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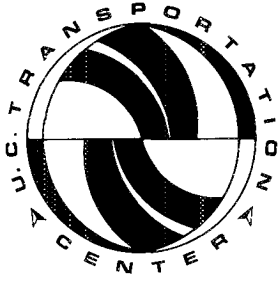
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**Designing and Implementing a  
Panel Study of Commuter Behavior:  
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Seyoung Kim

Working Paper  
UCTC No. 145

**The University of California  
Transportation Center**

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**Designing and Implementing a Panel Study of Commuter  
Behavior: Lessons for Future Research**

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*Working Paper  
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The University of California Transportation Center  
University of California at Berkeley

## **DESIGNING AND IMPLEMENTING A PANEL STUDY OF COMMUTER BEHAVIOR: LESSONS FOR FUTURE RESEARCH\***

We have been collaborating in a panel study of commuter behavior in southern California which has been running since winter 1990.<sup>1</sup> We were interested in setting up a panel so that we could study the dynamics of commuting behavior, especially in a situation where the environment was changing (with, for example, road construction and new Air Quality Management District (AQMD) regulations). The present paper focuses upon the design and implementation lessons we have learned from this project, leaving substantive and econometric conclusions for other papers (see, e.g., Brownstone and Chu, 1992; Kim, 1992; and Brownstone and Golob, 1992).

The survey instrument involves detailed reporting of the home-work-home trip chain, with summaries of general mobility and alternative choices for a recall period of two weeks. The survey also gathers information on attitudes concerning transportation, perceptions of incentives provided by employers to limit solo driving trips, past experiences with transit and ridesharing, and social, economic, and demographic questions.

Since this project was conceptualized as a pilot study, we have engaged in modifications more freely than we might otherwise. The details of the initial instrument design can be found in Golob and Golob (1989). While we did not carry out formal experimentation, we nonetheless believe that some things worked well while others created unforeseen problems. We discuss, first, construction of the sample, second, efforts to deal with attrition, third, modifications of the instrument, fourth, an attempt to obtain contextual measures, and, fifth, accounting and timing problems.

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## Construction of the Sample

The most obvious and statistically easiest to work with sampling approach, a probability sample of the population, was not feasible for resource reasons. First, the sample would capture substantial numbers of noncommuters. Second, a cold population sample would not, we believed, respond in sufficiently high numbers to a mailed instrument, and telephone interviewing would be expensive. An employer-based survey appeared to have the advantage of targeting commuters while increasing potential response.

Before finally settling on employer-based sampling, we considered and rejected on-board sampling of transit users and areal sampling. While the former would have been one of the few feasible ways to generate substantial numbers of transit users in the sample, experimentation with the idea by a research assistant persuaded us that the approach was not only labor-intensive but would yield a biased sample of transit users in southern California. It also left unresolved the problem of generating a comparable sample of solo drivers and ridesharers. With areal sampling we would survey commuters traveling to and from a specific destination area. This would hold constant local road and traffic conditions and, with appropriate choice of area, allow sampling of transit users and ridesharers. However, southern California urban cores experience substantial cross-traffic, and we could not arrive at any implementation scheme feasible with limited resources.

Employer-based sampling was made more attractive by what we thought would be the opportunity to use the population of firms generated by the AQMD in its implementation of the trip-reduction rules. At the time the AQMD was receiving responses from the largest firms with the intention of working down to smaller ones. One of the most difficult aspects of sampling

firms is establishing a population, and the AQMD was doing that. Moreover, we thought we would be able to obtain access to some of the firm-level data, so that we could establish population parameters for, e.g., mode choice and firm size. As it turned out, the AQMD was either unwilling or unable to help, so our sample lacked these nice characteristics. However, by that time we were committed to proceeding with employer-based sampling.

We used five techniques, sequentially, to locate respondents. The first, contacts through Commuter Computer, were initiated when we still anticipated being able to tie into AQMD data. The others include direct contact with a large firm, a sample of firms in the Irvine Business Complex, firms contacted through a Chamber of Commerce (the Industrial League of Orange County), and contacts through a local transportation coordinating service agency (Spectrumotion, in the Irvine Spectrum area).

Our initial approach was to contact firms through Commuter Transportation Services (Commuter Computer). Many southern California firms used Commuter Computer's services to comply with AQMD regulations requiring firms to determine the mode split of their employees; they also provide services to facilitate carpool formation. Transportation coordinators from the serviced firms attended a session at Commuter Computer. We obtained permission to make a presentation at those sessions in which we solicited the cooperation of the coordinators. We asked that they attach to the Commuter Computer survey distributed to their employees a short form from us introducing our project and asking employees whether they would be willing to be part of the panel study and, if yes, for their home address. We also asked mode of travel to work. The intent was then to send the questionnaires to the home addresses. We anticipated

over sampling transit users and ridesharers, depending upon the mode choices of the persons who agreed to participate.

