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Behavioural Mechanisms of Non-Response in Mailback Travel Surveys

By

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ABSTRACT: In the conduct of sample surveys in transport, there will inevitably be some level of non-response. The issues of non-response are fundamentally connected to the questions of reducing survey bias and increasing the accuracy of sample estimates. This is because non-respondents in sample surveys have often been shown to have significantly different characteristics from those of the respondents. These differences are in terms of the socio-demographic characteristics and, more importantly, in terms of travel behaviour characteristics. For example, non-respondents to household interview surveys tend to travel more than respondents to such surveys, because one of the main reasons for their non-response is that they are out of the house (travelling) when the interviewer calls to perform the interview. If due allowance is not made for this known difference, then estimates of total travel and travel distance will be under-estimated from such surveys. This will then result in under-estimates of emissions and fuel consumption in the survey area. Other types of non-response bias are associated with other types of survey method.

This paper considers a range of issues associated with non-response to mailback travel surveys. It begins by reviewing some of the previous research on non-response in mailback travel surveys, in particular methods of correcting for this non-response. It then proposes a number of different behavioural mechanisms that might be associated with non-response patterns in those surveys, and suggests that previous methods of correcting for non-response in mailback travel surveys may be in error. The paper concludes by suggesting further steps that must be taken to fully understand the behavioural mechanisms underlying non-response in mailback travel surveys.

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Introduction

In the conduct of sample surveys in transport, there will usually be a series of systematic errors that might appear in the data. The three major sources of systematic error (bias, distortion) in a typical sample survey dataset include:

(a) Inaccurate reporting
(b) Non-reporting
(c) Non-response

Inaccurate reporting describes the cases where the analyst has determined that some of the responses provided are objectively incorrect, inaccurate, or incomplete. *Non-reporting* refers to survey responses where the analyst is in receipt of a survey form on which certain questions have not been answered, or at least not answered in full. *Non-response* pertains to the situation where a household or individual did not provide a response at all, i.e. no survey form was filled out.

The issues of non-response are fundamentally connected to the questions of reducing survey bias and increasing the accuracy of sample estimates. This is because non-respondents in sample surveys have often been shown to have significantly different characteristics from those of the respondents. These differences are in terms of the socio-demographic characteristics and, more importantly, in terms of their travel behaviour characteristics. For example, non-respondents to household interview surveys tend to travel more than respondents to such surveys, because one of the main reasons for their non-response is that they are out of the house (travelling) when the interviewer calls to perform the interview. If due allowance is not made for this known difference, then estimates of total travel and travel distance will be under-estimated from such surveys. This will then result in under-estimates of emissions and fuel consumption in the survey area. Other types of non-response bias are associated with other types of survey method. This paper is concerned with non-response to mailback travel surveys. In particular it is concerned with efforts made to correct for the effect of non-response on trip rates calculated from the data.

Previous Research on Mailback Non-Response

The two basic concerns with respect to non-response that need to be stressed are the importance of recognising the existence of non-response and of the need to find ways of assessing its impact on the quality and representativeness of the information derived from the survey. The analyst has to satisfactorily answer the question as to whether the results of the survey would have been the same even if a one hundred percent response rate had been achieved. This question translates into a recommendation that the analyst try to establish some information about the non-respondents that will permit judgment about whether the information that could have been obtained from the non-respondents would have been statistically different from that actually collected from the respondents. Ideally, it would be desirable to have available a series of adjustment factors that could be applied for different surveys and population groups in order to account for the information lost through non-response. Unfortunately, these adjustment factors can only be obtained through significant survey research efforts into the characteristics of population of non-respondents, which are generally costly and time-consuming. Since survey budgets generally tend to be very tight, it is virtually impossible to advance the state-of-the-art of adjustments for non-response through regular survey activities.

Separately funded and carefully staffed research efforts are necessary to achieve significant and analytically sound advancements in this area. On the other hand, it has been shown through the limited research efforts in transport that exist in this area (1, 2, 3, 4, 5, 6, 7), some understanding of non-response effects can be obtained by explicit consideration of non-response effects within the survey design process.

One of the main procedures for increasing response rate, and also gaining some information on late respondents and non-respondents, is by the use of a series of reminders that follow the distribution of the main questionnaire, and the conduct of special interviews with non-respondents. The number of reminders can vary from one or two up to a maximum of about five. A number of studies (4, 5) have shown that the use of reminders can double the response rate that would have been obtained from a single mailing with no reminders.

The use of reminders can also give information about the types of people who respond early and the type who respond late. Wermuth (4) investigated the socio-economic status of respondents in the various response groups, and found that, in a number of German surveys, larger households were more likely to respond and to respond earlier, probably because of the increased chance of finding someone in the household willing to complete the survey. Older people are more likely to respond, probably because of their greater amounts of free time. Employed people are more likely to respond, probably because of their greater extent of trip making and hence the greater perceived relevance of the travel survey. There appears, however, to be no difference in response between males and females.

Since household size, employment status, age and time availability are likely to have an impact on trip-making characteristics, it is reasonable to assume that the travel characteristics and data for late respondents will be different from that for the early respondents. Brög and Meyburg (1, 2, 3) have demonstrated that trip-making characteristics do change substantially as additional response waves (usually defined in terms of weeks after initial Travel Day) are obtained from reminders. For example, for a survey of nine cities in Germany, Figure 1 shows that both the (linked) trip frequency and the proportion of mobile persons in the population (i.e. people who make at least one trip) decrease as the time to respond increases (4).

Similar results were found in the South-East Queensland Household Travel Survey (5), as shown in Figure 2, where the respondents in the first wave have the highest (unlinked) trip rate and those in the last waves have the lowest (unlinked) trip rates. This relationship is very similar to that obtained by Wermuth (4) in that the trip rate falls relatively uniformly after the second response wave. Using such a relationship, Brög and Meyburg (3) postulated that non-respondents are more likely to have trip-making characteristics like those who respond late to travel surveys than those who respond early to travel surveys. They assumed a linear decrease in trip rate after the second response wave up till the last respondents to the mailed questionnaire. They then projected forward to estimate the likely trip rate of the non-respondents.

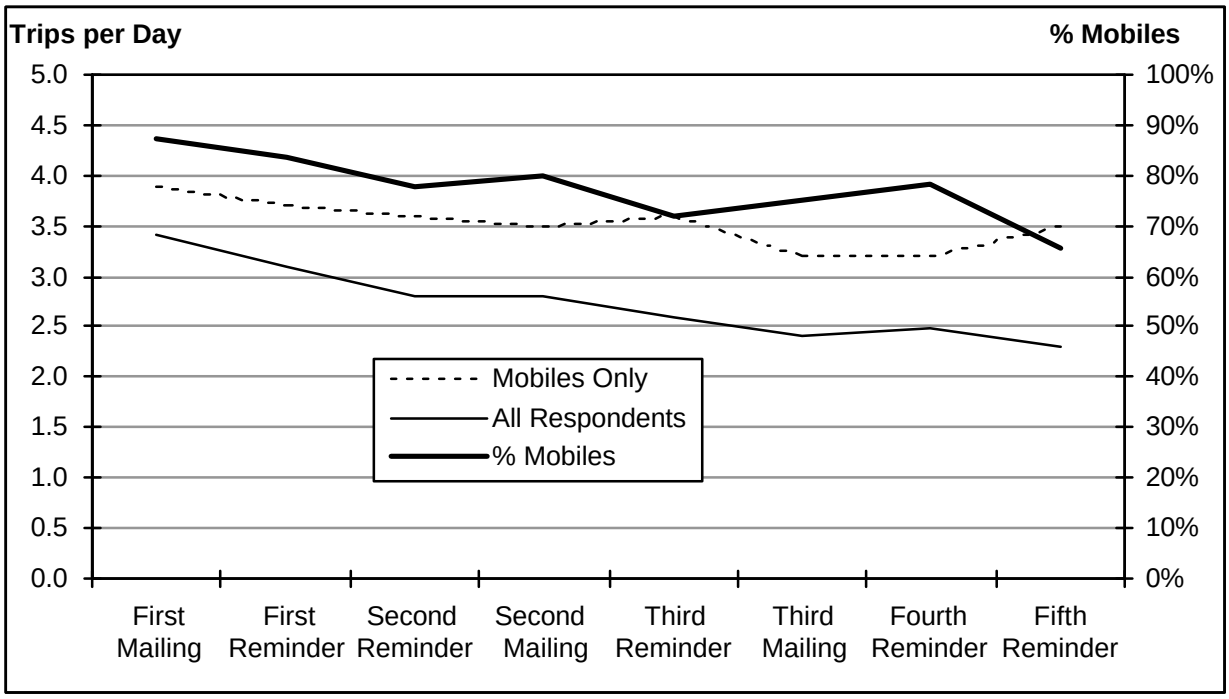

Figure 1 Travel Characteristics as a Function of Response Speed (9 German Cities)

