International Steering Committee for Transport Survey Conferences

Mixed mode survey design and panel repetition – findings from the German Mobility Panel

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Abstract

The German Mobility Panel is a multi-day and multi-period panel survey, which has been collecting data on travel behavior in Germany since 1994. Declining survey participation rates in the last decade in various socio-demographic groups resulted in the implementation of a mixed-mode design for the German Mobility Panel, both in the sampling stage (landline and mobile phone recruitment) and in the data collection stage (paper and web). This study deals with two questions: does the new mixed-mode design affect a person's willingness to continue participating in the consecutive survey waves? Is there a causal relation between data quality and completeness of survey repeaters and survey mode in the data collection stage? Our results show that survey mode and drop out propensity are not linked but web participants are more likely to switch their survey mode in the consecutive year. Overall, our study makes a case of how adaptations to the survey modes in a longitudinal panel survey on travel behavior affect the survey outcomes.

Keywords: Germany Mobility Panel; mixed-mode survey; panel repetition

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1. Introduction

In the last decade, many repeated and longitudinal travel surveys have been facing declining participation rates (Christensen, 2006; Weiss et al., 2016a). Declining participation rates diminish the coverage and representativeness of a survey. Indeed, rates decrease not equally amongst all socio-demographic groups, but certain populations groups are particularly affected. Furthermore, declining participation rates lead to higher survey costs, since one must initially contact more potential survey participants to ensure comparable sample sizes. Consequently, a variety of approaches have been introduced to compensate for these problems and improve coverage, for example, additional recruitment procedures and alternative reporting channels for participants (De Leeuw, 2005).

The German Mobility Panel (Deutsches MObilitätsPanel, MOP) is a longitudinal national household travel survey (NHTS) that has collected data on travel behavior in Germany each year since 1994. The MOP is designed as panel survey, i.e., participants are asked to take part in the MOP during three consecutive years. Each year, a subset of the households is dropped from the subsequent wave and replaced with new households – either because they have already participated three times or because they refuse to repeat the survey in the consecutive waves. To ensure the comparability of survey results from year to year, survey design adaptations were largely avoided. However, due to declining survey participation and survey repetition in some socio-demographic groups – particularly young adults – adaptations of the MOP-design eventually became inevitable, in order to ensure the survey's representativeness and coverage. Thus, in 2013, we adapted the survey design of the MOP in both the sampling design and data collection stage. Now, the sample is drawn both, via landline and via mobile phone and survey participants can choose between a paper and pencil interview (PAPI) and a computer-assisted web interview (CAWI) survey.

This study is an update and continuation of earlier studies on the survey mode adaptations in the MOP (Chlond et al., 2015; Weiss et al., 2017) with focus on the panel properties of the MOP. Research questions of this study are: does the survey mode in the data collection stage in the first survey year affect the willingness to continue participating in the consecutive surveys? Is a causal relation between data quality and completeness of survey repeaters and survey mode in the data collection stage conceivable? By and large, we aim to better understand the effects of survey mode adaptations and mixed-mode designs on panel surveys about travel behavior.

2. Literature review

Mixed-mode surveys in general but also in transport surveys enable researchers to combine advantages from different modes (de Leeuw et al., 2009), giving them the chance to enhance data quality by, for example, improving response rate (De Leeuw, 2005; Dillman et al., 2009). Mixed collection methods have been intensively discussed in the literature in statistics as well as applied to specific research fields (see for example de Leeuw, 2005; Link et al., 2007; Beuckelaer and Lievens, 2009).

Mixed-mode surveys have been used by transport researchers. Examples of mixed-mode design include among others Denmark (Christensen, 2013), Quebec City (Thériault et al., 2013), Lyon (Bayart and Bonnel, 2010), the New York mega-region (Wolf et al., 2013), Stuttgart (Kagerbauer et al., 2011) or Germany (Chlond et al., 2015; Weiss et al., 2017). The survey mode adaptations implemented in the MOP (Germany) have been analyzed in terms of socio-demographic groups affected in Chlond et al. (2015): Changes in travel quantities, which have been caused by the altered sampling approach, have been observed. This altered sampling approach represents the population better, but other typical characteristics of the MOP (e.g. stable composition of the yearly samples in terms of first-, second- and third-year-reporters are affected. As a consequence, Chlond et al. assumed effects in terms of attrition between waves.

