Estimating Long-Distance Travel Behaviour from the Most Recent Trip

by

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Introduction

In the United States and Europe, increasing attention is being paid to the measurement of long-distance travel behaviour. Such measurement poses special problems which are not encountered in the measurement of daily mobility in urban areas, which has been the focus of attention of most previous household travel surveys. Because long-distance travel is a relatively rare event, a major issue has been the selection of the period of observation. Unlike daily mobility surveys, where the most common survey period is a single 24-hour period, long-distance travel surveys have used survey periods from several weeks to several months.

However, selection of too short a period means that many respondents have no long-distance trips to report, while selection of too long a period means that frequent long-distance travellers have many trips to report, some of which occurred a long time before the conduct of the survey. This results in problems or recall or, in the extreme, problems of non-reported trips or even non-response. As a result, many surveys have used survey periods of 2 to 3 months. However, this method can result in under-reporting of trips from infrequent travellers, who are recorded as non-travellers, and possible under-reporting from frequent travellers because of the recall and response problems mentioned above.

In response to the above-mentioned problems, an alternative survey design is proposed by the authors which seeks to obtain information from all respondents about the most recent long-distance trip they have made, irrespective of when that trip was made. For frequent travellers that trip may have occurred today, while for infrequent travellers the trip may have occurred months or even years ago. Each respondent reports the details of only their most recent trip. In this way, trip information is obtained from all respondents, while limiting the response burden for the frequent long-distance travellers. The paper describes, theoretically and empirically, how the data obtained from this survey design can be used to obtain unbiased estimates of long-distance trip rates. It then compares these results with what would have been obtained from more conventional long-distance travel survey designs. It then suggests modifications to the basic design of long-distance travel surveys.

Issues in Recording Long-Distance Travel

Long-distance travel surveys are different from urban mobility surveys in two fundamental ways. Firstly, the definition of a "long-distance trip" is more difficult than the definition of a "trip" as used in urban mobility surveys. In the latter, the definition often takes the form of any travel outside of the respondent's residential property, although some surveys impose a minimum distance or time restriction, such that "trips" must be at least 50 metres, say, in length. In long-distance surveys, the definition of what comprises a "long-distance trip" is open to far more questions. In most cases, a minimum distance is involved but this varies between countries and surveys. Some distances are measured in round-trip distance, some are straight line distances to the most distant point in the trip; the unit of distance is different, being miles in the USA and kilometres in most other countries; the actual magnitude of the distance is different, ranging from 50 to 100 kilometres (or miles, as the case may be); some surveys contain exceptions, such as commuting trips in the American Travel Survey (ATS). Others have suggested that a "long-distance trip" should be based, not on distance, but on the presence of an overnight stay in the trip. The reasoning for this is that urban mobility surveys can easily be adapted to pick up all trips which start and end within the study area on the Travel Day, no matter what distance is involved, whereas trips which start and/or end the day outside of the study area are much more difficult to capture. For these trips, a "long-distance" travel survey is particularly appropriate.

The second major difference is in the relative frequency of "short-distance" and "long-distance" trips. Whereas urban mobility surveys are measuring trips which occur, on average, about four times per day, "long-distance" travel surveys are measuring something which occurs about four times per year. The relative rarity of "long-distance" trips means that the period over which this behaviour is recorded must be much greater than the typical 24 hours of an urban mobility survey.

The typical reaction of most long-distance travel survey designers has been to select a survey period of several weeks to several months, over which long-distance trips are recorded. Typically, this recording has been by retrospective recall methods, although some surveys have used prospective recording where respondents are given a diary in advance of the period and asked to record trips as they occur.

In the more typical case of retrospective recall methods, a number of problems can occur. Selection of too short a period means that many respondents have no long-distance trips to report, because of the relative rarity of these trips. It therefore appears, from the distribution of trip rates, that many people make no long-distance trips. On the other hand, selection of too long a period means that frequent long-distance travellers have many trips to report, some of which occurred a long time before the conduct of the survey. If they are expected to provide details of all these trips, this can result in problems of recall because of the well-known problems with recall of past events over extended periods (Sudman and Bradburn, 1973). In the extreme, for those with high trip rates, there may be problems of non-reported trips or even non-response due to the excessive respondent burden placed on them. On the other hand, there is another problem in the reverse direction due to "telescoping" (Neter and Waksberg, 1964) whereby respondents may over-estimate the number of trips in a period by including trips which may have been made before the start of the survey period. The extent of "telescoping" depends on the frequency of trip-making and the length of the recall period. In an attempt to balance these possible under-reporting and over-reporting effects, many long-distance travel surveys have used intermediate survey periods of 2 to 3 months. However, this method can still result in non-reporting of trips from infrequent travellers, who are recorded as non-travellers, and possible under-reporting from frequent travellers because of the recall and response problems mentioned above outweighing the "telescoping "effect.

The Most-Recent-Trip Survey Method

In response to the above-mentioned problems with long-distance travel survey designs, an alternative survey design is proposed by the authors which seeks to obtain information from all respondents about the most recent long-distance trip they have made, irrespective of when that trip was made. For frequent travellers that trip may have occurred today, while for infrequent travellers the trip may have occurred months or even years ago. Each respondent reports the details of only their most recent trip. In this way, trip information is obtained from all respondents, while limiting the response burden for the frequent long-distance travellers. This method still suffers from the possibility of a recall problem, but since the task is much simpler it is possible to minimise this problem by appropriate question wording, and prompting in interview surveys. The recall problem is potentially worse for the infrequent traveller, because the trip they are reporting probably occurred a long time ago. On the other hand, research has shown that respondents can have more difficulty recalling a specific event, such as the most recent trip, when they have many of those events during a period (Watkins and Kerkar, 1985).

The estimation of the time to a specific event in the past can also suffer from "telescoping", whereby the time to that event is shortened (Huttenlocher et al., 1990). However, by careful probing to establish, as close as possible, the actual date of the trip, by means of relating the date of the trip to other events in the respondent's life, it should be possible to minimise the extent of the telescoping for that single event.

The most-recent-trip survey method asks the simple question of "when did you last make a long-distance trip?". This assumes that the definition of a long-distance trip has already been explained to the respondent and that the date of a multi-day long-distance trip has been clarified. For example, a multi-day trip might be defined as being "made" on the last day of that trip. For the analysis to be described later, a long-distance trip which is made (or ends) today will be defined as being made on Day 0. A trip made yesterday was made on Day 1 and so on (counting backwards in time). It is assumed that full details are also obtained about this trip (such as mode, purpose, destination etc). However, for the purposes of this paper, attention will simply be focussed on the occurrence of the trip and the subsequent calculation of average trip rates. Later papers will discuss the derivation of more general travel behaviour characteristics from the method.

The type of data obtained from the most-recent-trip survey method is represented in Table 1.

Table 1 Typical Data from the Most-Recent-Trip Survey Method

Days Before Survey Day	0	1	2	3	4	5	6	7	...	365	...	Never Made
No. of Most-Recent-Trips	5	3	3	2	4	0	1	2	...	1	…	50

It can be seen that five people said that they finished a long-distance trip on the survey day, three said the finished one yesterday. Three said they finished one the day before and so on, backwards in time. One person said they finished a trip 365 days ago and so on, theoretically forever. Fifty people, however, said that they have never made a long-distance trip. This may be entirely correct, or it might just be that it's been so long ago that they can't remember. In the subsequent analysis, such subtle differences make no difference to the final results.