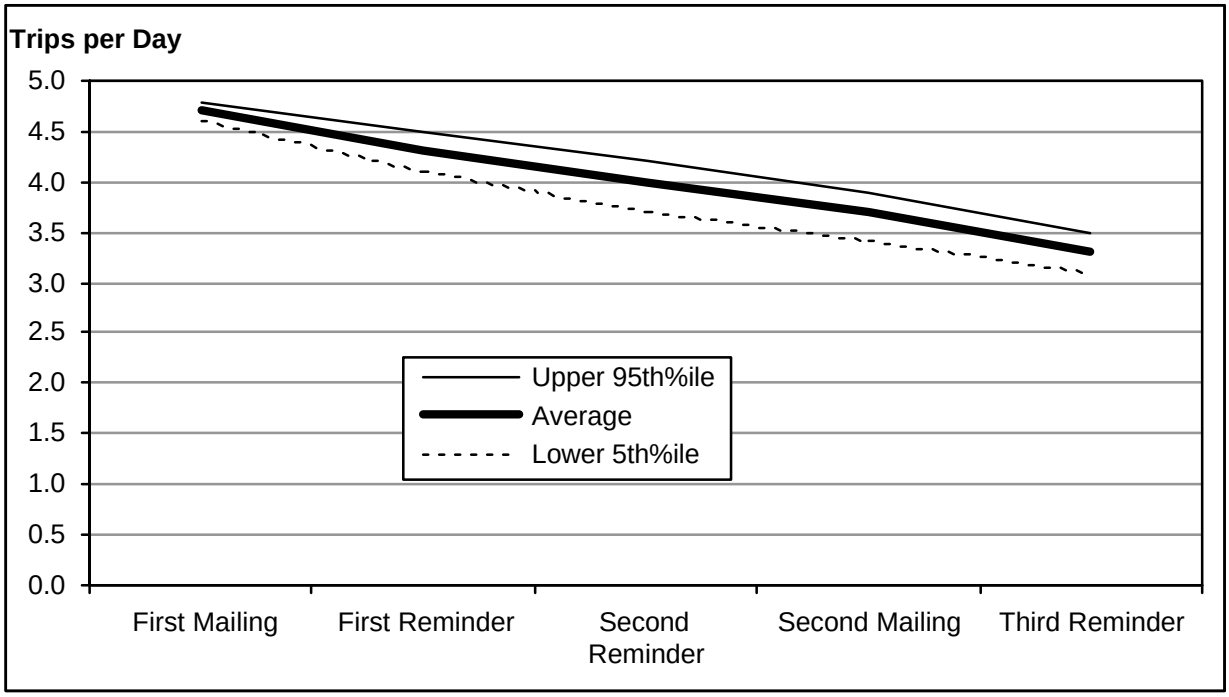

Figure 2 Average Trip Rate as a Function of Response Wave (Queensland)

Behavioural Mechanisms for Non-Response

One of the common features that emerges from previous research in the area has been the trend of reducing trip rates for later respondents to mailback survey reminder systems. It has also been assumed that non-respondents are more likely to behave like late respondents. On the basis of these two pieces of information, it has often been

assumed that non-respondents to mailback travel surveys will have lower trip rates than respondents. However, there are a number of behavioural mechanisms that could potentially explain the reduced trip rate for late respondents, which might result in different ways of correcting for non-response.

Different socio-demographics

It is possible that the lower trip rate observed for late respondents could arise because of socio-demographic differences between the response waves. That is, people of a particular socio-demographic persuasion (e.g. low income, low car ownership, older) may respond more slowly to the survey, and these socio-demographic groups may have lower trip rates than those socio-demographic groups that reply more quickly. It may also be that non-respondents are from different socio-demographic groups to respondents and that it is this difference which leads to different trip rates for non-respondents, rather than any difference between respondents and non-respondents within a particular socio-economic group. If this is the case, then the differences in trip rates between respondents and non-respondents can be corrected for by socio-demographic expansion factors. However, if there are differences in trip rates between respondents and non-respondents within a socio-demographic group, then the non-response bias cannot be corrected solely by socio-demographic weighting.

Lower trip rates

It could be that within a socio-demographic group, those who respond late, or not at all, actually make fewer trips than those who respond early. The behavioural mechanism for this might be that those who make more trips are more interested in the survey because they see it as being more relevant to their daily activities. On the other hand, those who make few trips (the mythical “little old lady”) feel that a travel survey is not relevant to them because they make so few trips. This explanation has anecdotal support from those who answer the help-lines associated with mailback surveys, and who speak to many “little old ladies” who ask whether they are meant to complete the survey. It is not until they have received many reminders, or have phoned the help-line, that they realise that the survey is meant for infrequent travellers as well as frequent travellers, and send in their completed surveys (with few trips) towards the end of the survey. Presumably, however, many of these people never send in a completed survey and hence the non-respondents also contain many infrequent travellers.

Higher non-reporting

It is also possible, however, that it is the people with average or higher trip rates who fail to respond to the survey early, simply because the task of answering is more difficult for those who make many trips. Only after receiving one or more reminders do they begin to feel uncomfortable about not responding. However, they may still resent the amount of effort involved in completing their survey correctly, and hence to resolve their guilt about not completing it at all, they fill it out but do not provide details for all their trips. Thus the lower trips rates observed in later response waves may not be due to lower actual trip rates but to lower reported trip rates. If this is the case, then the non-respondents may consist of many people with very high trip rates, for whom the effort of completing the survey is too much.

Self-selection of travel day

One of the features of most mailback reminder systems is that, for each reminder, the date of the Travel Day is moved back so that the respondent is always responding about a relatively recent day, rather than one which is receding further and further into the past. The objective of this updating of the Travel Day is to minimise the effect of recall problems that are known to occur for distant events. However, this procedure could also lead to a behavioural reaction that could explain the reduction in trip rates with later response waves. It could be that those who don't respond to the first mailing, because they perceive the effort to be too great, might wait until they get asked about a Travel Day on which they really didn't make many trips and for which the effort of reporting truthfully is greatly reduced. They can then answer completely honestly about that day, with no non-reporting, and send off their reply. The difference between this mechanism, and the previous one, is that in this mechanism there is no non-reporting, just a self-selection of a Travel Day on which they happen to make few trips.
There are probably other behavioural hypotheses that could be used to explain the observed trend of reducing trip rates with increasing response wave. However, the above four are sufficient to demonstrate the differing mechanisms of non-response, the different procedures that could be used to correct for this non-response, and the different outcomes of such correction procedures.

Possible Diagnostic and Corrective Actions

Each of the above behavioural hypotheses require different diagnostic and corrective actions, as described below. These actions will firstly seek to identify which of the mechanisms is contributing to the non-response. It could well be that all of the mechanisms are partly responsible for the non-response, in that different segments of the population are employing different mechanisms. For each mechanism, there is a corrective action that can be employed, and each corrective action will cause a shift in the final trip rate.

