	-0.196	(-0.82)
Household automobile ownership		
Has no automobile	0.430**	(2.56)
Has at least one automobile (base)	-	(-)
Regional statistical spatial typology at household location		
Rural region	0.477**	(2.55)
Regiopolis, urbanized aras	0.412***	(2.64)
Metropolitan center (base)	-	(-)
Public transport mode usage frequency in April 2023		
Less than once per week (base)	-	(-)
One to three days per week	0.669***	(4.53)
More than four days per week	0.0253	(0.11)
Recruited through professional agency	-1.041***	(-6.90)
Constant	-1.610***	(-5.16)
Observations	717	
Pseudo R^2	0.171	
Log-likelihood at convergence	-257.7	
Log-likelihood constant only model	-309	

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

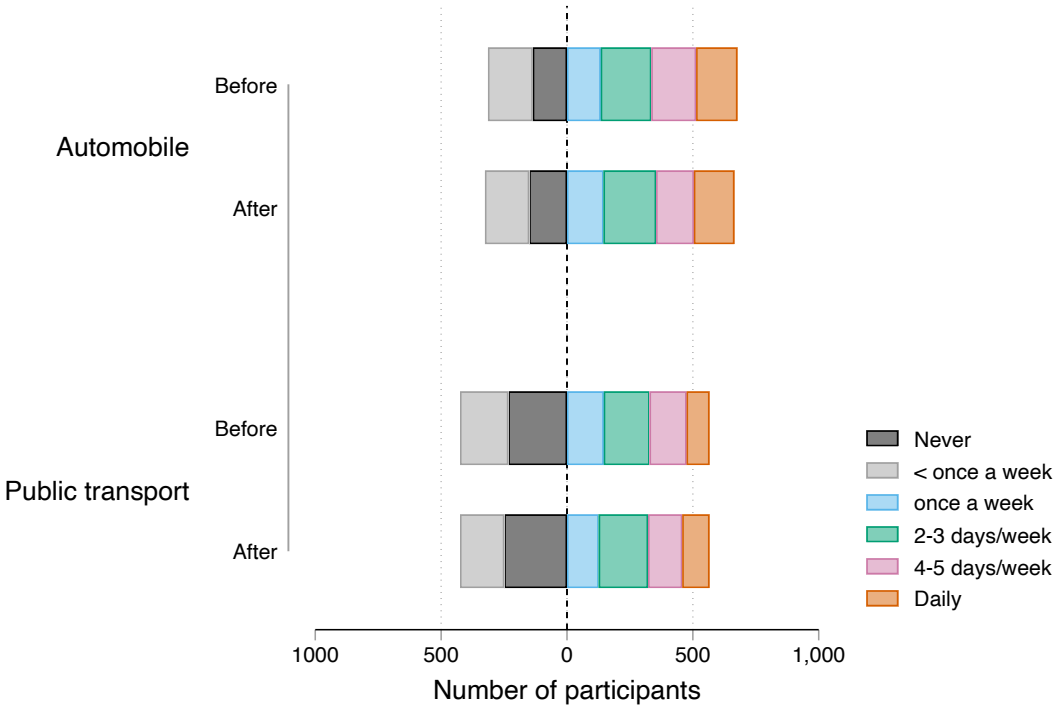


FIGURE 1 : Changes in the reported mode use frequencies for automobile and public transport use from before and after the introduction of the "Deutschlandticket".

the responses. It can be clearly seen that more participants are using the automobile in general compared to public transport, while no substantial differences between the time before and after the introduction of the "Deutschlandticket" can be identified. Overall, 5.8% of respondents indicated that they increased public transport usage while reducing automobile usage. Here, increase or decrease is defined as changing the category shown in Figure 1.

