

### THREE VIEWPOINTS ON THE COLLECTION OF TRAVEL BEHAVIOUR DATA OVER TIME

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#### INTRODUCTION TO THE THREE VIEWPOINTS

These summaries present new information on response bias and non-respondent characteristics for three different diary techniques applied to large samples in recent travel surveys. Follow-up investigations, including re-surveys in two of the three, are described. Lee covers a low-cost retrospective technique to capture one day of driving; Lawson examines a seven day prospective diary, also for driving; Brög and Meyburg cover a one day diary of all personal travel and include estimates of bias arising from different levels of non-response. These are highly abridged. The full text may be obtained from the authors.

#### I: A DECENTRALIZED ONE DAY TRIP RECONSTRUCTION INTERVIEW

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This section discusses the experience gained from a survey of vehicle ownership and usage operated throughout Michigan during all of 1976. The Michigan Driving Experience Survey (MDES) methodology exemplifies one of several recent directions in the collection of microdata on travel: it was especially designed to confront potential policies in energy conservation and traffic safety with the actual travel patterns of constituencies of drivers, and to discover, from the travel data, the characteristics of groups likely to be hurt by policies. As driver license renewal requires the periodic appearance of every driver in person, it was an ideal sampling situation for driving trip reconstruction. The response rate was 85% of those requested to take part, and 72% of an ideal number predicted from workload volumes and sampling rate. The methodology offers significant advantages over conventional survey techniques using specially hired interviewers: lower project costs; utilization of the generally excellent public contact skills of government officials; and adequate data collection in thinly populated areas. The major innovations tested concerned decentralized survey management and quality control.

#### METHODOLOGICAL ISSUES

##### Potential problems with the retrospective diary

Problems of particular relevance included:

- motivating both interviewers and respondents to persist in the recall of every driving trip on a designated day in considerable detail;
- detecting attempted circumvention of the random respondent selection system to reduce interviews during lunch-time and other peak office hours, possibly thereby biasing the sample against active travellers, such as those in the work force;
- avoiding excessive refusals by those with exceptional travel habits (eg. elderly or low-income);
- avoiding deterioration over the twelve months of the project in the travel data collection, and in refusal and administrative failure rates, which might lead to incorrect conclusions about seasonal shifts in travel;
- avoiding response bias attributable to the "official business" transacted, ie. license renewal

##### Lessons from field management

Our general experience in facing these problems was that an elaborate quality control system was needed and could be made to work, and that most of the solutions required closer attention to organizational issues than to the details of data coll-

ection. Above all, it required a process of open negotiation around workload and data quality. The single most important source for detecting operational failure or bias was a manual compilation of interview form characteristics as weekly mailings were received; quantitative evidence of any attempt to circumvent random selection, for example, was used in feedback to the offices. Managers were encouraged to negotiate for a lower sampling rate in exchange for improved quality; usually, quality improved without a lower rate. Also, the knowledge that every eligible respondent was centrally matched to form receipt logs kept response high. Other activities to monitor the field (see (2) for details) included public response; overcooperation was more frequent than undercooperation -- the diaries sometimes led to discussions little to do with driving.

#### MEASURES OF DATA QUALITY

##### Non-respondent characteristics

There were two sources of non-response -- refusals and administrative failures. Validation of the residual, non-refusal sample of 7581 against all Michigan drivers is particularly important because nothing is known about people who missed the opportunity to participate. Age/sex distributions were compared to a 1% random sample of official driving records and the results showed only a few small differences between the usable MDES cases and the record sample, notably a slightly greater proportion of drivers aged 19-34 and males aged 55-64 in MDES.

The 1310 refusals could be examined in some detail because a number of personal characteristics were collected during license renewal, or from state driving records. In addition, most refusals agreed to give an estimate of the number of miles driven in the past year, and their reasons for refusing.

The distributions of estimates of past year miles follow for the interview and refusal groups:

Annual Miles	1-500	500-1000	1000-2500	2500-5000	5000-7500	7500-10K	10K-20K	20K-40K
Interviewees (n=7581)	4.8	9.7	18.9	35.4	43.0	60.8	87.9	97.5
Non-responds (n=1310)	7.3	13.4	19.8	34.4	41.3	59.0	87.4	96.4

##### CUMULATIVE % BY MILES DRIVEN: PARTIC. VS REFUSALS

The only significant differences occur below 2500 miles. It should be noted that driving activity is not the same as total travel activity, and a population of driver license applicants is by definition a subpopulation of adults who have sought documentation. It is reasonable to assume that biases from non-response are more limited with these people.