Different socio-demographics

If different socio-demographics are to be the cause of non-response bias, then an essential pre-requisite is that there be different socio-demographics for respondents and non-respondents. Ideally, this requires a description of the socio-demographics of the non-respondents. This can come about either through a socio-demographic survey of non-respondents, or by knowing the difference between the respondents and the population from which the overall sample was drawn.
If one accepts the Brög and Meyburg (3) hypothesis that later respondents are more likely to resemble non-respondents than are early respondents, then this also means that the socio-demographics in each of the response waves should be systematically different (moving from the early respondents to the non-respondents). If socio-demographics are the cause of the different trip rates observed for each response wave, then socio-demographic weighting (expansion) of each of the response waves should eliminate the trip rate differences in each of the response waves. To the extent that this process does not eliminate the difference in trip rates, however, then some other mechanism must be the cause of the differences between response waves.

Lower trip rates

If one is to assume that later respondents, and non-respondents, actually have lower trip rates than early respondents, then the other mechanisms must be discounted. Firstly, it must be shown that socio-demographic weighting does not eliminate the difference in trip rates between response waves. Secondly, it must be shown that the observed differences are real differences and not just differences in reported values because of increasing levels of non-reporting of trips in the later response waves. Thirdly, it must be shown that the reducing trip rates are not due to the self-selection of low-activity Travel Days by respondents. Only after these mechanisms have been discarded can the assumption of lower actual trip rates be adopted. If non-respondents do have lower trip rates than respondents, then correcting for this bias will give a lower overall trip rate.

Higher non-reporting

If it is assumed that later respondents are under-reporting their trips, then this can be checked by comparing their reported trip rates with other estimates of their trip rates. These other estimates may come from secondary data sources (such as GPS traces of their daily movements), or from follow-up surveys where the possibility and extent of under-reporting is specifically investigated. If under-reporting is the cause of the reduction in trip rate in later response waves, then correction of this problem will result in a higher overall trip rate.

Self-selection of travel day

If respondents are not under-reporting, then it should be checked whether they are self-selecting days of low travel activity. Ideally, this should be done by determining their travel patterns on the earlier Travel Days on which they did not report. However, since (by definition) they have not reported their travel on these days, it would be difficult to obtain reliable estimates of their travel on these days. The best that could be obtained would be estimates of general travel activity on those days, or cognitive laboratory investigations where they describe the reasons for their non-reporting on those earlier days so that the researcher can determine whether self-selection was a possible problem. If self-selection of Travel Days is the cause of the reduction in trip rate in later response waves, then correction of this problem will result in a higher overall trip rate.

The Data Set (VATS 94-96)

To investigate which of the above behavioural mechanisms are contributory factors in the non-response process in mailback travel surveys, a new data source will be used to explore variations in response over the various response waves. The Victorian Activity & Travel Survey (VATS) is a continuous travel survey being conducted in Melbourne, Australia. The survey began in December 1993 and has continued unbroken since then. Approximately 5000 households respond each year. The VATS survey records all travel by all modes by all people in responding households in the survey sample. Each household is asked to provide this information for a specified travel day. However, the survey is a continuous process, covering all 365 days of the year, thus enabling seasonal

variations in travel and activity patterns to be observed. The survey uses a mail-out/mail-back self-completion questionnaire with six discrete stages:

1. **Initial contact letter**
2. **First mailing, including:**
    - a follow-up covering letter
    - a household and person form
    - 6 trip forms (to cover the maximum expected number of persons in the household)
    - a trip form with a pre-printed completed example
    - a postage-paid return envelope
3. **First reminder**
4. **Second reminder**
5. **Third reminder, including:**
    - all the items sent in the first mailing
    - a cover letter from the Survey Director stressing the importance of cooperation by respondents
6. **Fourth reminder.**

In addition to the postal reminders, a number of other techniques are used to improve response rates and the quality of the reported data. Firstly, for responding households in which there is some question over the quality or completeness of the reported data, telephone interviews are conducted to clarify any points of uncertainty. Secondly, a sample of responding households is selected for validation interviews, conducted by personal interview. The purpose of these interviews is to check on the manner in which the questionnaires have been completed, and to assess the quality of the reported data (especially relating to the identification of non-reported trips). Thirdly, a sample of households that have not responded after the fourth reminder is contacted personally to ascertain the reasons for their non-response and, if possible, to conduct the travel survey with them. The data used in the current analysis comes from three years of the survey (1994-96), containing approximately 17,500 households, 45,000 respondents and 175,000 unlinked trip stages.

Results by Response Wave

Mobility rates by response wave

The emphasis in this paper is on understanding the reasons behind variations in trip rate within different response waves and by non-respondents. The first step therefore is to determine whether the variations in trip rate by response wave observed in previous studies are also present in the VATS data.

The results for the VATS analyses for 1994, 1995 and 1996 are shown in Figure 3 through 5. It can be seen that they follow the same trends as shown in Figures 1 and 2 for the reminder waves. However, the VATS data includes an extra item of information that has not been included in previous studies. In the VATS surveys, a follow-up interview was performed with non-respondents, firstly to ascertain reasons for their initial non-response and then, if possible, to conduct the survey with them to obtain details of their travel characteristics. The results from these surveys are also included in Figures 3 through 5. It can be seen that, rather than continuing the downward trend of mobility with increasing response wave, the trip rates and mobility rates of non-

respondents return to essentially what was recorded in the first wave of respondents. This would seem to contradict the technique previously employed by ourselves and others (3, 4, 5, 7) of extrapolating the trend observed over the response waves to predict the behaviour of the non-respondents. Although the non-respondent interviews were conducted by personal interview, and not by self-completion survey as was the case for all the previous response waves, it is unlikely, as will be shown later, that the increase in measured mobility is due entirely to the change in survey method. Some other factors appear to be at work in producing the higher-than-expected mobility rates for non-respondents. In order to understand the behavioural mechanisms at work, the paper now looks at socio-demographics by response wave and the extent of under-reporting of trips by response wave.

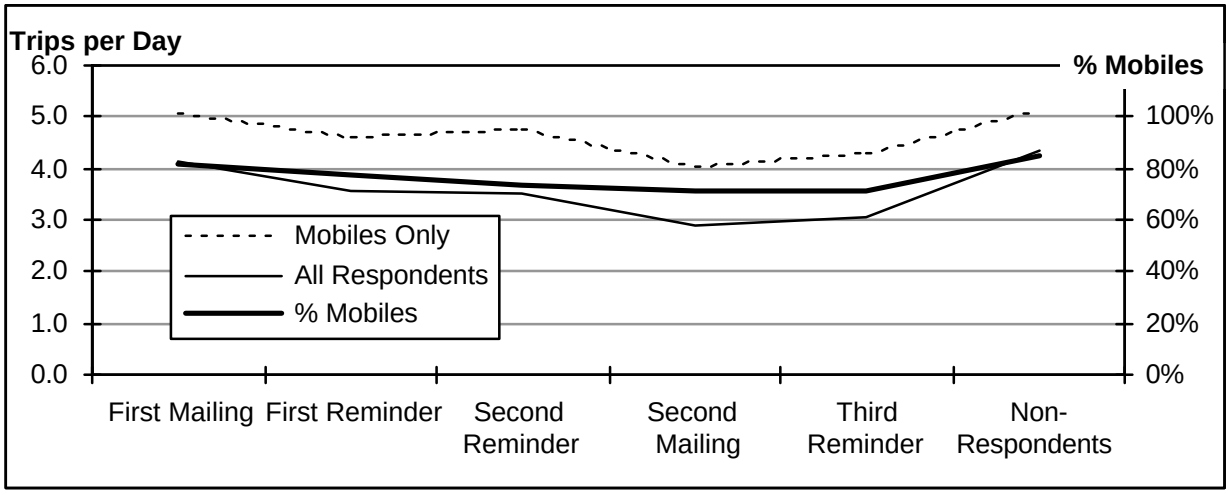

Figure 3 Travel Characteristics as a Function of Response Wave (VATS 94)