Nonetheless, the approach through Commuter Computer was cumbersome; it yielded about 500 persons who agreed to take part in the study. Thus, we used other techniques to augment the sample. The second scheme entailed contacting employees from a sample of firms in the Irvine Business Complex (IBC) (located near John Wayne Airport). This was a stratified sample from a well-defined population, in contrast to the *ad hoc* nature of the other sampling. We were able, with the cooperation of the Irvine Transportation Authority, to piggy-back onto the "Irvine Business Complex Commuter Survey" conducted by Jacqueline Golob Associates in 1989. They generated a listing of the companies in the IBC (roughly 2400) from business license lists for the city of Irvine. After stratifying the companies by company type and size, they drew a sample of 152 firms. With the cooperation of these firms, about 11000 surveys were distributed to employees, of which 3060 were returned. Our project was able to add an item to the survey asking the respondents if they would be willing to be part of our panel study and, if so, to provide their home address. We added 862 respondents to our sample through this procedure.

The fifty percent response rate we experienced with the first wave gave us some concerns about the sample size dropping below a useable level, so we decided to generate a refreshment sample. For part of this we used a sample of convenience. One of the team members developed a contact at a large aerospace firm. Their employees were distributed a sign-up form similar to that used for employees at firms contacted through Commuter Computer, with the exception that the employer insisted that we contact them only through work, not obtaining home addresses. In addition, the Industrial League of Orange County provided a list of its member firms and



helped us contact them. For those that cooperated, we again used the mechanism of a sign-up form distributed through the workplace. The two processes yielded 1611 sample members (of which 442 came from the single large firm), referred to below as the "refreshment" sample. Their Wave 1 questionnaire was sent out at about the same time as the Wave 2 questionnaire for the original sample.

Our fifth means of finding panel members was not inspired by a need to compensate for attrition as much as by an apparent opportunity to generate better contextual data (a topic discussed further below). A presentation on the project to the Irvine Transportation Authority in 1991 led to an offer of help from the Spectrum Demand Management Association (Spectrumotion), which services the Irvine Spectrum area near the junction of the I-5 and I-405. We believed that they had reasonably current mode-split data for each firm in the Spectrum, as well as other data on, for example, firm size. Thus, like in the IBC, we could deal with a well-defined population, albeit much smaller. Spectrumotion maintained a list of transportation coordinators in each firm and offered to let us use their name in contacting these people. This time, however, we first sought responses to an employer survey (discussed below); we then returned to the firms requesting permission to distribute a sign-up form like the one already described above. Through this process, we added to the panel 561 individuals from eleven firms (out of the fifty firms initially contacted). It was only once we were well along in the employer survey process that we obtained access to the contextual records, at which time we discovered that they were neither readily useable, nor complete, nor as up-to-date as anticipated. We thus had to abandon our initial idea to sample directly from lists of employees sorted by mode choice. As it turned out, the transportation coordinators were uncomfortable with that procedure anyway,

preferring the sign-up sheet approach. Wave 1 for the "Spectrum" sample was sent out at the same time as Wave 6 for the original sample and Wave 5 for the refreshment sample.

One disadvantage of our strategies is that it is not obvious to what population, if any, we can generalize. One way to compensate is to estimate well-specified models, as parameter estimates should then be unbiased. However, models are not generally that well-specified in the real world, and that still leaves us unable to derive population marginals from the sample. The solution was to use census data for the five county southern California region, in which panel members reside, to develop weights for the sample, matching on demographic variables such as age, sex, income, and number of young children. (see appendix in Brownstone and Golob, 1992). In the case of the IBC subsample, the stratification characteristics used to select the original sample of firms could be used straightforwardly to develop weights for inferences about the IBC population. For both this subsample and the entire sample, results from model estimations run using weighted and unweighted data were statistically indistinguishable. More generally, it proved feasible to generate the weights, and insofar as we were able to test against known population characteristics, they performed well.

Lessons from sample construction:

1. Weights can be derived to make nonprobability samples useful.
2. Nonetheless, if we were doing this over again, we would sample from better-defined populations and do so more coherently.
3. Help from an agency that is a) respected by the firms and b) willing to exercise some persuasion upon them is very helpful in obtaining employer cooperation. In the current regulatory climate, avoiding identification with the AQMD is also useful.

4. The closer the agency is to the firms and the greater their ongoing relationship, the more likely the firms are to cooperate. Thus, we had more success with the contacts through the Industrial League of Orange County and Spectrumotion than we had had through Commuter Computer.

5. Even very helpful agencies may overstate what informational sources they have available.

6. Repeated and extensive follow up is needed to obtain cooperation from businesses. That cooperation is not always forthcoming. Most businesses had more pressing matters to deal with than another transportation study, and many had concerns about privacy issues for their employees.