A second study conducted with the MOP data (Weiss et al., 2017) focused on survey participants in their first year of participation. Weiss et al. analyzed whether the adaptations in survey mode do indeed improve the results (i.e., travel quantities reported, such as trips made, distance travelled in the survey week) and, if so, why and to what degree. Ideally, the survey mode adaptations have increased the representativeness of the MOP. To decompose survey mode effects (measurement and selection effects), the propensity score weighting method have been applied (Klausch, 2015). This method imputes the hypothetical responses participants would have given in different survey modes; disparities between actual responses and hypothetical responses under another mode are traced back to the mixed-mode design. Results indicate that trip-rate biases on shopping, leisure, and short trips are partly caused by the mixed-mode design;

in contrast, lengths of time spent in the transportation system, trips made by car and public transportation, and commuting trips are hardly biased.

3. Data

This section gives an overview of the MOP, summarizes the survey mode adaptations made since 2013, and introduces our study sample.

3.1. The German Mobility Panel (MOP)

The MOP, the source of our data, is a German NHTS that has been conducted every year since 1994. The survey is carried out on behalf of and funded by the German Federal Ministry of Transport and Digital Infrastructure. The market research firm Kantar TNS is responsible for the field work (i.e., recruitment and data collection) and the Institute for Transport Studies of the Karlsruhe Institute of Technology is in charge of the design and scientific supervision of the survey (Weiss et al., 2016b; Zumkeller, 2009).

The general sample is controlled by spatial categories, household type, and car ownership. The sample size is 1,000-1,700 households containing 2,000-2,700 individuals (aged ten years and older). Participants are asked to take part in the MOP during three consecutive years. Each year, a subset of the households is dropped from the subsequent wave and replaced with new households.

The MOP survey is conducted each autumn, and the survey weeks are chosen to avoid school and bank holidays, since the survey aims to track everyday travel. The participants are asked to provide a complete trip diary containing information about all their trips during a whole week, i.e., distances traveled, means of transportation, trip purposes, and start and end times. Information about the socio-demographics of the participants, the availability of cars and bicycles, and the possession of transit passes is also collected.

3.2. Survey mode adaptations made

In the original survey design, households were contacted only by landline phone. In 2013, we introduced a dual-frame sampling approach, with a landline phone sample and a mobile phone sample. Our aim was to reduce coverage errors, since households without landline connections – especially small households with young household members – were thereby included in the sampling frame. Moreover, households that do indeed have a landline connection but are, for all practical purposes, only reachable via mobile phone, were also better represented in the sample.

Working with two independent sampling frames requires a design weighting that adjusts the different chances of being selected. This design weighting considers the overall probability of a household's inclusion in the sample by combining the probability of being interviewed by landline or mobile phone (Gabler and Ayhan, 2007).