The question now facing the analyst is how to use the above information to calculate the average (and the distribution) of the annual long-distance trip rate. Theoretically, the average trip rate can be calculated using only the information from those trips ending on the Survey Day. If the total sample of respondents was, say, 500, then the probability of making a long-distance trip on any random Survey Day is equal to 1% (=5/500). Converting this to an annual trip rate, the average annual trip rate would be 3.65. Clearly, however, estimates of the trip rate calculated in this way would be subject to substantial sampling error, unless the overall sample size was increased significantly such that a "large" number of long-distance trips were observed to end on the Survey Day. From an economic point of view, such a method would also be very wasteful. A total of 500 people would need to be questioned in order to get information from 5 people which would then be used to estimate the trip rate. Clearly, a more efficient method would try to use much of the information provided by the other 495 respondents. This concept is the key to the analysis method associated with the most-recent-trip survey method.

The information contained in Table 1 can be expressed in a slightly different way, as shown in Table 2. On Day 0 (i.e. on the Survey Day), five respondents said that this was the end of their most recent trip, and hence we know that the other 495 did not travel on this day. Therefore, we can be confident that the number travelling on this day was 5. On Day 1, three respondents said that this was the end of their most recent trip and hence we can be sure that they travelled on this day. However, there are also the five respondents who said they last travelled on Day 0. It is possible that they also made a long-distance trip on Day 1. Hence the minimum number travelling was 3 and the maximum number travelling was 8. If those travelling on Day 0 have an average daily trip rate (or probability of travelling on any given day) of P_0, then the expected number travelling on Day 1 is $3 + 5P_0$.

Table 2 Estimation of Number Travelling on Each Day

		Trip Made?			Number
Days Before	Frequency	YES	Maybe	NO	Travelling
0	5	5	0	495	5
1	3	3	5	492	$3 + 5P_0$
2	3	3	8	489	$3 + 5P_0 + 3P_1$
3	2	2	11	487	$2 + 5P_0 + 3P_1 + 3P_2$
4	4	4	13	483	$4 + 5P_0 + 3P_1 + 3P_2 + 2P_3$
…	…	…	…	…	
None	50	…	…	50	
TOTAL	500	450	0	50	

By similar reasoning, the expected number travelling on Day 2 is $3 + 5P_0 + 3P_1$ and so on, as shown in Table 2. If it is assumed, for the current example, that there is no seasonality in trip rates, then the expected number travelled on each day should be equal, such that:

$$4 + 5P_0 + 3P_1 + 3P_2 + 2P_3 = 2 + 5P_0 + 3P_1 + 3P_2 = 3 + 5P_0 + 3P_1 = 3 + 5P_0 = 5$$

If the above system was deterministic, then the equation system could easily be solved to find that $P_0 = 0.40$, $P_1 = 0.00$, $P_2 = 0.33$ and $P_3 = -1.00$. However, clearly these solutions are incorrect. If P_1 was equal to zero, then no-one should have said that they made their last long-distance trip on Day 1. Equally as obvious is the fact that it is impossible for those saying they last travelled on Day 3 to have a negative trip rate! Clearly, we are dealing with a stochastic system, and the sampling errors involved create situations which are not deterministically possible. One fact that does come out of this discussion, however, is that in the long run and with large samples, the most likely statement from respondents is that they last travelled on the Survey Day. This somewhat paradoxical result, for a rare event such as long-distance trips, is because the difference between consecutive values in Table 1 must be positive in order to avoid zero and negative trip rates for any cohort of respondents on any travel day.

Given these constraints, what then are the average trip rates for each daily cohort (i.e each group who state that they last travelled on a particular day). For the moment, assume that we know the real distribution of annual long-distance trip rates among the population. There is little published evidence about the shape of this distribution, but if it is similar in shape (although not scale) to that found from daily mobility surveys, then a triangular distribution similar to that shown at the top of Figure 1 would be a good approximation. Thus low trips rates are the most common, with a practical maximum value at a value of Max. Because of the triangular distribution the overall mean trip rate is equal to one-third of the maximum trip rate (Max).

On any given day, such as Day 0, those respondents with the highest trip rates are more likely to make a trip. Indeed, the probability of making a trip is directly proportional to the trip rate, as shown in the middle of Figure 1. Convolution of the top two distributions gives the distribution of trip rates for those travelling on Day 0, as shown at the foot of Figure 1. Because this distribution is symmetrical, the mean trip rate of this cohort is equal to half the maximum trip rate. Relating this to the mean population trip rate, it can be seen that the mean trip rate for the Day 0 cohort (P_0) is 150% of the population mean trip rate.

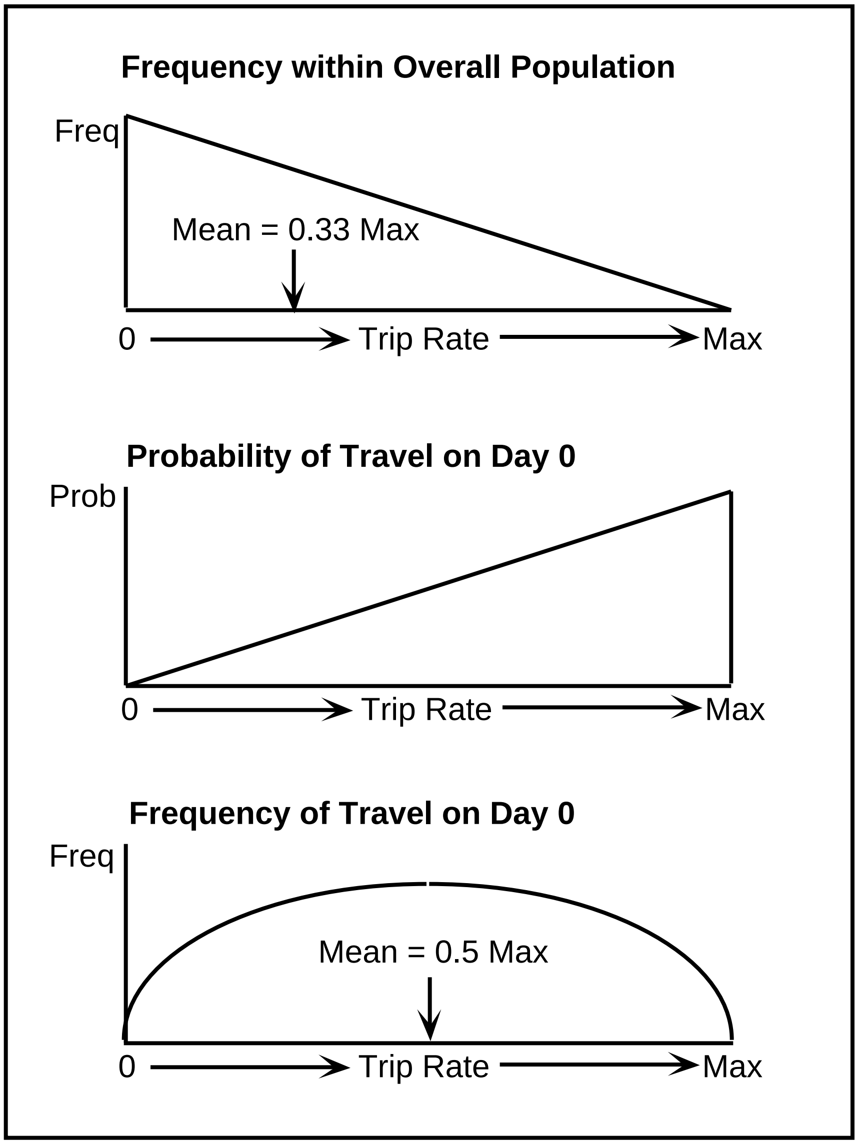

Figure 1 Estimation of Average Trip Rate for Day 0 Cohort

A similar process can be employed to determine the average trip rate of those in the Day 1 cohort (i.e. P_1). The difference, however, lies in the fact that those who last travelled on Day 1 are known not to have travelled on Day 0. Therefore, an additional step needs to be accounted for in the process, as shown in Figure 2.