A number of other comparisons between interviewees and refusals can be made. The overall percentage refusing rose slightly from around 12% in the early months of the survey to about 17% in the final months, acceptable given the length of the project. Interviews from versions used on Mondays and Tuesdays demanding longer recall did not develop higher refusal rates. Interviews at busy times averaged about 18% refusals compared to 11% at off-peak hours. There were only slight differences by age and sex, but office location was associated with large differences in refusal rates, ranging from 23% in Metropolitan

Detroit and counties with medium cities to 5.1% in remote rural areas; suburban and agricultural areas were close to the overall average. In addition, analysis of driver records showed slightly higher accident and violation rates among refusals; a small bias may exist to reduce travel estimates, because traffic violators tend to be fairly active drivers.

Reasons for refusal were analyzed across the same set of operational and personal characteristics. Project coders classified open-ended descriptions of refusal reason into about twenty codes under five headings: too busy (79%), hostile to surveys (13%), cannot believe survey applies to them (3%), and mechanic difficulties (3%); about 2% gave no reason. As a percentage of refusal reasons, hostility reached its highest: in July and September; during the "rush" weeks for license plate sales in the offices; at mid-morning hours; among the over 60's (even though a smaller proportion of elderly drivers refused for any reason); and in agricultural areas (where one third of refusals were hostile), and metropolitan Detroit. Hostility was very low among refusals in remote rural areas, Detroit suburbs and urban areas outside Detroit. "Too busy" was the reason for nearly nine out of ten lunch time respondents, and was also associated with: younger refusals (who were correspondingly less hostile), and offices outside Detroit and the agricultural centers. There was a slight trend (contributing very little to mean travel activity estimates) for very low mileage drivers to refuse because they thought the survey inapplicable to them. Overall, non-response seemed not to seriously affect representativeness, or to get worse over the year-long project.

#### Response bias

The substantial amount of detail which the MDES micro data contains required some innovative coding, editing and checking procedures. Part of this involved the identification, by interviewers, coders and editors, of data which were questionable or dubious based on the behavior of the respondent, the availability of other information or the consistency of responses. An elaborate system of flags permits the temporary exclusion of cases based on the presence of dubious data for items or sets of items used in a given analysis. The average proportion of cases with dubious data on some or all of the trip diary was 7.2% (544 cases) including cases in which the interviewer may have contributed to the problem through incorrect use of the survey form. A by-product of the "dubious" data system is an opportunity to investigate the characteristics of those providing questionable trip data. An analysis similar to those used for refusal rate and reason yielded several trends. The percentage of cases with dubious data declined slightly over the life of the project, hopefully reflecting increased experience by the managers. It peaked at almost 11% during the annual license plate "rush", and the size of the increase in this period might be viewed as a measure of the deterioration likely from the use of co-opted interviewers under overload. Hour of day and day of week had little effect. There is some evidence that the youngest and oldest drivers had the most problem

with the diary, as did a significant proportion of respondents in agricultural (but not remote rural) areas.

Another approach to the detection of response bias is to consider the distribution of cases in which the respondent claimed not to have driven on the designated trip-diary day (28.3% of respondents overall). Considerable incentive existed for the interviewer or respondent to "fake" such a claim, in that interviews were reduced to a few minutes in these cases. These distributions were monitored as forms were received, and also analyzed upon completion of the project.

Of major importance was that the percentage reporting no driving did not rise over the life of the project. As shown in the table, it

Month	% not driving	Miles driven		Minutes driven	
		Mean	Std. Dvn.	Mean	Std. Dvn.
Jan	36.3	20.7	40.0	42.5	66.5
Feb	29.3	25.2	50.2	49.1	68.6
Mar	31.3	24.4	50.9	49.6	72.0
Apr	26.8	27.0	50.3	53.7	75.6
May	25.0	27.0	49.6	49.3	63.7
June	25.9	32.2	72.2	58.2	93.3
July	26.8	30.6	57.4	55.2	73.5
Aug	26.8	31.6	59.7	56.6	78.4
Sept	25.4	27.8	44.7	54.7	72.1
Oct	27.9	32.8	67.7	56.7	80.2
Nov	26.8	27.5	46.2	51.6	68.7
Dec	30.3	28.3	46.2	54.9	76.9
All yr	28.3	27.9	53.6	52.5	74.5