Originally, the household questionnaire and trip diary were PAPI surveys. Since 2013, participants can choose between a PAPI and a CAWI survey (see Figure 1, illustration of both modes). The reason for the introduction of the optional mode has been to attract socio-demographic groups, which used to be underrepresented in the MOP sample before (e.g., young adults with a higher propensity towards new technologies). CAWI provides therefore an alternative access into the survey.
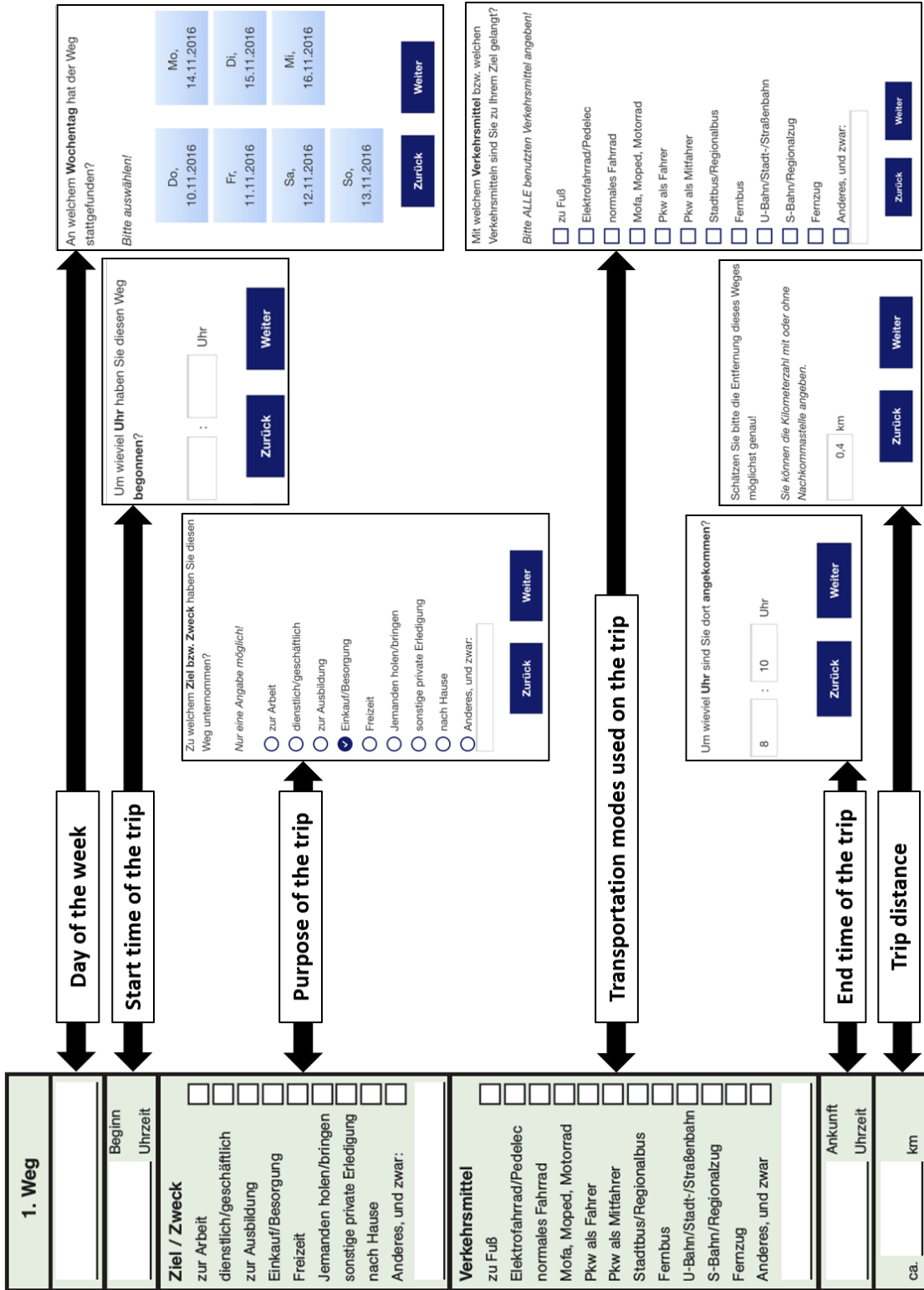
Figure 1: Illustration of the PAPI (left) and the CAWI (right) trip diary in the MOP

PAPI survey documents are sent out to every household in the sample. Hence, the CAWI link is printed on the PAPI questionnaire, along with individual log-in data. CAWI is accessible via IP address and QR code and can be completed on PCs, laptops, tablets, and smartphones. To facilitate the use of mobile devices, we chose a survey design, in which each question is displayed on one screen and subsequently answered (Arn et al., 2015). Based on our own experiences, filling in the CAWI questionnaire is more time-consuming than filling in the PAPI questionnaire. However, extensive time consumption measurements have not been conducted so far. One reason for higher time-consumption might be that CAWI participants need to reorient themselves on each screen and the screen switches for each question.

To reduce measurement errors, we did hardly include any plausibility checks when filling in the CAWI survey. In general, both groups of respondents thus have the same degree of freedom when filling in their diaries. The aim of CAWI is to reduce non-response errors and improve representativeness, since certain population groups might be more willing to use a CAWI than a PAPI diary. However, as we assume the completion of the CAWI to be more time-consuming and therefore tedious compared to the PAPI, this may affect reporting behavior and is therefore in focus of this paper.