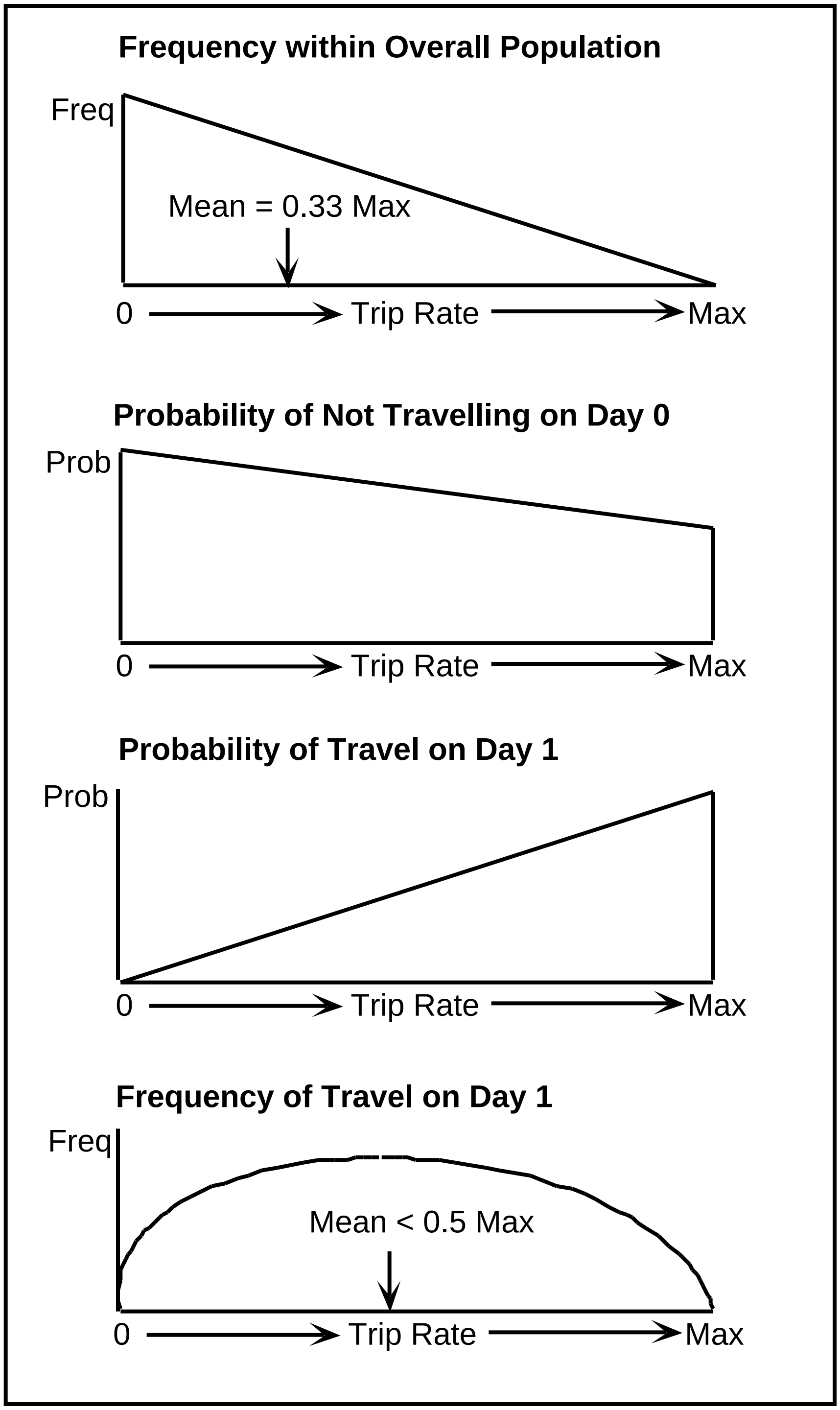

Figure 2 Estimation of Average Trip Rate for Day 1 Cohort

The second graph in Figure 2 shows the probability of someone not travelling on Day 0. This falls from a value of 1 for a zero trip rate (i.e. those who don't travel at all definitely don't travel on Day 0) down to a finite probability less than 1 for those at the maximum trip rate. Given an assumption of no seasonality, the probability distribution for travelling on Day 1 is the same as the probability distribution for travelling on Day 0, as was shown in Figure 1. The overall effect of convoluting the three distributions in Figure 2 is to obtain a negatively skewed bell-shaped distribution of trip rates for the Day 1 cohort, the mean value of which will be less than half the maximum trip rate. As a result, the mean trip rate for the Day 1 cohort (P_1) is somewhat less than 150% of the population mean trip rate.

The above process can be repeated to find the trip rates for all the daily cohorts, as a multiple of the mean trip rate for the population. These can then be used to find the expected number of respondents travelling on any day in the past, according to the equations shown in Table 2, and hence the average trip rate which will apply on each day. However, it is clear that the above situation involves a Catch-22 situation. In order to calculate the cohort trip rates, to calculate the trip rates on each day, an estimate of the population mean trip rate must first be obtained. However, this single estimate of the mean trip rate will give rise to many refined estimates of the mean trip rate (one for each day in the past). If necessary, these refined trip rates can then be combined and used to provide a new seed value for the calculation of the daily trip rates, until stable estimates are obtained.

The Survey-Testing Simulation Model

To explore and test the feasibility of the most-recent-trip survey method, a survey-testing simulation model has been developed. The underlying concept of this model is to start with some reasonable assumptions about long-distance trip-making behaviour, use this model to generate a population of long-distance trips, apply a specified survey method to the population data to obtain a sample of surveyed data, and then see whether an analysis process can be developed to reproduce the original description of long-distance trip-making behaviour.

The model, which is based on an Excel spreadsheet, starts with an assumed distribution of long-distance trip rates. In the study reported in this paper, a triangular distribution is used as shown in Figure 1. A population of 100 respondents is generated, with trip rates randomly selected from the assumed distribution. Given this trip rate, or probability of travel on any one day, a sequence of two years of travel days are generated for each respondent. On each day, the respondent either travels or doesn't travel based on the probability of travel on each day. For the moment, trips are assumed to last no more than one day; this assumption can be relaxed in later modelling studies. It is also assumed that no seasonality exists such that the average trip rate for each respondent remains constant over the two years. Once again, this restriction can be relaxed in later modelling to determine whether the survey method and analysis techniques can effectively detect seasonal variations.