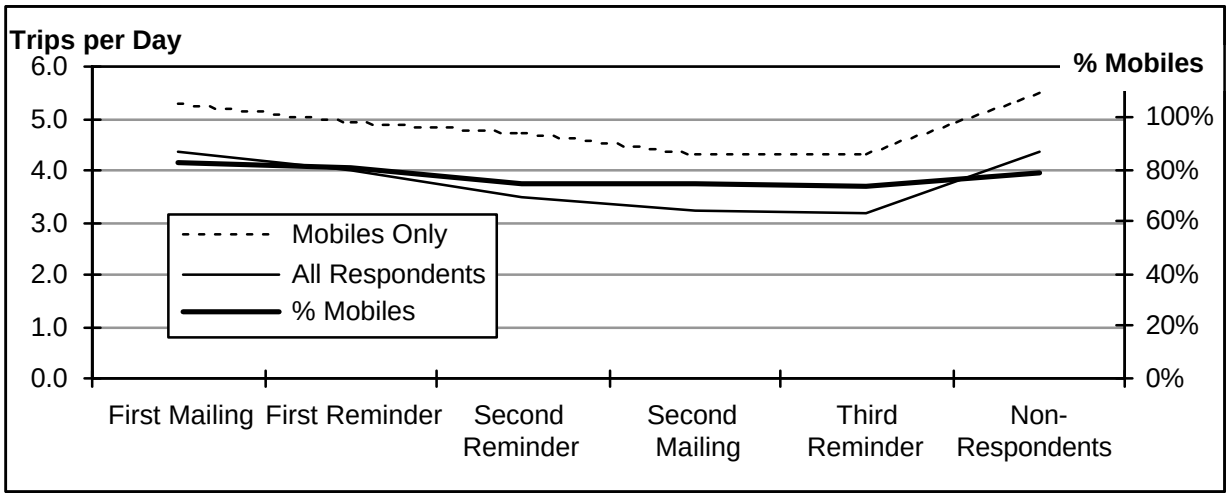

Figure 4 Travel Characteristics as a Function of Response Wave (VATS 95)

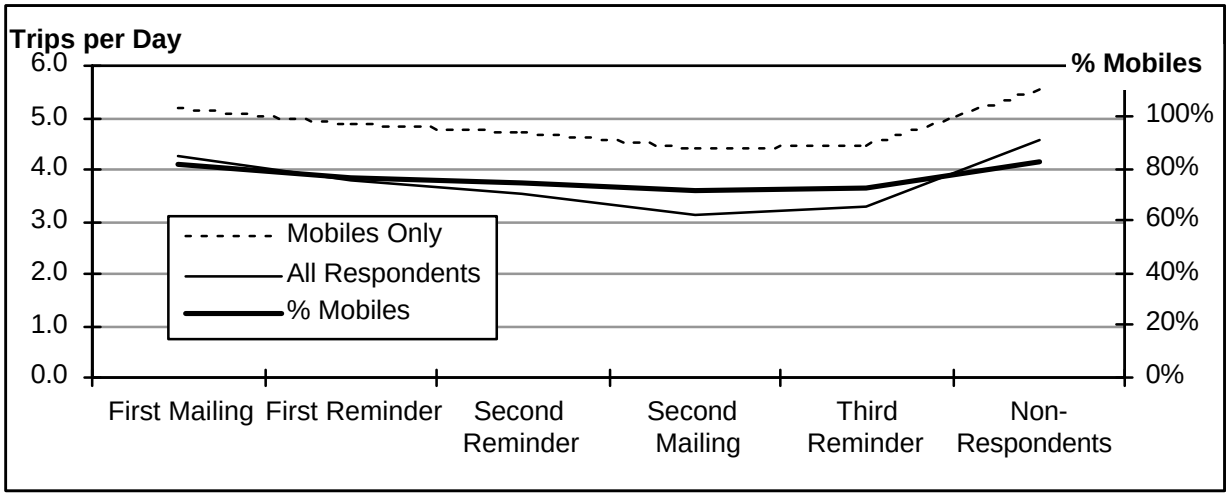

Figure 5 Travel Characteristics as a Function of Response Wave (VATS 96)

Socio-demographics by response wave

Previous research has indicated that the major socio-demographic differences between response waves lay in the area of age, employment status and household size. These three factors were therefore examined in the VATS data, and the results are shown in Figures 6 through 8.