In Table 3, we further separate the stated travel behavior changes by customer groups of no-season-ticket customers, existing season-ticket customers, and new season-ticket customers. Here, we define "more public transport" as a binary variable that is equal to one if a respondent reported a higher public transport usage frequency in June compared to April (in the levels shown in Figure 1), and zero otherwise; similarly, we define "less automobile" as a binary variable that is equal to one if a respondnet reported a lower automobile usage frequency in June compared to April (in the levels shown in Figure 1), and zero otherwise. While two-thirds of no-season-ticket customers did not report a change, around 50% of new season-ticket customers reported an increase in public transport use, but only around 20% reported a decrease in automobile use; one-third of existing season-ticket customers reported an increase in public transport use, but only around 7% also reported a decrease in automobile use. We corroborate these findings using a bivariate Probit model to see if other factors than the customer group affect the reported behavioral changes and if there is a correlation among unobserved factors between the two outcomes. We find no other significant effects than the customer group, no significant correlation in the unobserved factors, and the model's predictions are very close to the observed shares in Table 3.

Regarding savings from having the "Deutschlandticket" as a mobility tool, 75% of season-

TABLE 3 : Travel behavior changes in automobile and public transport use for the three considered customer groups.

	Season-ticket customer		
Behavioral change	No	Existing	New
Not more public transport, not less automobile	68.81%	50.99%	34.48%
Not more public transport, less automobile	16.56%	20.16%	13.79%
More public transport, not less automobile	11.90%	21.74%	31.90%
More public transport, less automobile	2.73%	7.11%	19.83%

ticket owners reported that they save money with the "Deutschlandticket", of which 50% saved less than 40 Euro per month and only 7% save more than 100 Euro per month.

Smartphone-based travel diary

Figure 2 shows the smartphone usage pattern during April and May 2023, with the activities of being mobile in Germany, being mobile outside of Germany, and moving across borders. The red horizontal line marks the 578 study participants who completed the questionnaire after introducing the "Deutschlandticket" and reported at least one day of data. It can be seen that not all participants were providing data all the time and that for around 32.5% of person-days, no measurements are available as respondents were either immobile or did not turn on their smartphones for tracking. A person-day here is one person providing one day of travel behavior measurements. Out of the available 23,799 person-days, we exclude 5,577 person-days for several reasons: all person-days without any travel, all respondents who have not at least five person-days in April and in May in Germany (i.e. ten person-days in total), all person-days with daily travel distances greater than three times the median distance of that respondent and all respondents who reported a change in daily travel distance more/less/of than 30 kilometers from one month to the other. In the end, this leads to 18,222 person-days of 506 distinct users considered for this analysis (8,860 in April, 9,362 in May), where, on average, one respondent reports 17 person-days in April and 18 person-days in May.

For each respondent, we compute the average total daily travel distance, the average daily automobile travel distance, and the average daily public transport distance for April and May 2023, i.e., before and after the introduction of the "Deutschlandticket". Figure 3 shows the changes in average total travel distance between April and May 2023. A positive value means that travel increased in May compared to April, and a negative value means that travel decreased in May compared to April (note that there are Easter holidays as well as several bank holidays in Germany in that period). Generally, travel increased on average by 0.98 km (median 0.47 km) in our sample (by mode: 0.63 km increase in public transport travel, 0.52 km decrease in automobile travel). Nevertheless, the figure also shows substantial variability in travel behavior within persons, which could be a confounding factor in determining changes in mode choice, e.g., April could be characterized by holiday travel, while May was a typical working month.

Figure 4 shows the changes in average daily travel distances (total, automobile, public transport) from April to May 2023 for the three previously used customer groups (no season-ticket customer, existing season-ticket customer, new season-ticket customer). A positive value