Given the days on which each respondent travels, the time since the most-recent-trip can be calculated for each day in the two year period. The data on most-recent-trip intervals can then be collected for any day in the simulation, just as if a survey had been conducted on that day, and a distribution such as that shown in Table 1 can be generated. In practice, the first year of the simulation is used only for warm-up purposes and is not used for data collection.

Results Obtained from Conventional Recall Surveys

Before using the simulation to test the most-recent-trip survey method, it has been used to generate a set of results which might have been obtained from a more conventional survey technique where all trips are recorded/recalled over a finite time period. At this stage, no allowance has been made for the effects of memory lapses, telescoping or respondent burden overload, although these effects could also be specifically incorporated into the simulation if required. The simulation is used to compare the results which might have been obtained, under ideal conditions, with recall periods from one to twelve months. Four specific measures are used to describe these results; the mean trip rate, the variance of the estimated trip rate, the proportion of respondents making no trips and, more generally, the frequency distribution of the trip rate.

The mean and variance of the trip rate are shown, from 100 repetitions of the simulation model, in Figure 3 for recall periods from one to twelve months.

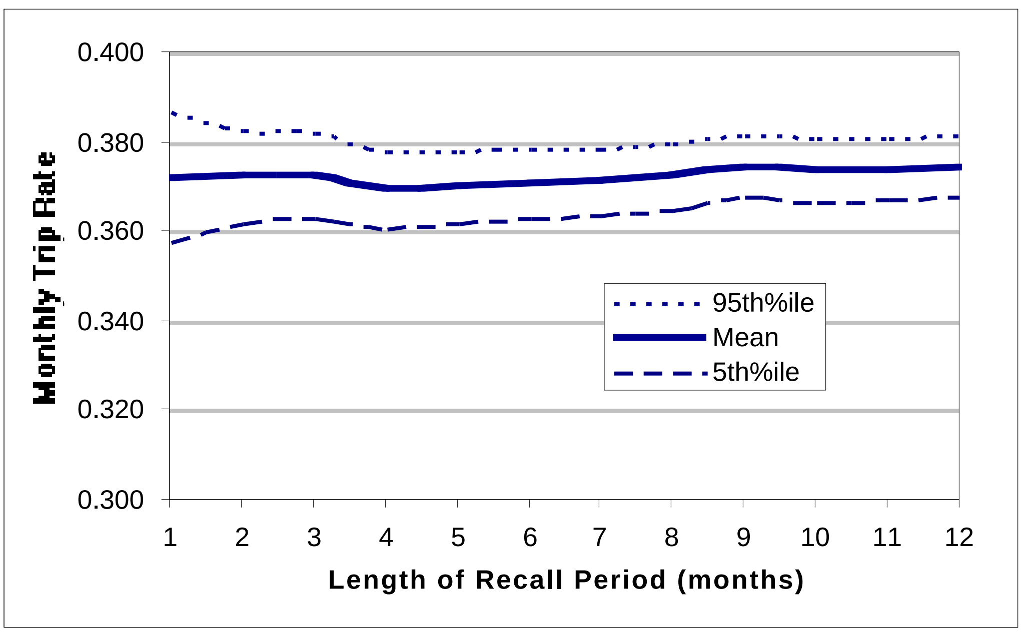

Figure 3 Mean and Variability of Trip Rate for Different Survey Lengths

It can be seen that the mean trip rate stays relatively constant at a value of about 0.375 trips per month, independent of the length of the survey period. Note, however, that this does not take any account of the recall problems described earlier, and only shows that, under these ideal conditions, the survey period length does not affect the mean trip rate.

The effect of the survey period length on the variance of the trip rate is also shown in Figure 3. It can be seen that the variability decreases as the survey period length increases, especially for the first three months, after which further decreases are minimal.

While the mean trip rate is unaffected by the length of the survey period, some parameters are highly affected. In particular, the proportion of respondents who report no trips is much higher for shorter survey periods than it is for longer survey periods, as shown in Figure 4. Over 70% of respondents report no trips in the last month, while only 20% report no trips in the last 12 months. The true proportion with zero trips, obtained from the distribution of trip rates used as input to the simulation model, is 12.5%. While it is obvious, in hindsight, that more respondents report no trips over the shorter survey periods, it should be remembered that these results are merely an artefact of the survey method. It is not correct to say, for example, that 20% of respondents make no long-distance trips (if the survey period had been 12 months). It is true that 20% made no trips in the previous 12 months, but we know that, in the long-term, only 12.5% make no long-distance trips. Therefore, care should be taken when interpreting zero trip rates from long-distance travel surveys.

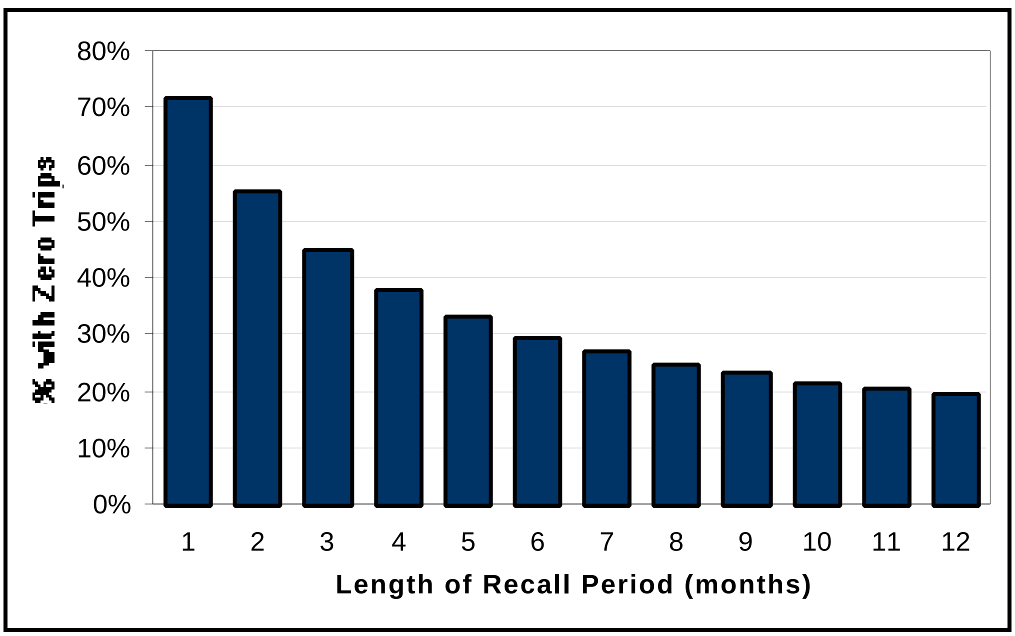

Figure 4 Proportion with Zero Trip Rates for Different Survey Lengths

Considering the results in Figures 3 and 4, it is clear that if the mean trip rate is correct and constant over all survey periods, but the proportion with zero trips varies with the survey period, then the rest of the distribution of trip rates must also vary with changes in the survey period. The distribution of trip rates for a twelve month survey is shown in Figure 5.

As noted earlier, the proportion with zero trips per year is higher in the twelve month survey than in the long-term distribution (20% cf 12.5%). This is balanced by an under-representation of most other trip rates as shown in Figure 5. However, by chance, there are also some respondents with higher trip rates than the maximum in the input distribution.