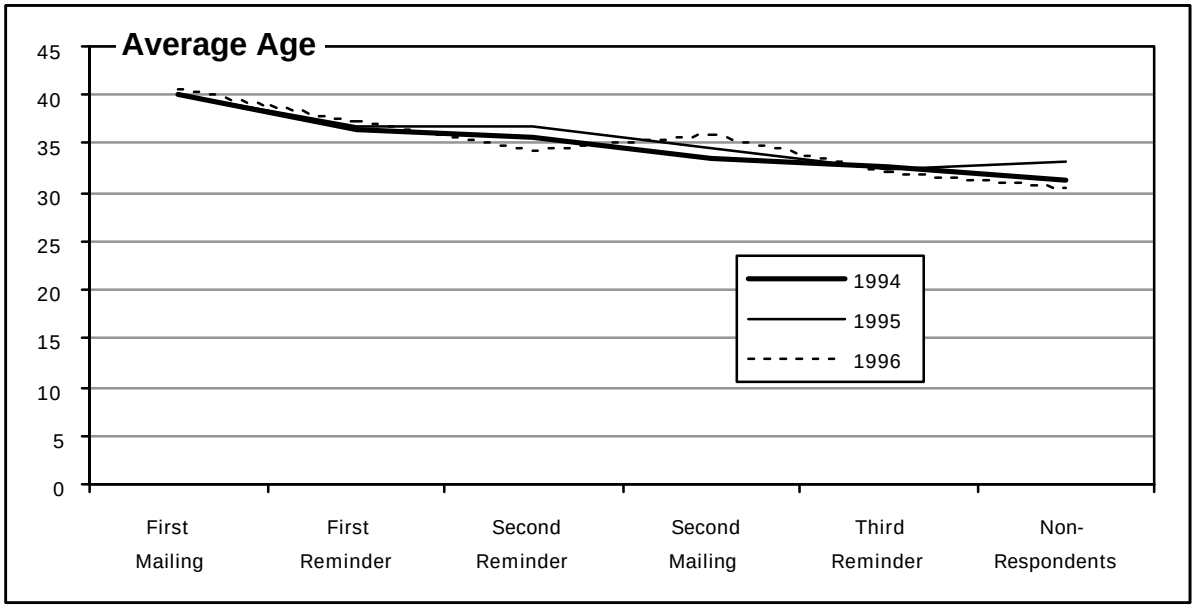

Figure 6 Average Age of Respondent as a Function of Response Wave

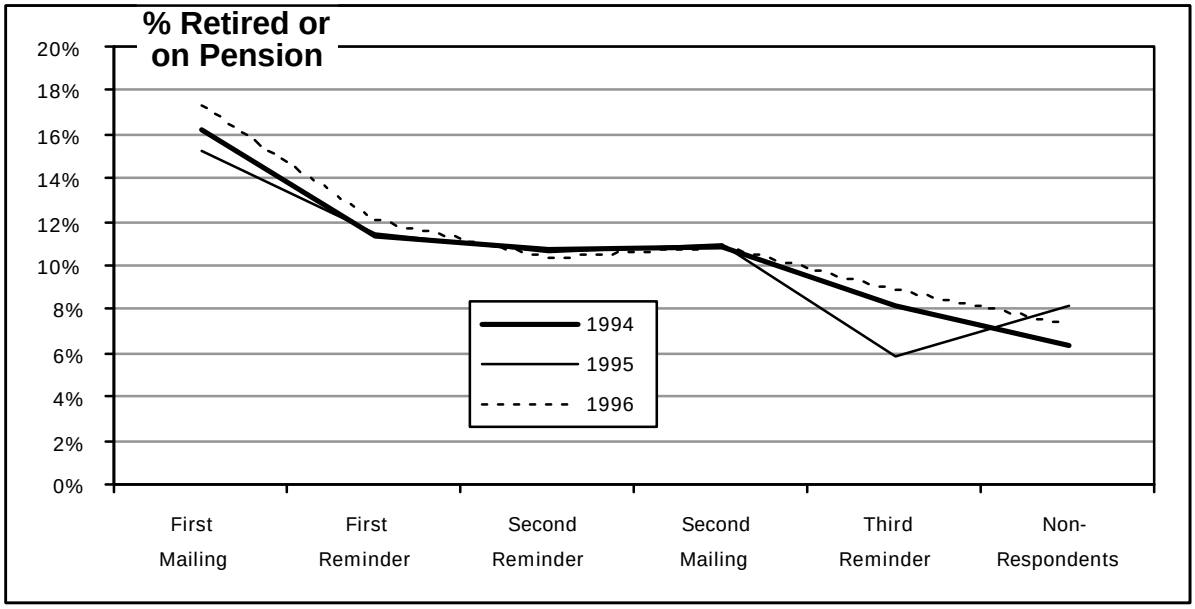

Figure 7 % Retired or on Pension as a Function of Response Wave

Figure 6 shows that the average age of respondents decreased systematically with increasing time to response. Those who responded to the first mailing had an average age of 40 years, while late respondents and non-respondents had an average age of only 32 years. This finding is also supported by Figure 7, which shows a much higher proportion of retired people and people on a pension in the early respondents than in the later respondents and non-respondents. Obviously, older people have more time to complete the questionnaire and hence do so without being reminded to do so. This finding is also confirmed to a certain extent by Figure 8, which shows that smaller households respond more quickly than larger households. Elderly people often live in households of size two, whereas younger people in the workforce tend to live in family situations in larger households.

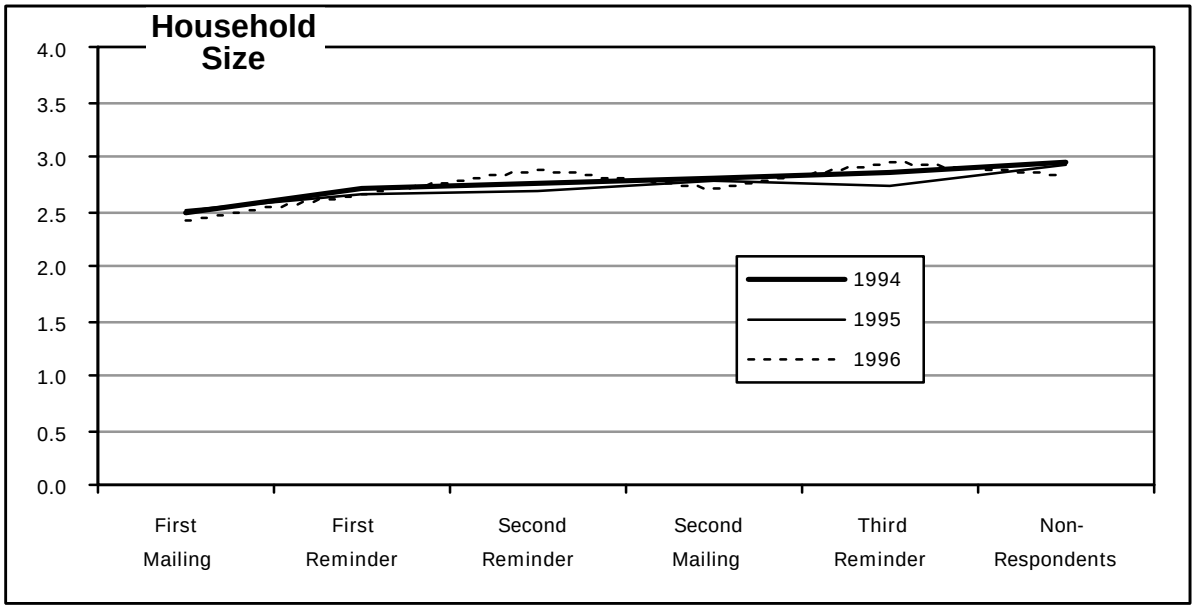

Figure 8 Average Household Size as a Function of Response Wave

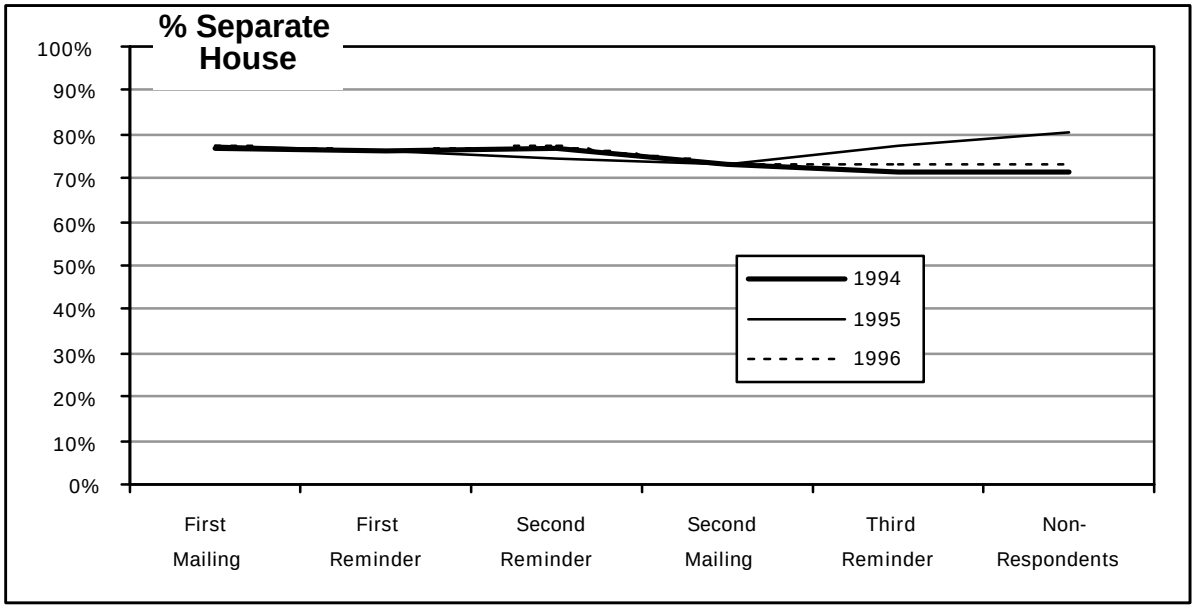

Figure 9 Average Household Size as a Function of Response Wave

Another finding is that respondents living in separate houses tended to respond more quickly than those living in apartments, townhouses and other forms of shared dwellings, as shown in Figure 9. This ties in with the previous findings since elderly retired people, in Australia, tend to live in separate houses rather than apartments.

Interestingly, some of these findings from VATS are directly opposed to Wermuth's earlier findings (4) that larger households were more likely to respond early, and that employed people were more likely to respond quickly. Perhaps this is due to cultural differences between Germany and Australia, but this is uncertain without further evidence.

The differences in socio-demographics between the response waves noted above are only of relevance if trip rates are also a function of these socio-demographic differences. To test this, average trip rates were computed from the VATS data for variations in each of the socio-demographic variables described above. The results are shown in Figures 10 through 13.

