Sustainable Commuting – An Empirical Analysis of Commuting Considering Changes Due to the Pandemic

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Abstract. Commuting trips constitute a substantial portion of the annual kilometers traveled in Germany, with the distance between home and work having increased significantly in recent years. The reasons for this trend remain largely unexplored. Additionally, commuting conditions have evolved due to the COVID-19 pandemic and the rise in teleworking. This paper examines commuting trends in relation to residential location preferences, offering empirical insights into recent developments and discussing their implications for sustainable commuting practices in the future.

Keywords: Commuting · Home Office · Coronavirus Impacts · Travel Pattern Changes · Empirical Data Analysis

1 Introduction

Commuting constitutes a significant part of a country's mobility, with distances between home and work increasing in recent years. In 2017, commuting represented about one-third of car mileage in Germany, although it accounted for only 16% of all trips [1]. The average commuting distance rose from 14 km in 2008 to 16 km in 2017 [1, 2]. Urban areas have shorter but longer-duration commutes (13.2 km, 33.3 min) compared to smaller cities (19.2 km, 27.2 min) [1, 2]. Reasons for increasing distances are varied and partly unexplored. The COVID-19 pandemic significantly altered commuting patterns due to the rise in remote work.

Despite several studies on residential location choices and travel behavior, there is to our best knowledge no common framework to understand the interrelation between long-term residential decisions and short-term mode choices. With the increase in teleworking opportunities fueled by the pandemic and simultaneously the high increase of the population in cities and consequentially also housing prices in cities, we can expect several changes also in commuting behavior. Key questions include how commuting has changed recently and how these changes impact residential choices. For instance, would people move farther from the city if regular commuting becomes unnecessary?

The project MOBITAT 2050 examines the link between commuting, residential, and workplace choices. This paper explores how the pandemic has affected commuting preferences and discusses implications for sustainable commuting in the future.

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2 Methods

The analysis is based on three datasets, two of them collected at the German Aerospace Center's (DLR) Institute of Transport Research. Furthermore, these datasets span different periods: pre-pandemic, during various pandemic phases, and post-pandemic.

The first dataset is from the 2017 national household travel survey "Mobility in Germany (MiD)," with 316,000 respondents and nearly a million trips. This data describes the baseline situation before COVID-19, analyzed using descriptive statistics.

The second dataset is a multi-wave survey starting in April 2020, conducted during the COVID-19 pandemic to track changes in travel behavior, including commuting and teleworking. The survey, conducted online by KANTAR GmbH, includes eight waves from 2020 to 2023 with sample sizes increasing from 1,000 to 2,500 participants in the last two study waves, representative of the German population aged 18 and over. This data helps visualize travel behavior trends during different pandemic periods.

The third dataset is a 2022 stated preference survey with 1,169 working respondents, focusing on residential location, workplace, and mode choices. The survey included two experiments on housing and commuting choices, considering teleworking scenarios. The first experiment focused on residential location and commuting choices. Respondents were asked to choose between two housing options, each defined by size, monthly cost, residential area (urban, suburban, rural), and commuting duration. The second experiment examined mode choices, where respondents selected between walking, bicycling, driving, and public transport for their regular commute. Each alternative was characterized by travel time and cost. For public transport, this included in-vehicle travel time, access/egress time, and waiting time. Both experiments featured two different scenarios – teleworking (commuting 2 days a week) and regular commuting (commuting 5 days a week). The data was analyzed using logistic regression models to understand the impact of residential location and transport modes on commuting preferences.

The results of the analyzes provide comprehensive empirical insights into changes in commuting preferences and choices due to the pandemic.

3 Results and Discussion

3.1 Commuting Travel Patterns Before the Corona Pandemic

Work trips are longer than other trips (16 km vs. 12 km) and more often made by car (60% vs. 43%). However, 36% of work trips are under 5 km and could be suitable for biking. Commuting distance increases with income and education level; full-time workers travel farther (17 km) than part-time workers (10 km), often a gender difference since part-time workers are mostly women. Gender differences in commuting are minimal when young but increase with children in the household.

Residence and workplace locations show clear patterns: 82% of big city residents also work there, commuting 10 km on average. In small towns and villages, only 40% work locally with similar commuting distances. Most small-town residents commute long distances (20–36 km) to city jobs, mainly by car. City dwellers who work in cities often use public transportation.