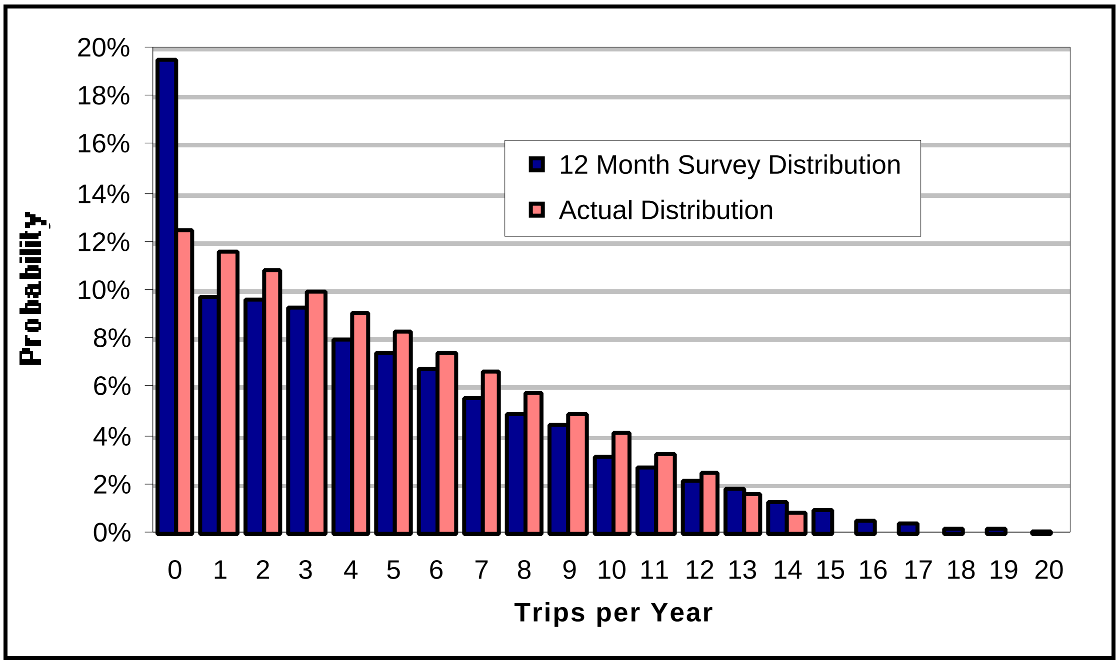

Figure 5 Distribution of Trip Rates for a 12 Month Survey Period

Results from the Most-Recent-Trip Method

The above section has shown that recall surveys covering all trips made in periods from 1 to 12 months can give a consistent value of the mean trip rate, but with an over-representation of zero trip rates for all such surveys. It has been assumed, however, that respondents are able to correctly report all the trips they make in those periods with no problems of response or recall. In an attempt to circumvent these response and recall problems, the most-recent-trip survey method has been proposed. This section of the paper will examine whether such a method can give unbiased estimates of the mean trip rate.

Typical Collected Data

The simulation program has been run for 2 years for a sample size of 100 respondents. In the following analysis, data has been selected for the 100 respondents for the last day of the two years. The simulation has then been repeated 100 times to obtain distributions of the various parameters. The probability distribution for the days since the last trip is shown in Figure 6.

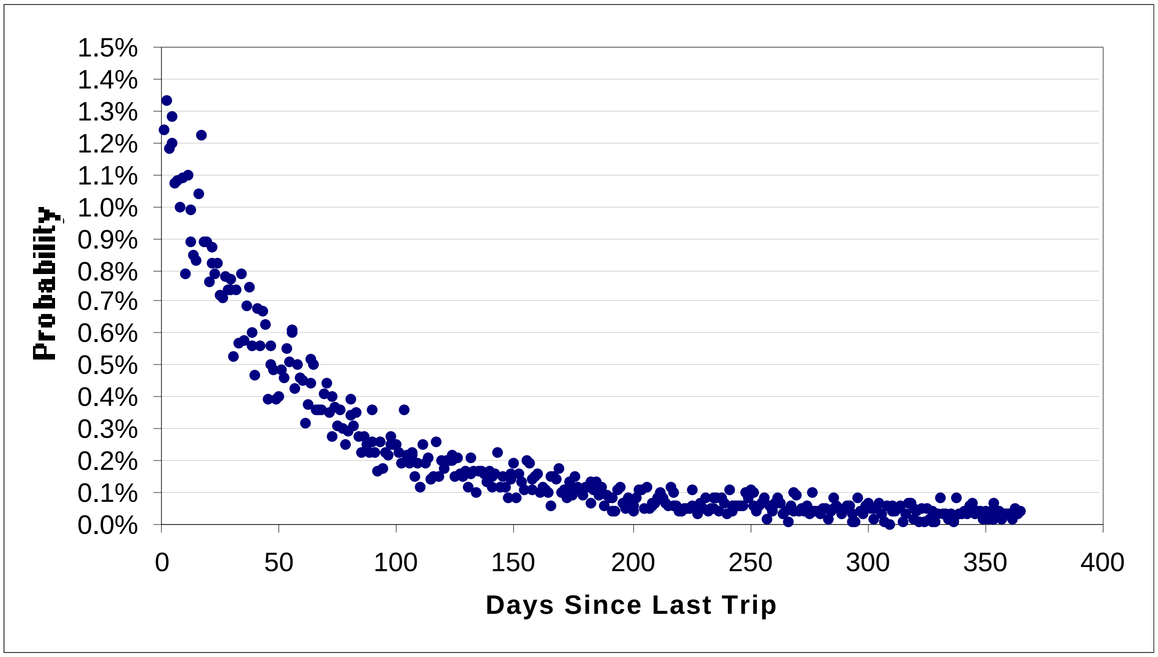

Figure 6 Probability Distribution of Days Since Last Trip

As suggested theoretically in a previous section, the most likely situation is for the last trip to have been made on the survey day, although even this situation is relatively unlikely with a probability of only about 1.3%. The variability of the probabilities of travel on any specific day before the survey day is shown in Figure 7, in terms of the coefficient of variation of the probability. It can be seen that the variability increases with increasing number of days since the last trip, rising from 100% at Day 0 to about 600% at Day 365.