It can be seen from Figure 10 that, in all years of the VATS data, trip rates increase for people up to the age of about 40, and then fall continuously for those above this age. Given that older people respond more quickly to mailback surveys (see Figure 6), this would imply, ceteris paribus, that the trip rate of early respondents should be lower than for later respondents (who are younger). This, however, is not the case, as demonstrated in Figures 3 through 5. Clearly, something else is at work in explaining the trip rate variations across response waves.

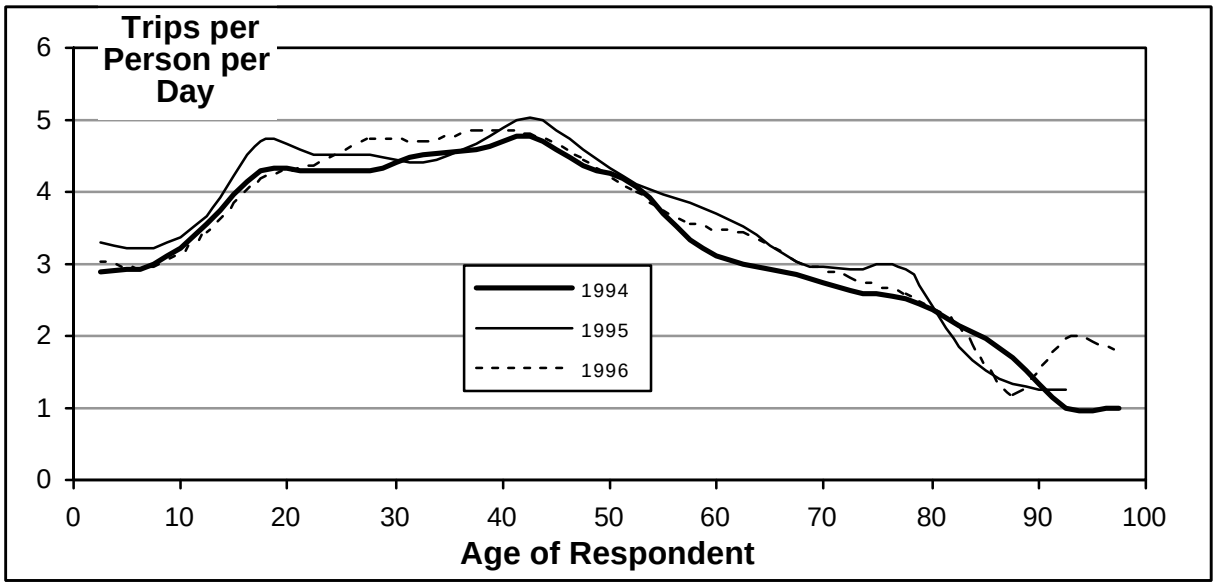

Figure 10 Average Household Size as a Function of Response Wave

The trip rates of respondents with different activity status are shown in Figure 11. Clearly, the retired people have the lowest trip rate. Paradoxically, again, these low mobility people were more likely to reply early to the survey, despite the higher average trip rate of the first response wave.

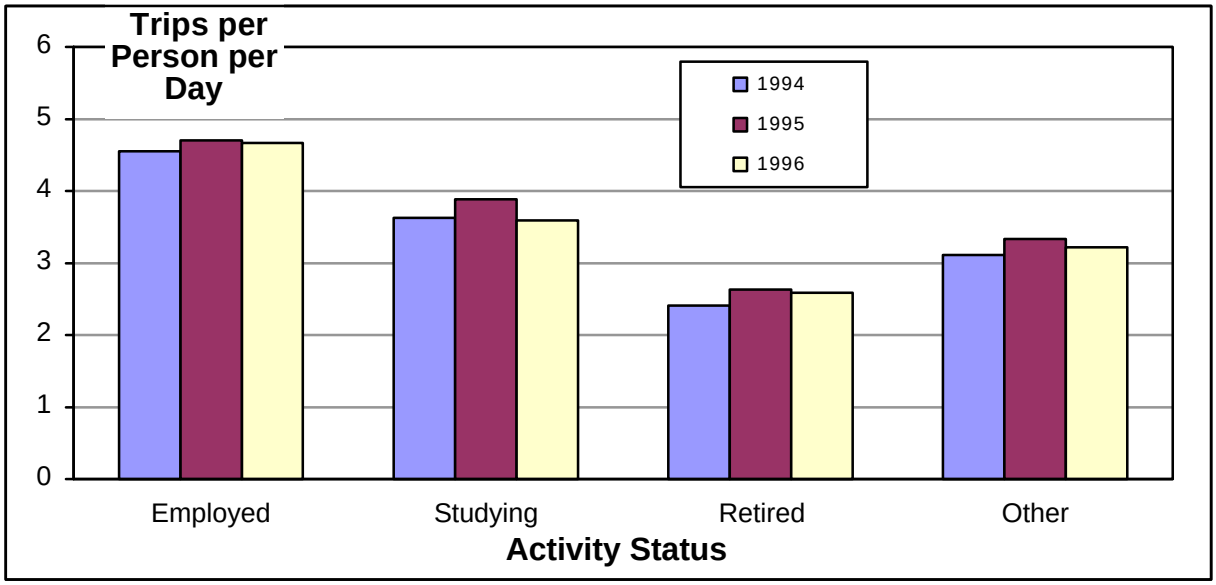

Figure 11 Average Household Size as a Function of Response Wave

The average trip rates for respondents within households of different size are shown in Figure 12. It can be seen that respondents in very small and very large households have the highest average trip rates.

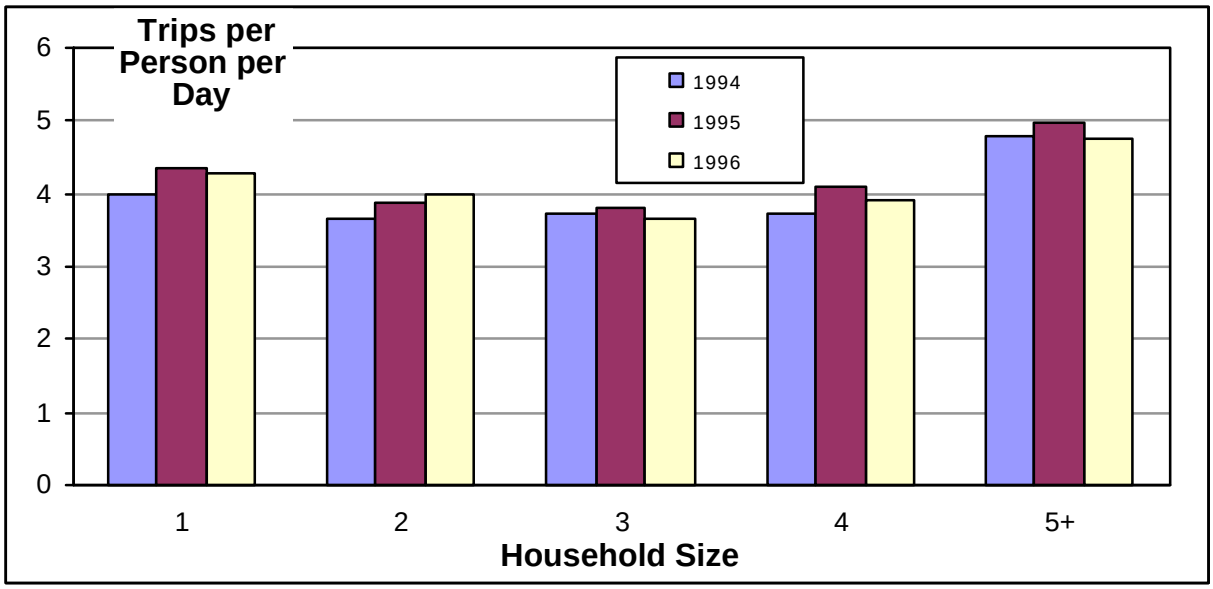

Figure 12 Average Household Size as a Function of Response Wave

The average trip rates for respondents within households of different dwelling type are shown in Figure 13. It can be seen that respondents who live in separate houses have the lower average trip rates. Paradoxically, again, these low mobility people were more likely to reply early to the survey, despite the higher average trip rate of the first response wave.