3.3. Study sample

For our study on survey mode effects, we analyzed the MOP participation rates and reported travel behavior of the MOP cohorts 2013 and 2014 (i.e., survey participants, which participated the first time in 2013 and in 2014 respectively) in the survey waves 2013, 2014, 2015, and 2016. We have not included the cohorts 2015 and 2016 in the sample because our study focusses in panel repetition; these cohorts have only participated in two, respectively one survey wave yet. Weighting factors are not used for this analysis, since we are focusing on the changes in panel repetition and travel behavior due to survey mode adaptations, and not on quantities of travel behavior.

The sample includes 5,837 trip diaries, which were filled in by 2,703 survey participants. 809 individuals participated one survey wave only, 654 individuals participated in two survey waves, and 1,240 individuals participated in the MOP in three consecutive survey waves. Of all trip diaries, 662 (11%) were filled in via CAWI and PAPI was used for 5,175 trip diaries (89%). About two third of respondents (65%, 1,750 individuals) were recruited by landline phone and 953 (35%) were recruited in the mobile phone sample.

4. Results

For the assessment of the mixed-mode survey design on panel repetition, descriptive analyses were applied. More sophisticated approaches, such as propensity score weighting approaches and regression models, were tested but it was not possible to obtain meaningful and statistically significant results due to the small sample sizes, especially for CAWI respondents. We suggest to assess the issue again in more detail after survey completion of the cohorts 2015, 2016 and 2017. The following paragraphs focus on survey repetition and reported travel behavior under the mixed-mode approach.

4.1. Mixed mode and survey repetition

With the CAWI questionnaire, we have intended to increase the participation and repetition rates of certain sociodemographic groups, e.g., young adults. To analyze this issue, we first need to understand the relation between survey dropout propensity and data collection mode (Figure 2). Therefore, we have nested the total sample according to their survey mode in their first year of MOP participation and according to their second year of MOP participation. A small subsample (208 participants, resp. 8%) has not participated in year one but in the consecutive years (called "drop" in Figure 2). This will occur if one of the following cases holds true: (a) a person has not filled in the trip diary in year 1 but other household members have, (b) the year 1 trip diary was removed from the sample due to insufficient data quality (Weiss et al., 2016b), (c) a child in the household has reached the age of ten after survey year 1 and is now allowed to fill in a trip diary, or (d) a person has moved into a MOP household after year 1.
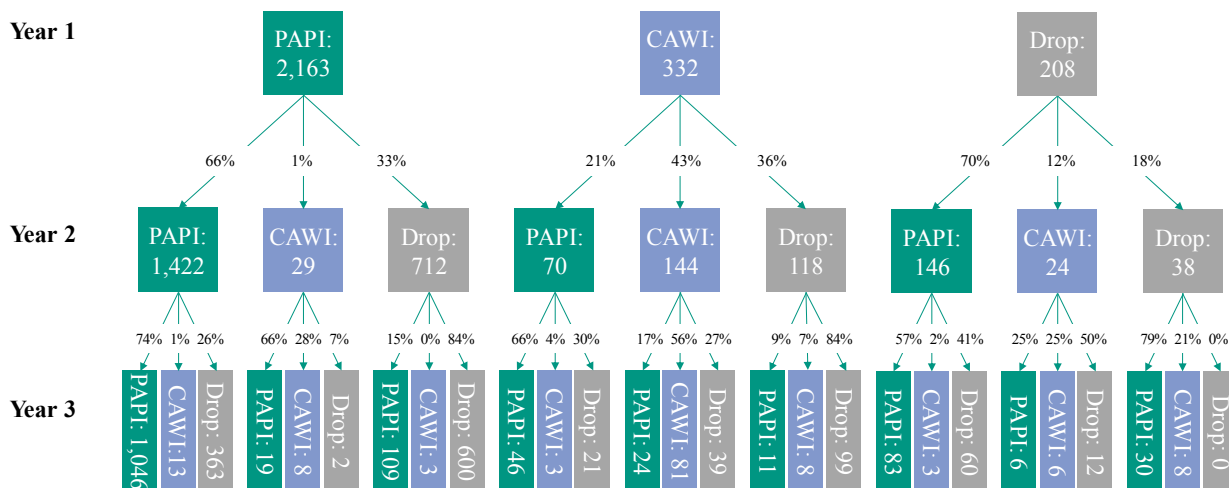
Figure 2: Survey repetition and data collection modes of MOP participants in their three survey years, cohorts 2013 and 2014