AVERAGE DRIVING ACTIVITY FOR ASSIGNED DIARY DAYS stayed rather constant for all but the winter months (notably January), when the effect would most likely be explained by weather. The table also shows that average driving trips, miles and minutes, all of which are much affected by the no-trip rate, follow plausible seasonal trends. The pattern over the day-of-week and time of day of the interview also meet commonsense expectations.

#### CONCLUSION

Non-response and response bias in a retrospective trip diary may, of course, take other forms, but these analyses suggest that the potential problems raised above under "methodological issues" have been substantially overcome in this application to driving activity. It was on this basis that it was decided not to use elaborate weighting procedures based on personal or mobility characteristics.

Perhaps the most significant caution implied by these analyses concerns the size of regional differences in some aspects of non-response and response-bias. In this survey, it is advisable to analyze at least the distribution of reported annual miles of the refusal cases within cells of analyses by region.

It is concluded that this methodology, developed to administer a trip diary using existing government employees, is a viable low-cost alternative for agencies needing to monitor driving as part of travel demand

#### REFERENCES

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## SURVEY RESPONSE

The overall response rates to the survey are illustrated in Figures 4 and 5, below. As described above, there were several stages to the survey procedure requiring household or driver response and a number of separate response rates could therefore be expressed. The most important response rates will be described below.

### Household response

The initial sample of 1893 blocks yielded an initial listing of 22,716 sample households. Of these, 508 (2.2%) were never visited, due to hazardous weather conditions, interviewer sickness or vehicle breakdown. A further 3,198 (14.1% of 22,716) were visited, but no adult was contacted during the interviewers' three trips to each location. Then refusals to provide any information were met from 2,087 households, amounting to 9.2% of the original sample, or 11.0% of the households where adults were contacted. This left 16,923 households in which the first interview was successfully completed, giving a response rate of 74.5% of the original sample for this first major step of the survey.

It should be noted that 2,535 households (11.2% of the original sample) responded that they had no licence holders, and so the subsequent sampling of drivers took place from only 63.3% of the original sample of households. This latter figure is not relevant as a "response" rate, however.

### Driver Response

Sampling from the household listings of eligible drivers resulted in an initial driver sample of 15,961. Of these, 1,345 (8.4%) were never contacted during the interviewers' three location visits (despite contact having been made with some other adult household member). Then another 1,228 refused to grant the first interview, amounting to 7.7% of the initial sample or 8.4% of those contacted. The "Participant Questionnaire" was completed with the remaining 13,388 drivers, 83.9% of the initial driver sample.

Following this interview, respondents were asked to complete the trip diary. 2,440 refused to accept a diary, amounting to 15.3% of the original sample, or 16.7% of those drivers contacted, or 18.2% of those who completed the interview and were asked to accept a diary. 10,948 drivers accepted, and received diaries.

The first phase of interviewing was now complete, and the next response required from participants was the surrender of the diary and completion of the diary review in the second set of interviews.

104 of the diaries were not retrieved at all (1.3%); and 2,031 (18.6% of those accepted) were retrieved, but not verified as completed, because respondents either could not be contacted for the diary review, or refused it. The remaining total of 8,793 diaries, 80.1% of those accepted, were retrieved and verified as complete. Expressed as overall response, the 8,773 drivers completing all phases of the process comprised 55% of the initial driver sample.

However, field and office checking of those returned diaries which were not verified in diary review interviews suggested that an additional 1,099 diaries (10.0% of those accepted)

## II: THE CANADIAN NATIONAL DRIVING SURVEY, 1978-1979 John J. Lawson, Dept. of Transport, Ottawa

### SURVEY OBJECTIVES & PROCEDURE

The Road Safety Branch of the Canadian Department of Transport undertook its "National Driving Survey" in 1978-79, to document the extent of travel by various classes of road user and vehicle, on various types of roadway and under various environmental conditions. While useful simply in describing travel behaviour, the particular orientation of this survey was to provide accurate estimates of travel distance and travel time involving some major factors in road accidents: primarily age, sex and experience of drivers, model year and type of vehicles, roadway type and surface condition, and time of day, week and month.