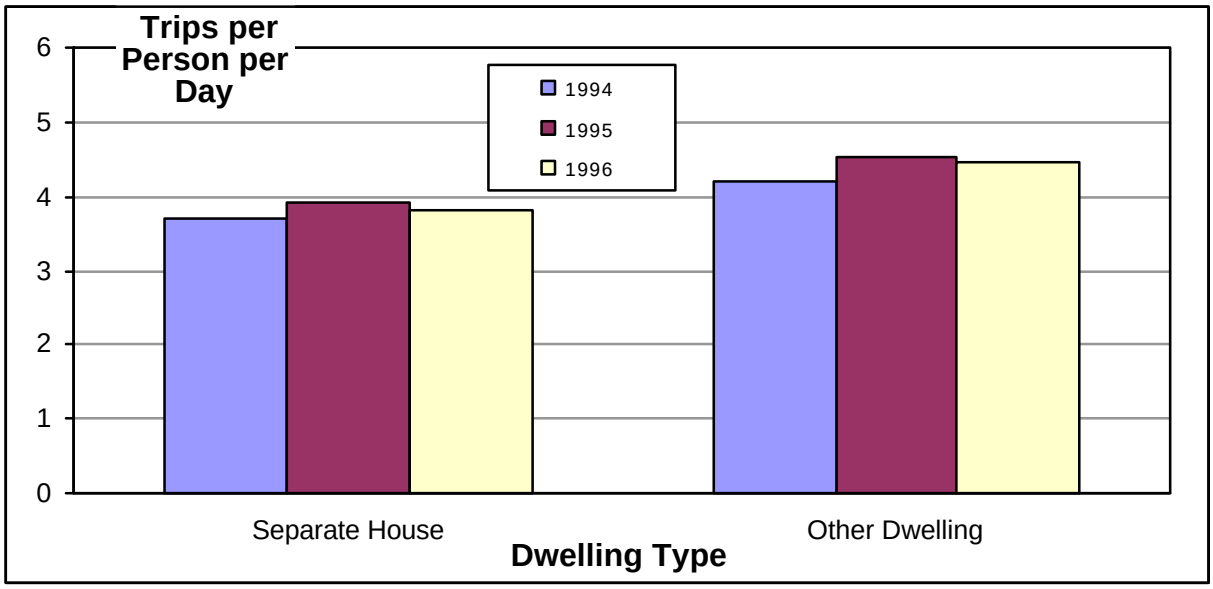

Figure 13 Average Household Size as a Function of Response Wave

Although there are socio-demographic differences between the response waves, it seems that the average trip rates of those groups who respond early are lower than average, despite the overall trip rate of early responders being higher than that of late responders. The question arises, therefore, as to whether socio-demographic weighting of the results will reduce the differences in trip rates between the response waves. If the differences in trip rate across the response waves were due largely to socio-demographic differences, then weighting should reduce much of these variances. The results within each response wave were therefore weighted and expanded to population totals obtained from the

Australian Census, using the control totals based on household size, dwelling type, age and sex of the respondent. The trip rates within each response wave after demographic weighting are shown in Table 1. By comparison with the unweighted trip rates, the trip rates across the response waves are even more different after weighting, as demonstrated by the standard deviations of the trip rates in each response wave, shown on the bottom line of Table 1. From all the above evidence, it appears, therefore, that socio-demographic differences are not the reason for the differences in trip rates across the response waves.

Table 1 Demographically Weighted and Unweighted Response Wave Trip Rates

	Average Trips per Person					
	Unweighted			Weighted		
Response Wave	1994	1995	1996	1994	1995	1996
First Mailing	4.14	4.37	4.24	4.19	4.37	4.20
First Reminder	3.57	4.00	3.78	3.52	4.02	3.69
Second Reminder	3.52	3.50	3.53	3.49	3.47	3.46
Second Mailing	2.88	3.26	3.15	2.79	3.20	3.03
Third Reminder	3.03	3.20	3.26	3.03	3.16	3.17
Non-Respondents	4.32	4.35	4.58	4.27	4.40	4.57
Average	3.58	3.78	3.76	3.55	3.77	3.68
Standard Deviation	0.57	0.53	0.56	0.59	0.57	0.60

Non-reported trips by response wave

An alternative explanation of reduced trip rates in later response waves is that respondents in later waves under-report trips that they make, in order to just get the survey completed more easily. This might especially be the case for respondents who make many trips and for whom completion of the survey is more burdensome.

In the VATS survey, validation interviews were performed with a sample of the responding households. The information for the estimation of non-reporting weights was obtained by means of identifying all additions made to the stop (trip stage) data as a result of the validation interviews. These added stops were also classified as to whether they were expected or unexpected. *Expected* extra stops were those where, during data entry (prior to validation), it had been identified that it was likely that an extra stop should have been reported, e.g. a person went to a shop and did not return home. *Unexpected* stops were those which had not been identified in this way, but which respondents reported during the validation interview checking.

The total proportion of added (non-reported) stops in each of the response waves is shown in Figure 14. It can be seen that, apart from some differences across the years in the second reminder, the proportion of non-reported trips rises with increasing response wave, from about 15% for the first mailing up to 30% for the third reminder.

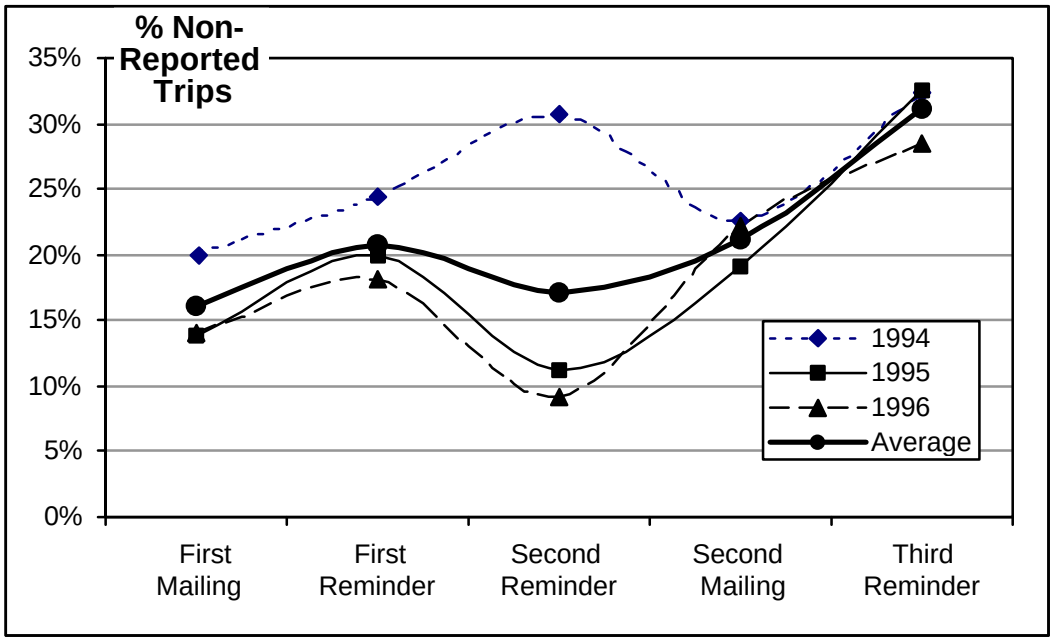

Figure 14 Total Non-Reported Trips as a Function of Response Wave

The results shown in Figure 14, however, are not truly representative of the overall situation, because they include both expected and unexpected non-reported stops. The expected non-reported stops would have been added to the stop file during the editing phase, and would be included in the trip rates shown in Figures 3 through 5. An analysis of the non-reported stops showed that they were most significantly correlated with the purpose of the stop and the position within the day. A series of non-reported stop weights were therefore calculated and attached to the stop records. The non-reported stop weights are applied in the following fashion:

- any household/person who was phoned or validation-interviewed does not need to have the *expected or unexpected* non-reported stop weights applied to their stops (because they would already have been found during the phone or validation interview),
- any household for which the data was judged to be perfect, and hence would not have been phoned, needed to have *unexpected* non-reported stop weights applied (because had they been interviewed, there was a chance that an unexpected stop might have been found); and
- any household which had *expected* errors but which was neither on the list to be validated, nor could it be phoned (because no number was given), would need to have both the *expected and unexpected* weights added.