7. The fact that the employer-based surveys need employer cooperation adds a hurdle in generating a sample.

#### **Increasing response; Reducing Attrition**

Any survey faces the problem of minimizing nonresponse, once a sample is selected. A panel study faces the additional problem of minimizing the attrition of former respondents in subsequent waves of the study. Our study is of course no exception. Table 1 summarizes our nonresponse and attrition history. In wave 1, we have a response rate of roughly 50% in each of the first two samples and 60% in Irvine Spectrum. The response rate in subsequent waves among persons who consistently stay in the panel is higher, going up to 60, 65 percent by wave 3 and over 75 percent by wave five. As the study progresses, panel members select themselves out, so that by later waves we are left with the most interested and loyal respondents.<sup>2</sup> Even with

the higher response rate in subsequent waves, however, the panel's size was diminishing alarmingly by wave 4.

At this point, we considered two alternatives. The first would be to refresh the sample again. While that could enlarge the sample, we would not have any history on the new panel members, reducing our ability to do dynamic modeling.<sup>3</sup> If, on the other hand, we could recapture some of the respondents who dropped out after earlier waves, we would have more history, even though we had lost some intermediate data. Moreover, it would be more efficient to add persons who had previously been willing to complete at least one questionnaire than to locate new participants starting from scratch. Thus, in July 1991, the new wave 5 questionnaire was sent to persons from the original sample who had responded to wave 1 and none or any subsequent questionnaire. Without this strategy, the wave 5 questionnaire would have been sent to only approximately 344 persons from the original sample. By including all previous persons who had ever responded, 1447 questionnaires were sent out. The same instrument was sent to 307 persons in the refreshment sample who had responded to wave 1 but to no subsequent wave. The 482 persons in the refreshment sample who HAD responded to wave 2 were sent wave 3 in March 1991 and wave 4 in July 1991 (whether or not they responded to wave 3).<sup>4</sup> We thus set up two recontacting experiments.<sup>5</sup> Table 2 clarifies the timing of the waves in the different samples. Table 3 reports the number of panel members who responded to each combination of waves, separating the original from the refreshment sample.

Recontacting appeared to work very well. Even including bad addresses and the like as nonresponse, 32 percent of panel members recontacted 18 months after they had last responded completed a questionnaire. The corresponding rate for those recontacted one year after the last response was about 37 or 38 percent. Those in the original sample contacted nine months later, after a single missed wave, had a response rate of 52 percent; the corresponding rate for the refreshment sample is 43 percent. Another 27 refreshment sample members came back in wave 5 after responding in waves 1 and 2 but not responding in waves 3 or 4; they almost balance the 34 who skipped wave 3, came back in 4, and then dropped out for wave 5. Figure 1 provides a schematic representation of the flow of persons in and out of the panel.

We conclude that it is unnecessarily costly to drop from the panel respondents who miss a single wave. Substantial numbers of them can be contacted in subsequent waves and will respond.

We pursued a number of other strategies, beyond the artfully crafted cover letter, to try to keep nonresponse to a minimum. These include a prize sweepstakes, reports on the project, and, in the latest wave, follow-up reminders. The project reports have been intermittent. On several occasions we prepared a brief summary of the findings to date, in lay terms, and sent it to respondents still in the panel. Informal feedback, including comments on the questionnaire, made us reluctant to do much of this, out of concern about increasing the perception of solo drivers that the study might have something to do with attempts to increase carpooling and transit

use. Thus, summaries of analyses showing, for example, the impact of incentives upon ridesharing behavior could, we feared, increase that perception.

We attempted to increase response by offering a chance at a prize to persons who returned their questionnaire. Figure 2 is a copy of the prize form used in the most recent mailing. Based on folk wisdom, notably from various Swedish studies, we believed that a sweepstakes provided a greater incentive than a certain gift with the same expected value. Due to university restrictions, we could not directly offer incentives to the respondents, whether in sweepstakes form or not. Thus we solicited the help of one of the cooperating agencies -- Spectrumotion in the example illustrated here, the Industrial League of Orange County in preceding waves. While we have no hard data on the effectiveness of the prize, informal feedback from some respondents and transportation coordinators suggests that it is useful. The latest prize form provides some information on the winners from the previous round to increase panel members' perceptions that the prize is "real." We also provided information on winners in the newsletters.<sup>6</sup>

One of the more effective means of increasing response was inadvertent. One of the participating large firms does a substantial amount of classified business. They therefore did not want us obtaining home addresses in the sign-up form, offering instead to let the questionnaires be distributed at the work site. We understand that on the days the questionnaire arrived, our panel members would sit at work and complete them. This situation was great for our research. It may not be unrelated that the firm has since laid off many employees as its business has declined. With most firms, we had to take pains to point out that the survey would not infringe upon work.