Following an assessment of previous research, initial decisions were taken for the Canadian study to sample drivers, and to attempt to obtain seven-day diaries of all driving trips, using extensive personal contact with respondents to encourage accurate and complete response. The diary was the central feature of the survey, but the interviews with the respondent driver obtained such personal data as age, sex and driving experience, and details of the vehicles available to him, to be subsequently cross-referenced to the diary data.

The target population consisted of all resident licensed drivers aged 16 years and over; and eligible driving was defined as that in motor vehicles under 10,000 lbs gross weight. The usual trade-off between accuracy of estimation and survey cost led to the choice of a target of 9,000 completed responses. To allow for seasonal and regional variation, the sample was drawn throughout a full year, with stratification by month, by Province, and by population density classes within Provinces; and diary start dates were randomised within months.

Sampling proceeded in two stages. First, households were sampled by selection of blocks with p.p.s., and interviewer selection of 12 households per block (taking every second from a random start point). Then interviewers conducted what amounted to a pre-survey of households, listing all eligible drivers and selecting one respondent per household using a pre-set randomisation procedure. Once selected, a respondent was initially interviewed and given the trip diary, and then re-interviewed after the diary recording period, to review the diary for completeness and accuracy. No replacements were allowed for either households or driver respondents, and no proxy responses were allowed at any stage.

A pilot test of the survey procedures and instruments was undertaken in March, 1978, with a sample of 520 households; and a number of minor methodological changes resulted. The main survey then took place from May 1978 to April 1979.

were apparently complete. After analysis of this sub-sample showed that the average trips per diary and average number of zero-trip days per diary did not differ substantially from those in the verified diaries, they were accepted into the file of "completed diaries" for analysis purposes. Thus completed diaries eventually amounted to 9,872, 90% of those placed with respondents; and by this criterion 61.9% of the original sample of drivers provided completed diaries.

Response by Month

Analysis of household response by month reveals some slight seasonal differences, with household (adult) contact poorest during July/August and December/January. Once the household was contacted however, refusal rates and subsequent driver responses showed no marked seasonality. Furthermore, no overall trend is discernible in response rates chronologically though the survey; suggesting consistent application of survey procedures.

Consistency of Trip-Recording in Diaries

Some indication of the consistency with which drivers recorded trips in diaries can be gained from an examination of the proportions of total trips and proportions of total distance travelled which were reported during each diary day. Randomisation of diary start dates should have ensured that Days 1 to 7 of the diary reporting were distributed in similar fashion among days of the week (Monday to Friday) and months. Then the proportions of total trips and total trip distance recorded on each diary reporting day should have been approximately equal. Analysis shows that 16.5% of all trips appeared in Day 1 of diary reporting, and that this proportion fell slightly, but consistently, through reporting days, with only 12.4% of total trips appearing in Day 7 of diary recording. A similar but smaller decline is evident in distance reported by diary day, from 15.1% of total vehicle-km. on reporting Day 1 to 13.1% on reporting Day 7.

These trends are of course consistent with degradation in the completeness of reporting by drivers through their assigned seven days. If it is assumed that the reporting for diary Day 1 is most accurate, it can be computed that total trips were underreported over the seven reporting days by 15.5% of the reported figure. However, under the same assumptions distance travelled was underreported only by 5.7% of the reported figure. This all suggests that underreporting took the form of drivers becoming less conscientious in recording trips, tending to ignore the short-distance trips. However, this estimated rate of under-reporting of distance (the main target variable in the survey) is encouragingly low, and the randomisation of diary recording periods ensures that it is not concentrated in particular times or days of the week.

NON-RESPONDENT FOLLOW-UP SURVEY

To try to assess the extent of non-response bias, an attempt was made to reach a sub-sample of the non-respondents by mail, and to encourage them to provide information on a very short questionnaire, primarily requesting age, sex and estimated distance driven annually (for comparison with similar estimates obtained in the main survey's "Participant questionnaire"). This follow-up survey was conducted in February/March

of 1979, aimed at a target population consisting of the non-respondents to the main survey from the month of September, 1978. Of the total of 661 non-respondents from that month, full addresses were available for 485 (main survey fieldwork had not required recording of full postal addresses).