3.2 Commuting Mode Choice Changes Due to the Pandemic

Based on the DLR Corona panel survey with eight waves since April 2020, changes in transport demand during the pandemic are highlighted.

Mobility behavior is categorized into following modal groups: monomodal (using only car, bicycle, or public transport) and multimodal (using a mix). Preferences shifted significantly towards car use during the pandemic. Before the pandemic, 50% of respondents used cars exclusively. This figure rose to around 60% after initial fluctuations during the pandemic, while multimodal behavior, especially involving public transport, declined due to discomfort using public transport.

The 9-Euro-Ticket, a low-cost monthly pass available from June to August 2022, reversed this trend. Monomodal car use dropped by 10 percentage points to pre-pandemic levels, and multimodal behavior increased. However, after the campaign, mobility behavior stabilized between pre-pandemic and pandemic levels (Fig. 1).

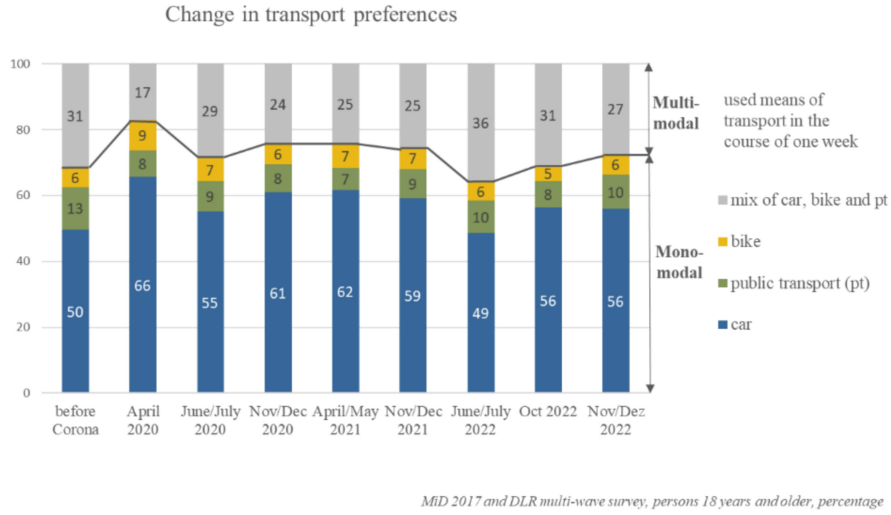

Fig. 1. Development of the proportion of teleworkers during the pandemic.

3.3 Changes Due to the Increase of Teleworking

Before the pandemic, 13% of employed persons worked at home occasionally according to MiD. With the onset of COVID-19, many employees had to telework almost overnight. During the first lockdown, teleworking jumped to 32%, peaking at 50% in summer 2021, and then settling at 40% by fall 2022. Thus, working and commuting patterns have fundamentally changed due to the pandemic.

We examined potential changes in residential location due to teleworking, summarized in Fig. 2 from the fifth wave of the DLR Corona panel survey. Among city residents, 19% are willing to move to suburban areas, and 18% to rural areas. This may be influenced by the high number of current teleworkers living in cities. In suburban areas, 20%

would move to rural areas, while only 10% would move to the city. For rural residents, only 7–8% would consider moving to the city or suburbs. Rural residents also showed the highest reluctance to move due to teleworking. The trend indicates that more people are willing to move from cities than from other areas, suggesting that the need for shorter commutes is less important with teleworking opportunities.

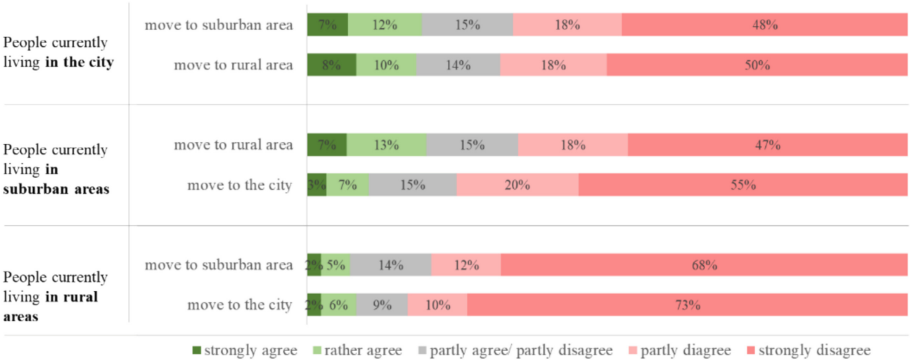

Fig. 2. Descriptive analyses of the willingness to move to other residential areas due to the availability of teleworking

The stated choice experiments reveal insights on how teleworking might affect commuting decisions, such as mode and distance choices. Table 1 shows that in a teleworking scenario (commuting only 2 out of 5 days), the negative impact of commuting time is less significant compared to a regular daily commute. This suggests that with teleworking becoming more common, people might be willing to travel longer distances or move further from their workplace, as travel time becomes less burdensome. This aligns with the findings from the DLR Corona panel survey.