After application of these weights, the average trip rates were again calculated for each response wave, and compared with the trip rates shown in Figures 3 through 5. The increase in trip rates, average across the three VATS years, are shown in Figure 15 for each of the response waves. It can be seen that there is an increase of about 4% in trip rates, with relatively little variation across the response waves. Thus while the total non-reported stops increases across the response waves, many of these omissions in later response waves are of a type which is relatively easy to correct during the editing phase (especially omitted return trips). It therefore appears that under-reporting is not the cause of the decreasing trip rates in later response waves.

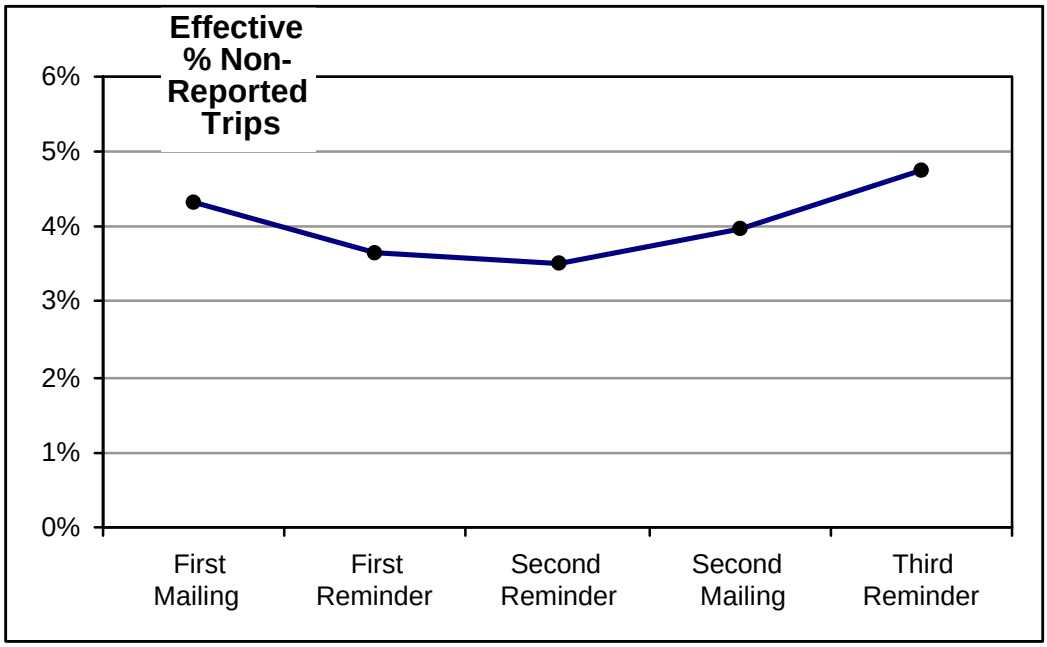

Figure 15 Effective Non-Reported Trips as a Function of Response Wave

A Choice Between Remaining Mechanisms

The previous sections have effectively eliminated two of the four mechanisms proposed earlier in this paper for the reducing trip rate in later response waves. The socio-demographic groups who respond early appear to have lower, not higher, trip rates, while the extent of under-reporting of trips appears to be relatively constant across the response waves. This leaves us with two alternative hypotheses: either later respondents actually do travel less, or else later respondents have more opportunity to select a Travel Day on which they make fewer trips, thus reducing their response burden. Both would result in a reduced reporting of trips in later response waves.

The choice between the mechanisms may be seen as somewhat academic, except for the fact that the corrective actions will produce very different outcomes. If one assumes that late respondents, and non-respondents, actually travel less than early respondents, then correcting for non-response will mean that the overall trip rate will fall, compared to the trip rate that would have been calculated only from the respondents. On the other hand, if one assumes that the fall in trip rates in later response waves is because of self-selection of (low mobility) Travel Days and that the trip rate of the non-respondents is the same as that of the early respondents, then correcting for this effect will mean increasing the trip rate of the late respondents to overcome the effect of the self-selection, and assuming that the non-respondents have the same trip rate as the early respondents. This will result in an overall increase in the trip rate.

From the data on trip rates in the response waves, there is no way of distinguishing between these two alternative mechanisms. The choice will have to depend on other information sources. Firstly, only the self-selection mechanism is consistent with the trip rates recorded in the non-response interviews. Since the non-response interview is performed on a Travel Day of the interviewer's choosing, the respondent cannot self-select a day of low mobility. Indeed, they are back to the same position they faced in the first response wave, when respondents filled out the survey on a day chosen for them. This may well explain why non-respondents have effectively the same trip rate as those in the first response wave.

According to the other mechanism, the trip rate of non-respondents should have been even lower than the trip rate of the late respondents. However, the trip rate of non-respondents is in fact higher. Even if one allows for the fact that the non-response interview was performed by personal interview, it was shown in Figure 15 that the difference in trip rates between the personal interview (used in the validation surveys) and the fully-edited self-completion interview was only about 4-5%. This is far less than the difference in trip rates between late respondents and non-respondents as shown in Figures 3 through 5.

A second source of information to select between the two mechanisms is of a more pragmatic nature. It was noted earlier that corrections based on the first mechanism would result in a lower overall trip rate, whereas corrections based on the self-selection mechanism would result in a higher overall trip rate. Both types of correction were in fact applied to the VATS data, and then compared with other sources of data on total trip production. These secondary data came from varied sources such as highway traffic counts, public transport patronage counts, and activity centre visitation counts. In each case, the unweighted (i.e. not weighted for non-response effects) VATS data gave estimates of total travel which were lower than that provided by the external sources. Application of non-response weights based on the first mechanism (i.e. non-respondents travel less) would have increased this disparity, whereas application of non-response weights based on the self-selection mechanism gave VATS estimates which agreed much better with the external sources. While this is not an absolute test of the alternative non-response mechanisms, it is a test that cannot be ignored in real-world circumstances.

Conclusions and Further Research

This paper has compared a number of alternative mechanisms for the often-observed characteristic of lower trip rates in later response waves to a mailback survey with multiple reminders. Two of the mechanisms (socio-demographic effects and under-reporting of trips) have been extensively tested and found not to be the cause of the effect. In comparing the remaining two mechanisms (lower actual trip rates by non-respondents, and self-selection of Travel Day by late respondents), a preference is expressed for the self-selection mechanism, based on the results of a survey of non-respondents and on the outcome of applying correction factors based on the two mechanisms.

However, the preference for the self-selection mechanism is based on circumstantial evidence. There is no definitive proof that the self-selection mechanism is really at work, just as there is no proof that non-respondents travel less (indeed there is some evidence from the VATS non-response surveys that they travel about the same as early respondents). What is needed is a more extensive testing in a real-world mailback survey of the alternative mechanisms. This would involve validation and non-response surveys as in the VATS survey, plus a parallel survey by mailback and personal interview in the initial stages to test for any differences between early respondents (in an initial personal interview survey) and non-respondents (in the non-respondents personal interview). It would also be useful to expand the validation surveys with late respondents to include a cognitive laboratory investigation, wherein the reasons for their late response were explored in more detail to determine whether self-selection of Travel Day is a reasonable hypothesis.

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