CAWI was used for 662 trip diaries, respectively 11% of all trip diaries filled in by the cohorts 2013 and 2014. Contrary to our expectations the CAWI shares are rather low: one explanation might be that the survey documents sent out as paper may be suggestive to use the PAPI forms. Furthermore, the share of CAWI trip diary drops from 13% in year 1 to 11% in year 2 and 9% in year 3. Two potential reasons are conceivable for this drop: either CAWI participants may more often drop out from the survey or they may change their survey mode.

About a third of the sample participants in year 1 drop participation in panel year 2, regardless their year 1 survey mode (33% resp. 36%). The dropout shares of nests with two-year participation (modes in year 1 and year 2: PAPI-PAPI, PAPI-CAWI, CAWI-CAWI) are similar (26%-30%) as well. The dropout sample of year 2 CAWI participants with PAPI diaries in year 1 is too small (n: 29 participants) to derive meaningful conclusions. About 16% of dropouts in the second panel year participate again in the MOP in year 3, regardless of their survey mode in year 1. Thus, second year dropouts with PAPI in year 1 are more likely to stick with their survey mode in year 3 (third year: 109 PAPI vs. 3 CAWI) than dropouts with CAWI in year 1 (third year: 11 PAPI vs. 8 CAWI). These results show that there is no relation between dropout propensity and trip diary modes used.

However, we found a higher propensity of survey mode adjustments in the consecutive year amongst CAWI participants: 33% of CAWI participants but only 2% of PAPI participants, which stay in the panel, change their survey mode in the consecutive year. If MOP participants, who filled in their trip diary in three consecutive years, used PAPI in year 1 and year 2, are very likely to use PAPI in year 3 as well (1,046 of 1,059 participants). MOP participants with CAWI in year 1 and 2 are more likely to switch their survey more in year 3: 81 participants use CAWI in year 3 but 24 participants change to PAPI. About 66% of panel participants in year 2 with different modes in year 1 and 2 use PAPI for their third trip diary. The subsample of MOP participants with survey participation in three consecutive years is grouped as follows: 1,046 (84%) use PAPI in each panel year, 81 (7%) use CAWI in each panel year and 113 (9%) switch modes between the survey years.

Earlier studies have shown that the likelihood to stay in the MOP raises with increasing age (Weiss et al., 2016b; Wirtz et al., 2013). Therefore, we have analyzed whether survey modes affect the dropout propensity of different age groups (Figure 3). The sample was split according to their survey mode in year 1. In the youngest age group (10-35 years), the likelihood to stay in the panel in year 2 is six percentage points higher for PAPI participants than for CAWI participants. On the other hand, initial CAWI participants with survey participation in year 2 have a five percentage points higher likelihood to participate a third year (75%) than initial PAPI respondents (70%). Participants aged 61 years and older have the highest propensity to stay in the MOP. The vast majority of this age group (93%) filled in a PAPI diary in year 1. Thus, the few CAWI participants aged 61 and older showed even higher repetition rates than any other CAWI or even PAPI respondents with 82% in year 2 and 98% in year 3. We assume for this special case the