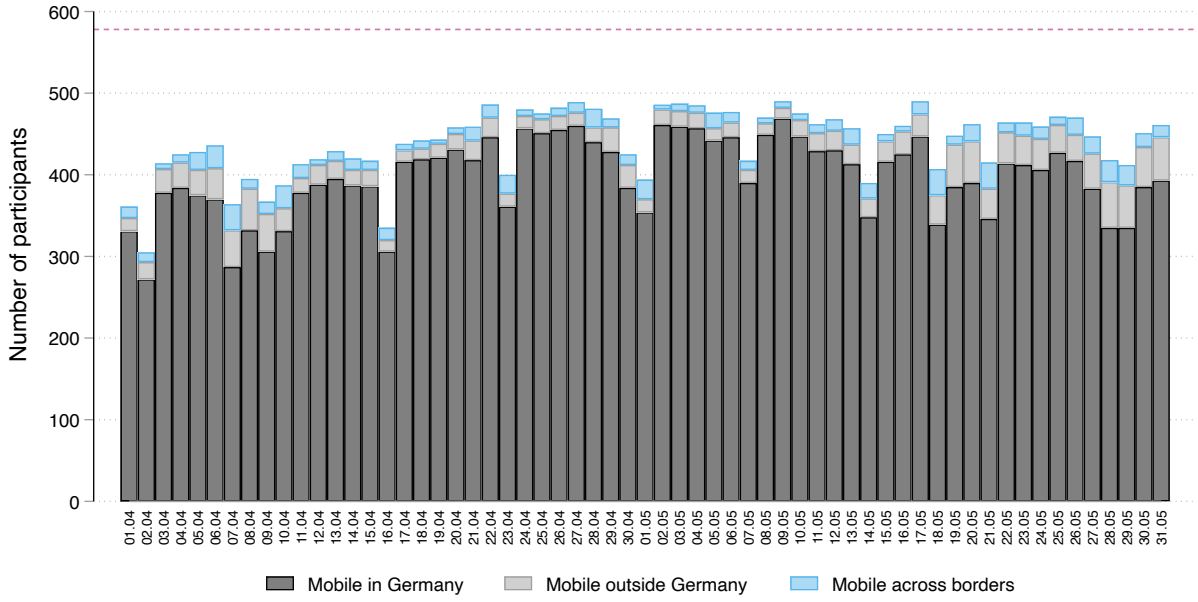


FIGURE 2 : Smartphone use and travel behavior in April and May.

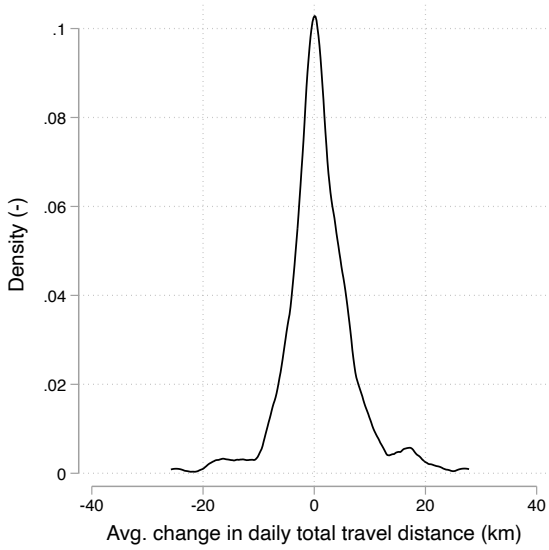


FIGURE 3 : Changes in average total travel distance between May and April 2023.