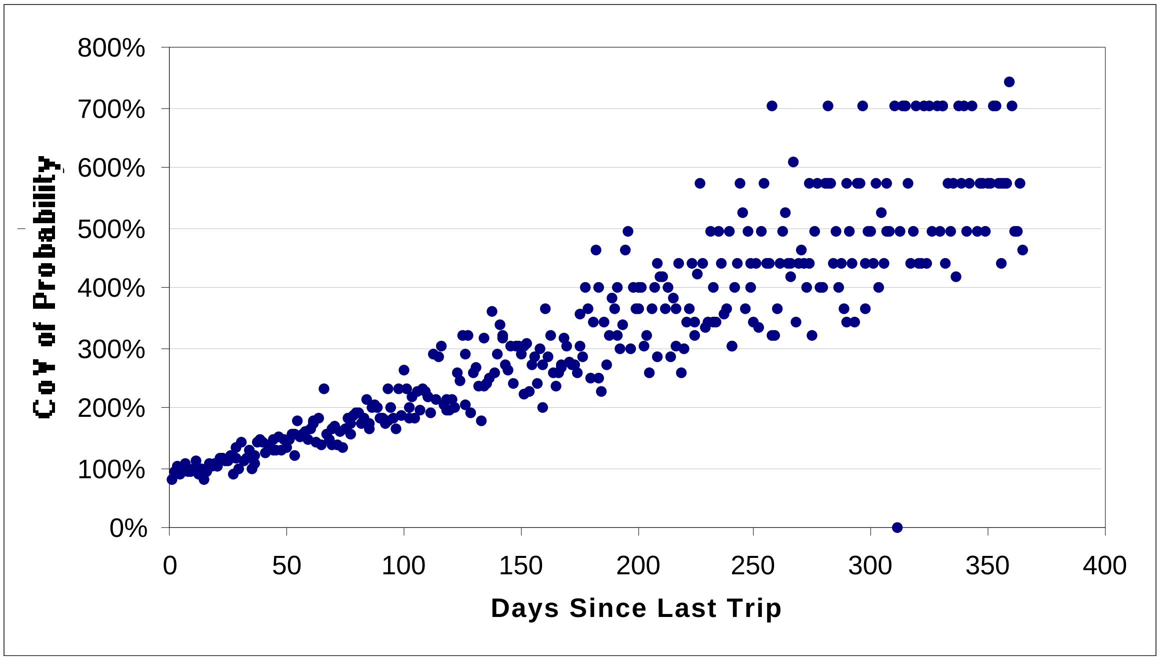

Figure 7 Coefficient of Variation of Probability of Days Since Last Trip

Cohort Trip Rates

Given the number of respondents reporting their last trip on each of the preceding days, it has been shown earlier that the trip rate on any of these preceding days can be obtained by adding those who last travelled on this target day to those who last travelled on later days, but may also have travelled on the target day. This number can be calculated by applying the trip rate for each cohort to the number in that cohort, as shown in Table 2. The task at this point is to calculate the daily cohort trip rates, in terms of mean trip multipliers, as explained in Figures 1 and 2. This has been done by extending the process outlined in Figure 2 for calculating the trip rate for the Day 1 cohort up to higher and higher number of days since the last trip. The results are shown in Figure 8, when the assumed trip rate distribution for the population is a discrete version of the triangular distribution shown in Figure 2. It can be seen that the mean trip rate multiplier starts at a value of 1.61 for the Day 0 cohort (i.e. the average trip rate for those who last travelled on the survey day is 1.61 times the trip rate of the overall population) and then falls gradually as the number of days since the last trip increases. This Day 0 cohort value is higher than the multiplier of 1.5 derived earlier because a discrete, rather than continuous, distribution of trip rates has been used. These trip rate multipliers, when multiplied by the population trip rate, give the values of P_i which are needed to calculate the number of respondents travelling on any day in the past.

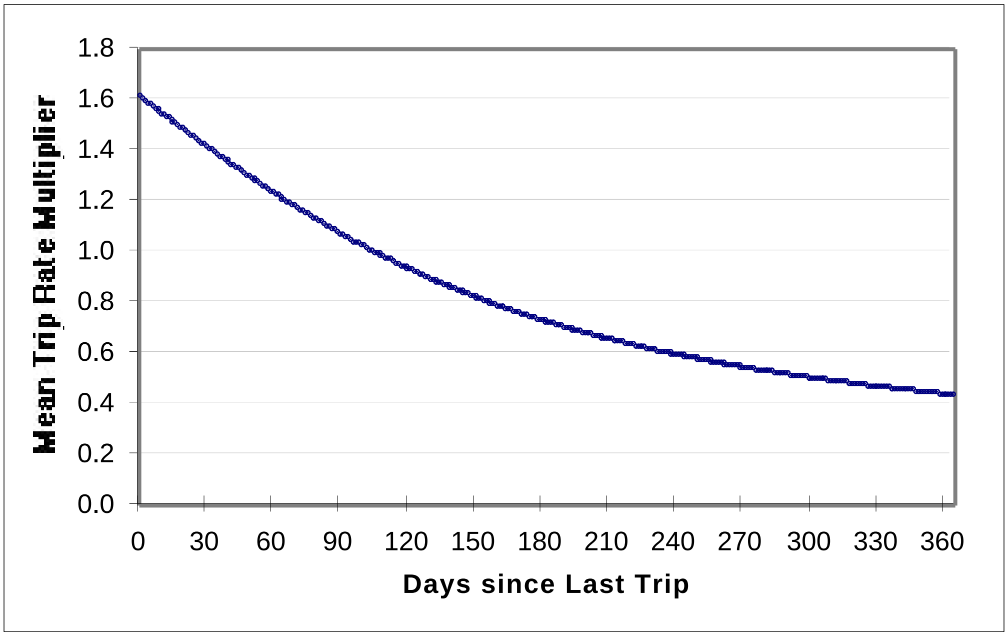

Figure 8 Mean Trip Rate Multiplier by Days Since Last Trip

Initial Estimate of the Mean Trip Rate

In order to use the trip rate multipliers calculated above, it is necessary to select an initial estimate of the population mean trip rate. As noted earlier in this paper, one can obtain such an estimate by using only the number of travellers on the survey day. However, with a relatively small sample size, such as the 100 in this simulation or the number that might be available in a real survey, it is quite feasible that, by chance, no respondents travelled on the survey day (about a third of all repetitions of the simulation had zero respondents travelling on the survey day). This would give an estimated population trip rate of zero, thus removing the option of using the trip rate multipliers to obtain the rest of the daily cohort trip rates. An alternative estimate of the average population trip rate has therefore been obtained by considering all respondents who travelled in the past week, and dividing this number by seven to give an approximation of the number travelling on the survey day. While this value would be a slight under-estimate of the number travelling on Day 0, it is a reasonable approximation which has the advantage of practically never being equal to zero.

Final Estimate of the Mean Trip Rate

Given the initial estimate of the average population trip rate, the trip rate multipliers in Figure 8 are used to calculate the daily cohort trip rates and hence the probability of any respondent travelling on a day earlier than the day on which they made their last trip. These travellers are then added to the number who actually made their last trip on any given day to give an estimate of the population trip rate from that day's data. The estimated trip rates for each day in the year before the survey day are shown in Figure 9. Each data point consists of the number who made their last trip on that day plus those who made their last trips on later days, but who may also have travelled on that day. It can be seen that the estimated trip rate is relatively constant across the entire year, but that the variability of the estimate decreases with an increase in the number of days since the last trip. This is confirmed in Figure 10, which shows the decrease in standard deviation of the estimated trip rate as the number of days since the last trip increases.