higher motivation by reasons for higher education levels with interest in scientific research and the willingness to contribute by advanced modes.
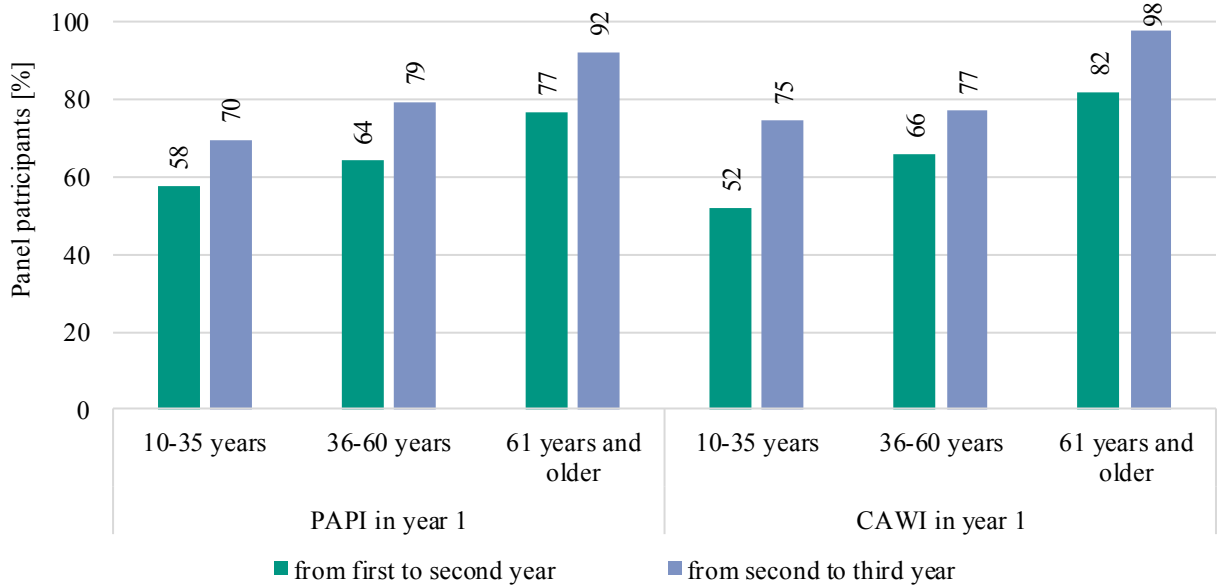

Figure 3:   MOP repetition rates, distinguished by age groups, cohorts 2013 and 2014 with MOP participation in year 1

Summing up the analyses so far, we observe a reversion to the conventional PAPI mode. We have – with the entitlement of the MOP as a scientific survey – an education bias in the sample. Participants are willing to test new reporting approaches – at least to a certain extent. However, participants seem disillusioned after testing CAWI. A potential reason is that CAWI is more elaborative. CAWI does not allow for a quick and efficient reporting, but needs even for a trained panelist a certain amount of time – even for reporting standardized trips. Therefore, experienced MOP-participants try to find the most efficient reporting mode and this seems to be the PAPI-approach. Therefore, further aspects, e.g., how different survey modes – and especially the switch between modes – affect the quantities of travel reported need to be analyzed.

4.2. Travel behavior of MOP repeaters under different modes

This section deals with the question whether the quality of travel, respectively panel fatigue, is linked to the survey mode in the data collection stage. We have therefore analyzed the trip diaries of MOP participants, who filled in their trip diary in three consecutive years. Table 1 illustrates average values for the number of trips made, the distance travelled, the time spent in the transportation system, and the number of days in the survey week with any trip making as well as the corresponding levels of significance compared to the previous wave. The sample of three-year reporters was also subdivided according to the survey modes used in the data collection stage.

Our analysis shows a slight but obvious fatigue in consecutive survey years. However, the underlying reasons for fatigue in the MOP are not surveyed. Therefore, we interpret these findings as follows: Once having decided to participate (as a result of to the complex and intensive recruitment procedures), MOP-panelists show a high motivation. They are willing to report completely and accurately (we even observe a kind of excess motivation on the average in year 1 on the very first days), but they learn to report more efficiently. Except for those, who stop reporting completely (the "drops" in year 2), panelists are motivated to report their mobility. They have understood the purpose of the survey but they try to ease the burden by omitting short trips or by summing up some trips to larger ones. Therefore, we observe a decline in the number of trips but not in the distance travelled. The reported time spent in the transportation system is also affected as "slow" trips by foot are mainly omitted. In principle the MOP-panelists are in most cases

willing to follow through with the MOP, but with reduced accuracy (see Chlond et al., 2013). Obviously, the adaptation in reporting behavior takes place during wave 1 and can be measured in the differences between wave 1 and 2.