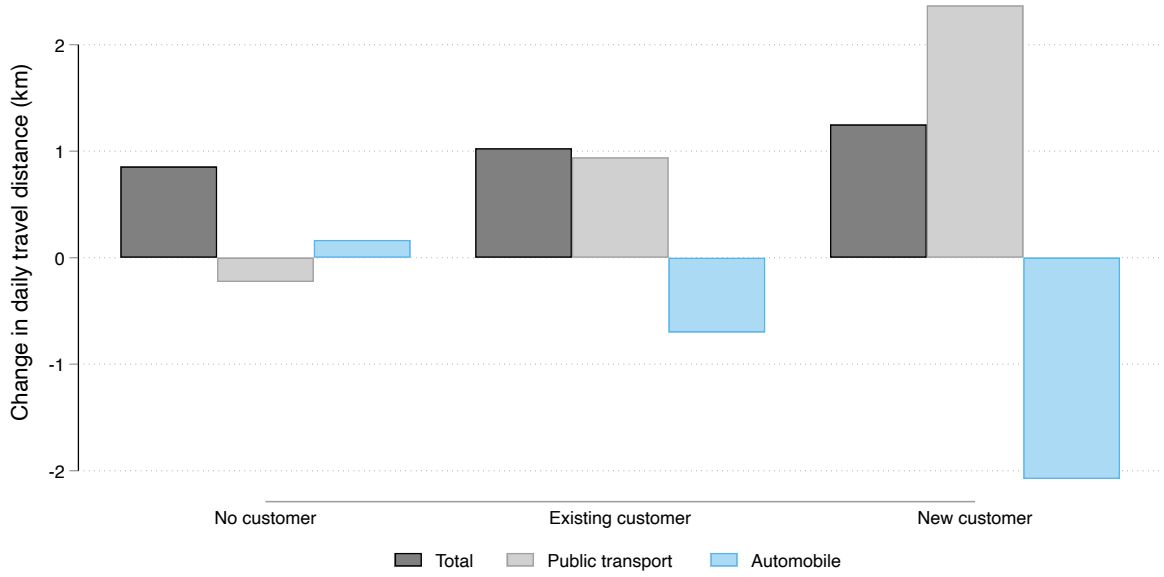
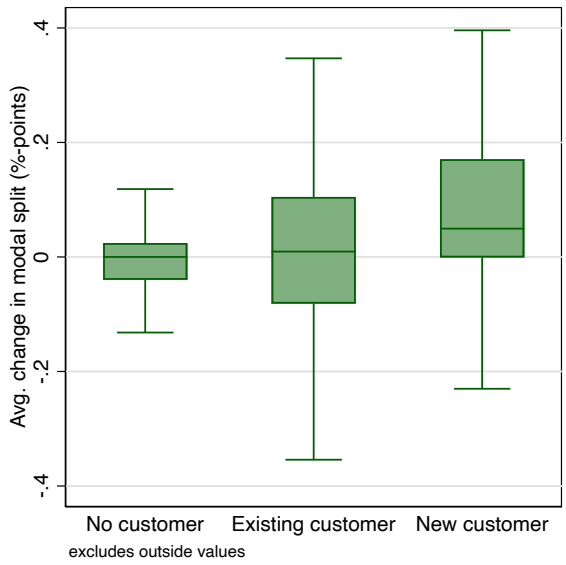


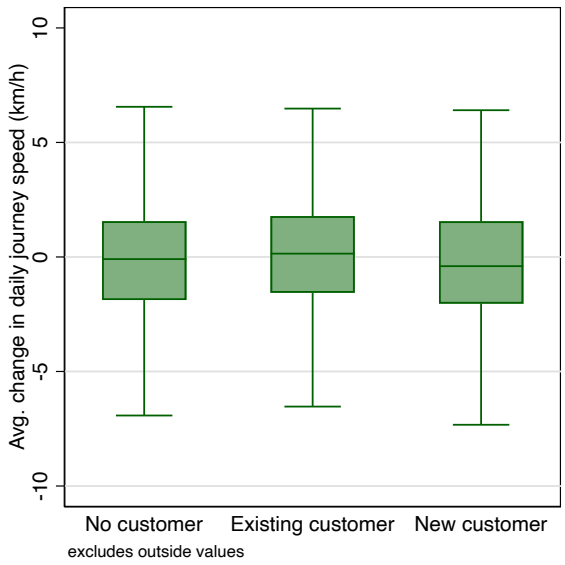
FIGURE 4 : Changes in average daily travel distances by customer group.

in Figure 4 indicates that the travel distance increased from April to May, and a negative value indicates a decrease. It can be seen that total daily travel distances increased in all three groups, while public transport travel increased substantially stronger for existing and new season-ticket customers. However, automobile travel did not decrease at the same level as public transport travel increased: the gap is 0.25 km for existing customers and 0.3 km for new customers. Nevertheless, the findings from Figure 4 align well with the hypothesis that the "Deutschlandticket" increases public transport use.