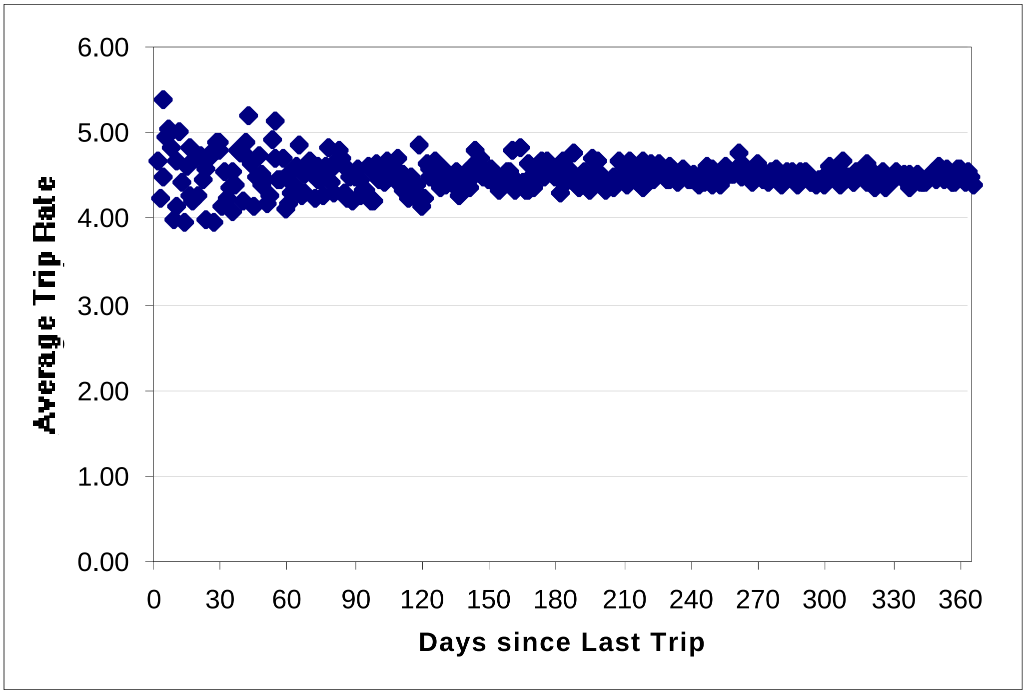

Figure 9 Mean Trip Rate by Days Since Last Trip

The results shown in Figures 9 and 10 are for individual days within the 12 month period before the survey day. For example, the results for day 90 are for that day only. An alternative method of calculating the trip rate, given that each day provides an estimate of the trip rate, is to calculate the average of the trip rates across all of the 90 days before the survey day.

The "running mean" results for 1 to 365 days before the survey day are shown in Figure 11. The mean trip rate results are shown as a ratio of the average of the trip rates used as input to the simulation. A value of 1.0 indicates that the most-recent-trip method has produced an estimate of the mean trip rate which is equal to that used as input to the simulation. It can be seen that the value is close to 1.0 across the entire year, although it is slightly higher for a low number of days since the survey day and slightly lower for a high number of days since the survey day. Figure 11 also shows the coefficient of variation of the running mean trip rate. It can be seen that this falls rapidly with increasing number of days included in the running mean, and then gradually rises as the number on days included increases further. It can be seen that an optimum period for calculating the running mean appears to be about 30 days. At this period, the ratio of the running mean to the actual input mean is equal to 1.0, while the coefficient of variation is close to the minimum value.