The follow-up survey obtained 153 complete responses, i.e., 32% of the target sample of 485. Comparison of the characteristics of the responding drivers with those of main survey respondents is shown in the table below.

	September Main Survey	Non- respondent Follow-up
N	1175	153
Sex:	%	%
Male	58	66
Female	42	34
Age:	%	%
16-24	23	22
25-34	23	22
35-54	28	30
55-64	15	16
64+	10	10
Km/yr	%	%
<8000	35	28
8000-15999	22	24
16000-23999	20	27
24000+	22	20

The table shows that drivers reached in the follow-up survey were more likely male than survey respondents, but were distributed similarly by age. Importantly, the follow-up survey respondents were apparently more active as drivers than main survey respondents, though the difference in the mean annual distance driven by the two groups was only 6%.

Full reports of survey procedures appear in:

- (1) Rochon, J., L. Swain and S. O'Hara: Exposure to the Risk of an Accident: A Review of the Literature, and the Methodology for the Canadian Study, Ottawa, Department of Transport, September 1978.
- (2) Lyn, A. and J. Rochon: Exposure to the Risk of an Accident: A Description of the Data Collection and Processing Procedures, and Analyses of their Effectiveness, Toronto, Canadian Facts, August 1979.

### III: THE EFFECT OF NON-RESPONSE ON THE ACCURACY OF SURVEY RESULTS

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#### INTRODUCTION

This segment of the paper reports on an attempt to estimate the effect of the non-response factor on population estimates (1). Empirical surveys are generally based on the assumption that the survey of a sample will provide sufficiently precise information about the total population from which the sample was drawn. The statistical significance tests are based on the further assumption that the desired information was obtained from every selected sample point. In practice, however, this assumption is rarely, if ever, met in survey sampling (2). This study investigated in how far the non-response factor distorts the results of investigations into travel behavior.

#### SURVEY PROCEDURE

The research is based on a household travel survey conducted in Berlin (West) in Spring 1976 as a follow-up of the KONFIV travel survey of 1975. By means of a carefully administered mailback questionnaire, supplemented by four follow-up reminders in one-week intervals, a total return rate of 77% was reached.

The respondents to the main travel survey and its four follow-up steps can be stratified as follows:

- Prompt respondents (29% response rate in group).
- Respondents to the 1st reminder (postcard-23%).
- Respondents to the 2nd reminder (postcard-19%).
- Respondents to the 3rd reminder (a second copy of the questionnaire-18%).
- Respondents to the 4th reminder (postcard-10%).

The effect of each subsequent follow-up naturally decreased in size, but they contributed substantially to the overall response rate.

Overall, it was found that the distribution of individual household characteristics was virtually identical over the four response-phases. This confirms the assertion that the willingness to respond to travel surveys, at least in Germany, has very little relationship to the socio-economic characteristics of the population. Rather, the personal interest in the phenomenon under investigation is of decisive importance.

The trip structure (e.g. trip length and duration, trip purpose, modal choice) showed an equally uniform picture across the groups of respondents as did the socio-demographic structure. If the degree of mobility is considered, however, the results are substantially different. The cumulative average trip frequency decreased by 4% between the main survey date and the last response phase. The relevant non-response problem to be investigated is the question as to whether the mobility of the non-respondents differs significantly from that of the respondents.

#### THE NON-RESPONSE INVESTIGATION

In order to maintain full compatibility with the main survey, the mail-back approach was also used in this investigation of non-responses. The

final hardcore non-respondents were contacted by specially trained interviewers in order to find out whether and to what degree genuine non-responses and genuinely immobile were still among the non-respondents.

The target group for this non-response investigation consisted of 209 households out of a gross total of 984 households (see Table 1). This survey of non-responses consisted of a main survey followed by two written reminder notices. Thirty households were found to be genuine non-respondents, while 59 completed questionnaires were received. The remaining households were visited by trained interviewers to identify additional genuine non-respondents and immobile households. Table 1 illustrates that the non-response survey added substantially to the information of this travel survey. Only 5% constitute the hardcore of project-specific non-respondents. All percentage values represent uncorrected gross values relating to the original survey sample.

Table 2 represents the cumulative response rates for the six groups of respondents. It also depicts the average and cumulative mobility per person per day.