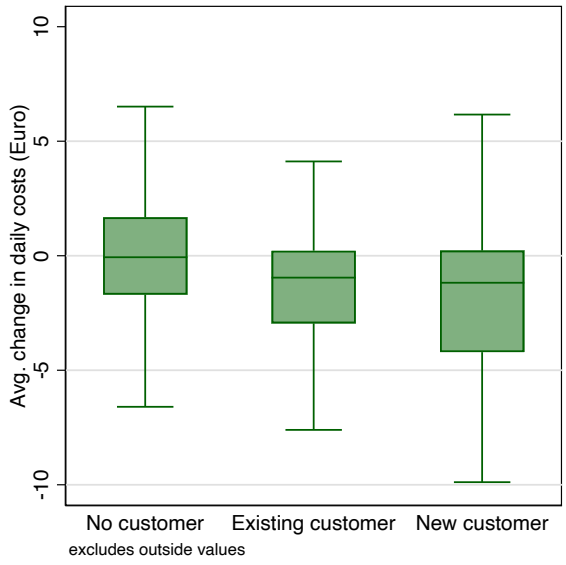
For every respondent, we calculate the average changes from April to May in public transport modal share, journey speed, travel costs, and carbon emissions, where all values refer to daily averages. Figure 5 shows the results, where a positive value on the vertical axis means an increase from April to May. For reference, Figure 5 shows the median, while we report the mean of each measure in the following. We separate the results by the customer groups used before: no season-ticket customers, existing season-ticket customers, and new season-ticket customers. Figure 5a shows for non-customers no change in the public transport modal share, the modal share of existing customers increased on average by one percent point, while it increased for new customers on average by 7%. Figure 5b shows the speed changes, which decrease for every customer group less than 1 km/h. It can be concluded that existing and new customers are not traveling faster by using the "Deutschlandticket", but slightly slower, but not much as it could be expected when thinking of public transport as a "slower mode" compared to the automobile. The savings in travel costs as shown in Figure 5c, which comprise the time costs (for public transport 3.83 Euro/h, for automobile transport 4.66 Euro/h, both taken from (*34*), 0.5 Euro/km automobile costs as well as the savings indicated by respondents as a consequence of the introduction of the "Deutschlandticket". While non-customers report on average no changes in travel costs, existing customers save around 1.46 Euro per day and new customers around 2.11 Euro per day. When considering cost savings by Germany's regional statistical spatial typology, we find that new customers in more rural areas



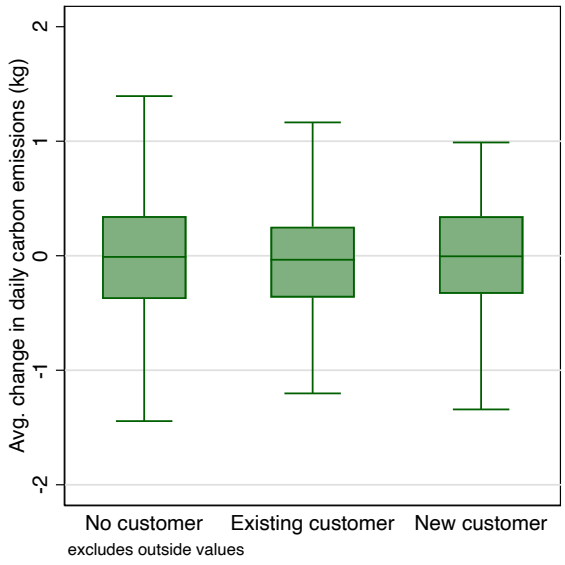
(a) Changes in public transport modal share



(b) Changes in journey speed



(c) Changes in travel costs



(d) Changes in carbon emissions

FIGURE 5 : Changes in modal share, journey speeds, travel costs, and carbon emissions for the three customer groups.

save around 4.5 Euros per day, new customers living in urban areas around 2 Euros per day, and new customers in metropolitan centers around 1.36 Euros per day. Ultimately, the observed behavior so far did not result in substantial changes in daily carbon emissions, as seen in Figure 5d. Note here, however, that emissions are calculated based on German averages (*35*), which do not consider local factors, e.g., whether electric services run on green power, as in the case of Munich.