Nevertheless, the results shown in Table 1 indicate a link between survey modes and size of the fatigue effect. E.g., the decline for the three years PAPI-participants is smaller than for the three years CAWI-participants. Participants that switched survey modes between survey years show the lowest fatigue. This illustrates that the switch is related to a high motivation to participate in the MOP. As shown in Figure 2 the switch takes place in the direction to the mode with the highest efficiency, which is up to now still in most cases the PAPI mode.

All results need to be seen against the small sample sizes. Further statistical techniques, such as propensity score methods are suited for a more in depth analysis of reported travel quantities (Weiss et al., 2017), as they would allow an assessment of measurement errors in different survey modes. However, the small sample sizes, especially amongst CAWI repeaters do not allow such analyses.

We have shown in earlies studies (Chlond et al., 2013) that there is a general relation between the completeness to report and the probability to remain in the MOP. This results in a self-selectivity of the MOP, which has to be regarded as positive, as those individuals, who report incompletely or inaccurately, are obviously more likely to drop out. These findings can be updated as follows: the accuracy will become better if we offer the participants a survey mode according to their requirements and a choice between survey modes as fallback solution.

Table 1: Quantities for reported travel behavior in the survey week (mean) of MOP respondents with three-year panel participation, grouped by their survey modes in the data collection stage. T-tests compare the variation of reported travel quantities with the previous years.

	first year	second year	third year
MOP participants with three year reporting, n: 1,240			
Trips made [#]	25.2	23.7 ***	23.6
Distance travelled [km]	293	310.6	295.9
Time spent in the transportation system [min]	601.9	586.9	559.9 **
Days with any trip-making	6.5	6.3 ***	6.3
PAPI in all three years, n: 1,046			
Trips made [#]	25.0	23.7 **	23.4
Distance travelled [km]	283.4	306.9 *	289.8
Time spent in the transportation system [min]	602.9	589.8	558.2 **
Days with any trip-making	6.5	6.4 ***	6.3
CAWI in all three years, n: 81			
Trips made [#]	28.4	25.2	26.8
Distance travelled [km]	394.1	311.7	335.5
Time spent in the transportation system [min]	626.5	525.4 **	578.9
Days with any trip-making	6.5	6.2 *	6.3
Switch between PAPI and CAWI between years, n: 113			
Trips made [#]	24.5	22.7	23.2
Distance travelled [km]	309.7	344.1	323.6
Time spent in the transportation system [min]	575.5	603.8	561.7
Days with any trip-making	6.2	6.2	6.2

Significance levels: *** 1% level   **5% level   *10% level

5. Conclusions

In this paper, we analyze the relation of the mixed-mode survey design and panel repetition in the MOP. Our study makes a case of how adaptations to the survey modes in a panel survey on travel behavior affect the survey outcomes. Earlier analyses have shown that the additional options to fill in the trip diary as CAWI has improved the representativeness and coverage of the MOP sample in panel year 1 (Weiss et al., 2017). Analyses presented in this paper show that there is no link between survey mode and drop out propensity but CAWI participants are more likely to switch their survey mode in the consecutive year than PAPI participants are. We can observe a trend towards the conventional PAPI-approach in subsequent panel years. These findings suggest that the decision to offer both, a PAPI and a CAWI trip diary, was largely right – not least to attract participants with different socio-demographics. However, a gradually optimization of our CAWI questionnaire might not only be advantageous, but will be necessary to avoid frustration: The reporting of a single trip is, according to our own assessment, still more elaborative with CAWI than with the conventional PAPI approach. This would be a worthwhile place for improvements (e.g. by the representation of several questions on one screen, or the inclusion of autocompletion functions). Furthermore, it might be advantageous to provide an app for CAWI with automatic regular reminders to fill in the diary. By the use of such an app, CAWI respondents might be encouraged to report more comprehensively. However, we suggest to introduce such innovations to the survey modes only step-by-step and with a control-group in order to be able to assess the measurement effects.

This study shows once again that the participants of the MOP begin the survey highly motivated and many are willing to participate for three waves. The provision of different data collection modes and fallback solutions for their reporting might motivate for MOP participation. However, survey modes should, in any case, be designed as convenient as possible for the survey participants.

Acknowledgements

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