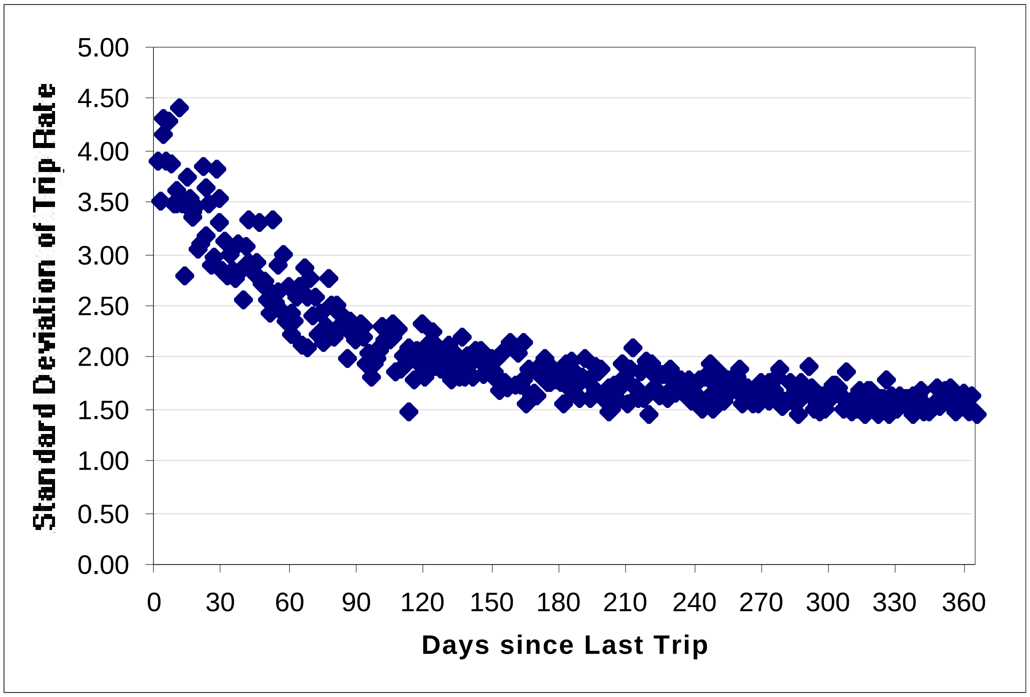

Figure 10 Standard Deviation of Trip Rate by Days Since Last Trip

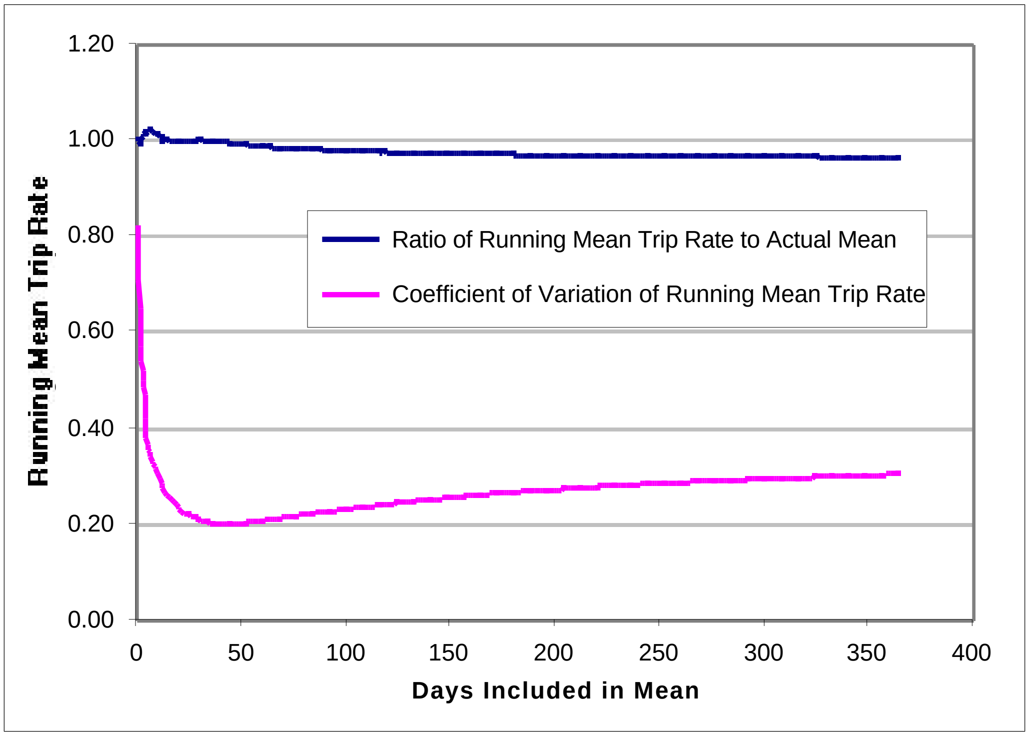

Figure 11 Running Mean and Coefficient of Variation of Trip Rate

Comparison of Most-Recent-Trip and Recall Method

The preceding section has shown that the most-recent-trip method is able to give good results in reproducing the underlying trip rate used as input to the simulation model. An obvious question is how the results from the most-recent-trip method compare with those obtained from the conventional recall survey method (assuming that there are no problems with obtaining either type of information from respondents). Since the best results from the most-recent-trip method appear to come from using a 30-day period, the results from the one month recall period survey will be used for comparison. The means and standard deviations of the trip rates obtained from 100 repetitions of the simulation are shown in Table 3. Firstly, it can be seen that the input trip rate for the 100 simulations is not constant but has a standard deviation of 0.358 (because of random variations in the generation process). Secondly, it can be seen that both survey methods give comparable measures of the trip rate, with the most-recent-trip method being 1% more than the input value while the 1 month recall method is 2.5% less than the input value. The standard deviation of these results is also similar, with the recall method having a slightly lower value (0.90) than the most-recent-trip method (1.01).

Table 3 Comparison of Most-Recent-Trip and Recall Method

	Trip Rate p.a.	S.D. of Trip Rate
Input Trip Rate	4.569	0.358
1 Month Recall	4.468	0.901
1 Month Most-Recent-Trip	4.573	1.009

The comparison between the two methods can also be presented graphically. Figure 12 shows a pair of figures comparing the input trip rates for the 100 repetitions of the simulation with the results obtained from the two methods. It can be seen that both methods give comparable results, as indicated by the size of the data point "clouds" and the values of the regression coefficients and the values of r-squared.

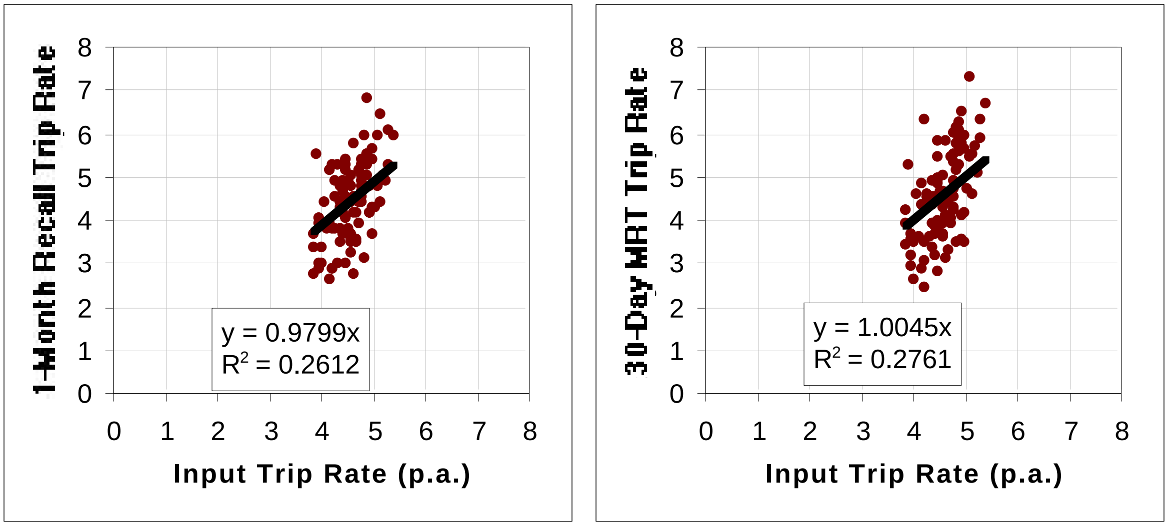

Figure 12 Comparison of Survey Method and Input Trip Rates

A direct comparison of the two survey methods is shown in Figure 13, where the estimated trip rate from each method is compared for each of the 100 repetitions of the simulation. It can be seen that there is reasonable correlation in paired results from the two survey methods.

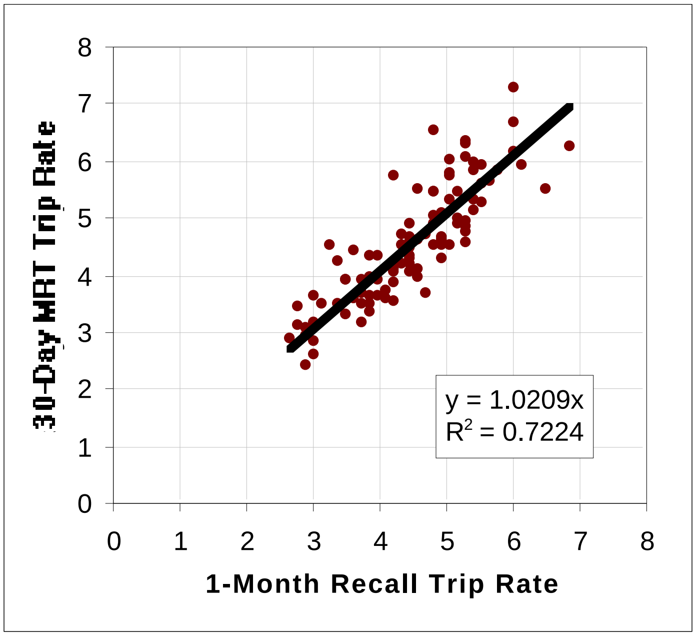

Figure 13 Comparison of Estimated Trip Rates from the two Survey Methods

Overall, therefore, given the results shown in Table 3 and Figures 12 and 13, it seems that the two methods give very comparable results for the 1 month surveys. The choice of method, therefore, should depend on other factors such as the ability of respondents to provide the required information accurately and the difficulty and cost of undertaking the survey.

Further Research

The above sections have shown that, assuming the required data can be obtained from respondents without error, the most-recent-trip survey method can give equivalent results to that obtained from a recall survey over a similar time period. This evaluation, however, provides a necessary but not sufficient testing of the new survey method. Before the most-recent-trip survey method can be fully accepted, the following issues need to be addressed:

- Can an analysis procedure be developed to obtain an unbiased frequency distribution of trip rates from the data on most-recent-trip days?
- Can a technique be developed to obtain trip weights to be applied to the detailed trip characteristics for those trips reported on the most-recent-trip days?
- Can the process be modified to allow for seasonal variations in trip rates?
- How sensitive are the results to the assumed distribution of trip rates?
- Can the simulation be modified to account for the different sources of response error inherent in the two different survey methods?
- How will the most-recent-trip survey method perform with data obtained from a real long-distance travel survey? This test will be performed using data from the 1995 American Travel Survey.

Conclusions

This paper has described a new survey method for long-distance travel surveys. In response to the difficulties involved in obtaining data on long-distance trips from recall surveys over extended periods, a method based on the timing of the most-recent-trip has been devised. The theoretical underpinning of the method has been described. The method has then been tested empirically using a survey-testing simulation model. It has been shown that the new method provides equivalent unbiased estimates of average trip rates to that obtained from a recall survey over a comparable time period. A number of additional tests of the most-recent-trip survey method have been identified for further research.

Providing positive results are obtained for the additional research tasks, and initial results indicate that they will be, it would appear that the most-recent-trip survey method will be preferable to the recall method, because of the lower potential for response error inherent in the most-recent-trip method.

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