To corroborate and quantify the observations from Figure 5a, we regress the change in public transport modal share on a series of explanatory variables. Here, we find that a marginal effect

of being a new customer compared to customers on public transport mode share of 7 percentage points and a marginal effect of existing customers of 5 percentage points. If new customers used public transport 1-3 days per week before the introduction of the "Deutschlandticket", their change in public transport modal share increases to around 11 percentage points; if they used public transport less than once per week before, their change in public transport modal share increases to around 15 percentage points.

DISCUSSION

The first insights on ridership, funding impact, and travel behavior suggest a positive trend toward the expected - and politically desired - outcomes. However, we must observe the introduction of the "Deutschlandticket" for an extended period of time to see at which level this trend settles. The introduction of the "Deutschlandticket" in May coincides with the summer holidays and the cycling season, where the period from September to November can be expected to provide more reliable estimates. In addition, many federal states and transit districts are still working on providing a "Deutschlandticket" for low-income people, pupils, and students. Consequently, only when this transition period is over, and further organizational questions are clarified, a reliable assessment of this policy instrument can be made; here, dimensions of interest are modal shift, carbon abatement costs, revenue loss, and consumer surplus. As the "Deutschlandticket" is also promoted as a sustainability policy instrument, especially the carbon abatement costs will be of interest compared to other measures such as subsidizing renewable energy generation.

The variability in travel behavior underlying Figure 4 also emphasizes the complexity of travel behavior in the 21st century, calling for future research that addresses the understanding, modeling, and integration of this complexity in the planning of future transportation systems, long-term policymaking, and for transit companies in the revenue distribution process. This involves developing methodologies to identify and generate representative entries for travel diaries based on mobility tracking and how to reliably identify modal shifts and induced demand. The six-week period used in the "MobiDrive" study provides a starting point (*36*), but given the growth in long-distance travel and the demographic change in the past 25 years, this parameter must be revisited.

CONCLUSIONS

In this paper, we presented the genesis of the fare policy innovation "Deutschlandticket", initial insights on the overall impact on ridership and funding, and findings on travel behavior outcomes using data from our "Mobilität.Leben" study. The "Deutschlandticket" is a flat-fare season-ticket subscription for all local and regional public transport services, which not only reduces the average cost, but also simplifies the entire fare policy system in Germany. The political and public expectation is that the "Deutschlandticket" boosts ridership and promotes public transport.

We found in our study and official figures that season-ticket ownership increased by about 10%, and especially new season-ticket customers, i.e., those who had no season ticket before, increased public transport use. Nevertheless, only 20% of new season-ticket customers and 7% of existing season-ticket customers indicated increased public transport use and decreased automobile use. Using the mobility tracking data from our study, we find that existing and new season-ticket customers reduced increased public transport use more than they reduced automobile use.

In closing, the fare policy "Deutschlandticket" can be considered a success. First and foremost, it is a marketing success that boosted the image of the public transport system. Second, early findings suggest that the "Deutschlandticket" is partially successful in moving Germany towards

a more sustainable transportation system, which immediately means calling for supply-side measures to maximize the realizable benefits. Nevertheless, ultimately an assessment will show how the costs and benefits of this fare innovation are distributed and whether it should be continued after the year 2025.

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AUTHOR CONTRIBUTIONS

The authors confirm their contribution to the paper as follows: study conception and design: Allister Loder, Klaus Bogenberger; data collection: Allister Loder, Fabienne Cantner, Victoria Dahmen; analysis and interpretation of results: Allister Loder, Fabienne Cantner, Victoria Dahmen, Klaus Bogenberger; draft manuscript preparation: Allister Loder. All authors reviewed the results and approved the final version of the manuscript.

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