Teleworking impacts mode choice preferences, as shown in Table 2. Overall, travel time has a less negative effect on mode choice in a teleworking scenario compared to regular commuting. The biggest difference is observed in walking and driving: walking is perceived 31% less negatively, and car use 28% less negatively when commuting only 2 days a week. This suggests that commuting time is less burdensome, potentially leading to longer distances traveled by these modes (though walking is still preferred for short trips). For cycling and public transport, the effect of teleworking is smaller. Notably, waiting time becomes less significant in teleworking scenarios, indicating a potential increase in the attractiveness of public transport.

The choice experiments suggest that teleworking may alter preferences for commuting distance and mode of transport, but predicting future commuting preferences is complex due to the interplay of short-term mode choices and long-term decisions like residential location and car ownership. Our study provides new insights into how teleworking influences these factors, which has been minimally explored before.

We further analyzed travel behavior patterns of teleworkers versus non-teleworkers. Key differences include mode choices: 52% of teleworkers use a car regularly compared

Table 1. Results of the logit model on residential location and commuting choices.

Coefficient	Estimate	t-value
ß cost for dwelling	-0.002	-21.45
ß sqm (size of dwelling)	0.022	20.43
ß city area	-0.156	-3.23
ß suburban area	*Reference*	-
ß rural area	*Reference*	-
ß commuting time (teleworking scenario)	-0.047	-29.50
ß commuting time (regular commuting scenario)	-0.036	-24.46
LL (0)		
LL (final)	-4861.73	
Number of individuals	-3640.11	
Number of observations	1169	
	7014	

Table 2. Results of the multinomial logit model on mode choices.

Coefficient	Estimate	t-value
ASC walking	2.561	4.52
ASC bicycle	0.982	14.92
ASC car	*Reference*	-
ASC public transport	-0.566	-5.61
ß walking (teleworking scenario)	-0.195	-7.38
ß walking (regular commuting scenario)	-0.284	-7.55
ß bicycle (teleworking scenario)	-0.083	-16.71
ß bicycle (regular commuting scenario)	-0.107	-27.11
ß car (teleworking scenario)	-0.035	-5.82
ß car (regular commuting scenario)	-0.048	-11.86
ß public transport (teleworking scenario)	-0.038	-7.17
ß public transport (regular commuting scenario)	-0.046	-13.40
ß access/ egress time (teleworking scenario)	-0.037	-3.10
ß access/ egress time (regular commuting scenario)	-0.056	-3.94
ß waiting time (teleworking scenario)	-0.007	-0.60
ß waiting time (regular commuting scenario)	-0.043	-3.31
ß cost	-0.101	-3.99
LL (0)	-9723.47	
LL (final)	-5492.49	
Number of individuals	1169	
Number of observations	7014	

to 63% of non-teleworkers, despite non-teleworkers having a higher rate of not owning a car.

4 Conclusions

Commuting significantly impacts overall mobility. Unlike other groups, employees can be effectively reached through company mobility management. The MOBITAT 2050 project explores various measures related to commuting.

The pandemic has fundamentally changed commuting patterns, notably increasing teleworking. It has also altered perceptions of transport modes, with more people feeling uncomfortable using public transport and favoring individual modes like bicycles and cars, despite higher fuel costs.

The 9-Euro-Ticket demonstrated that attractive pricing can influence travel behavior, though its effects were short-lived. Post-ticket, travel patterns returned to pre-pandemic levels, indicating price can mitigate some negative pandemic impacts on mobility.

Teleworking has reduced the value of travel time savings, making longer commutes more acceptable and hinting at a willingness to relocate. However, residential choices are influenced by more than just commute distance.

In summary, the paper provides evidence of changing travel and commuting behaviors due to pandemic conditions, especially teleworking. These findings offer a foundation for further analysis on optimizing teleworking to avoid increased commuting distances.

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