The results concerning the average mobility, determined by three simple estimation methods (i.e. trend extrapolation, min-max method, qualitative estimation) differed only insignificantly. The final value lies at an estimated trip frequency of 2.29 trips/person/day.

#### ANALYSIS OF RESULTS OF NON-RESPONSE ANALYSIS

For this investigation the weighting of the main survey sample resulted in a reduction of the average mobility. It turned out that the direction of the correction, including non-responses considerations, performed through the weighting process was correct, yet not pronounced enough. This confirms that the correlation between socio-demographic characteristics and travel behavior is not sufficiently strong to provide a corrected picture of travel behavior that can be obtained by means of weighting through demographic characteristics.

#### TRAVEL CHARACTERISTICS OF MOBILE VERSUS IMMOBILE RESPONDENTS

Table 3 shows that the portion of mobile persons was too high in the early phases of the survey, compared to the share of mobile people in the whole survey population. Nevertheless, at the end of the survey there remained a discrepancy between the expected share in the total population and the share evident in the survey sample.

On the other hand, it was found that the average trip frequency of the mobiles was almost independent of the return rate. This result is not affected by the results of the non-response survey. The observed reduction in overall mobility in later response groups can therefore be attributed exclusively to the underrepresentation of mobiles in early response groups. A further investigation of the relationship of response speed and choice of mode, trip purpose or destination, and trip length (time and distance) revealed that the non-response investigation did not result in any changes from the unweighted values of the main survey. On the other hand, the results obtained by weighting according to socio-economic characteristics do not show this homogeneous picture.

IMPLICATIONS WITH RESPECT TO SURVEY PRACTICE

This research has shown what consequences the use of low return rates will have on the quality of the collected travel data:

- Overestimation of mobiles.
- Overestimation of trip frequencies per person per day.
- Poor representation of the modal choice.
- Shopping trips are seriously overestimated.

In summary, the non-response bias for low-response rates is not only substantially greater but it also affects the trip structure more than is the case of a more exhaustive survey sample. As a consequence, the non-response error can certainly not be compensated for by a correction of the share of mobiles versus immobiles.

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	Main Travel Survey	Mail-Back Non-Response Survey	Interview Non-Response Survey	Combined Main & Non-Response Surveys
Gross Number of Households	984 (100%)	209 (100%)	116 (100%)	984 (100%)
Genuine Non-Responses	128 (13%)	30 (14%)	20 (17%)	178 (18%)
Other Non-Responses	49 (5%)	4 (2%)	2 (2%)	55 (6%)
Responses	598 (61%)	59 (28%)	42 (36%)	699 (71%)
Households for Which Information Was Obtained	775 (79%)*	93 (44%)	64 (55%)	932 (95%)
Households Not Responding at All	209 (21%)**	116 (56%)	52 (45%)	52 (5%)

\* Subtotal of preceding three rows.      \*\* Basis for the computations in the next column.

Table 1. Summary of Response Rates for Main Travel Survey and Survey of Non-Respondents

Response Group	Cumulative Return Rates	Average Mobility (trips/person/day)	Cumulative Mobility Values
Prompt Respondents	32.9%	2.72	2.72
Respondents to the First Reminder	51.2%	2.31	2.57
Respondents to the Second Reminder	62.2%	2.27	2.51
Respondents to the Third Reminder	70.5%	2.22	2.48
Respondents to the Fourth Reminder	74.2%	2.21	2.46
Respondents in the Non-Response Survey	86.7%	1.46	2.32

Table 2. Cumulative Response Rates and Mobility Values

Response Groups	Cumulative Share of Mobiles in Survey	Cumulative Trip Frequency for All Survey Elements	Cumulative Trip Frequency for Mobiles
Prompt Respondents	107	111	103
Respondents to 1st Reminder (Postcard)	103	104	101
Respondents to 2nd Reminder (Postcard)	101	102	101
Respondents to 3rd Reminder (Second Questionnaire)	100	101	100
Respondents to 4th Reminder (Postcard)	100*	100*	100*
Respondents in the Non-Response Survey	95	94	100
Weighted Values for the Main Survey	96	96	99
Final Estimates	92	93	100

\* For the computation of the index, the unweighted overall results of the main survey were set to 100.

Table 3. Mobile Sample Elements and Trip Frequency