Finally, we are currently attempting to increase responses by follow-up mailings in the latest wave. The latest questionnaire was sent out in early August 1992. Three weeks later a reminder letter with a new copy of the questionnaire was sent to those from whom a response had not been received. Six weeks after that a second reminder letter with another questionnaire was sent. The subsequent questionnaires were numbered in different ink, so that we could see from which mailing a returned questionnaire came. Table 4 tabulates the responses received from the first and second mailings, by date. The third mailing has just gone out as of this writing. Of the 1045 responses received by mid-October, just under twenty percent were on the questionnaires sent with the first reminder letter. Of course, some of those respondents might have eventually responded anyway with the first survey, but for reasons not important to us picked up the second copy instead. We would guess that is unlikely, especially for the 175 responses received shortly after the reminder went out. On the other hand, some of the 33 persons who sent back the original instrument after September 8 might not have done so without the reminder letter. Further analysis of patterns of response, especially divided by behavior in prior waves, must wait until we have the data in machine readable form.

### **Modifications of the Instrument**

In the course of the study, we have made a number of modifications to the survey instrument. We won't discuss the ones that concern clarification of wording or similar fairly minor issues. The greatest changes occurred with wave 5. One set of changes accommodated the recontacting strategy, discussed above, and also addressed tracking issues which arose with all respondents. One Some of these changes also permit better analysis of the effect of family

work patterns. A second set of changes reflects the recognition that many respondents sometimes rideshare, so a drive alone/rideshare dichotomy is inadequate.

Once we adopted the recontacting strategy, we had to modify "change" questions in the instrument to accommodate persons who might have last responded as much as 18 months before the current questionnaire. This was particularly an issue with regard to changing residence or employer. We thus added to the cover of the instrument questions asking respondents whether or not they had changed either since the date of the initial instrument and, if so, what was their current address or current employer. We considered trying to pick up intermediate moves for recontacted panel members, but gave up that idea as hopelessly cumbersome. These questions were also useful for respondents who had stayed in the panel. From their prior responses, we knew whether or not they had moved or changed employer, but not necessarily their new address (beyond zip code) or new employer.

It had become clear from analysis of earlier waves that the instrument was sometimes not filled out by the same household member from one wave to the next, contrary to instructions. In an attempt both to minimize this and, where it couldn't be changed, to explicitly track it, we also added on the front page a question asking "Are you the same person who filled out our previous surveys?" and, if not, whether it was filled out by another household member. An additional change we made to ease tracking of respondents from one wave to the next was to introduce a demographic grid, shown in Figure 3, which replaced a series of old questions. Birthdate is requested both for calculation of age and for identifying whether the same person responded in subsequent waves. The grid format is also intended to solve the problem of household count. In our previous questionnaires, we asked how many people were in the



household; whatever the question said, there was clearly ambiguity as to whether people counted themselves or not. To facilitate generation of estimates of missing data, it now seems that we should have retained that old question and used it coupled with the grid. Most importantly, the grid format allows us to obtain more information about family members other than the respondent. The work zip code item was added for a substantive reason; the second author is using that information in an analysis of "wasteful" commuting (Kim, 1992).

One concern we had in introducing the grid was the number of people who would be willing to answer. Out of 1062 wave 5 respondents, 91.4% provided their birth year on the grid and 96.3% provided their sex. Of the 994 who said they worked outside the home, 83.7% provided their work zipcode. Missing data on zip code went up dramatically for other household members; 593 respondents claimed that a second person in the household worked outside the home; two-thirds of them (62.5%) provided that person's zip code at work. In contrast, over 97% were willing to provide a birth year for a second household member (more than were willing to supply their own birth year). We had substantially less nonresponse to our prior age question, which asked respondents to check off the box corresponding to the correct age range. In waves 1 through 4 we had only 0.3% to 1.4% nonresponse to this. A similar problem arises for sex (with nonresponse of 1.3% to 0.3% to a direct question) and for workplace zipcode (with nonresponse rates near 5% in the first four waves). These results raise questions about the balance between the information provided by the grid and response rates; it might be better to keep some direct items in addition to the full grid. We suspect that the missing data on zipcode of other household members reflects lack of information to a substantial degree.

The other major modifications to the instrument stemmed from relaxing the drive alone/ride share dichotomization. The first versions of the instrument branched respondents from their mode choice on their most recent work trip to one section of the instrument, geared, respectively, to ride sharers, solo drivers, and transit users. It became clear that a substantial portion of the ride sharers sometimes drive alone. That is, "sometimes rideshare" is a necessary category in addition to "drive alone" and "ride share." The earlier instruments did not provide enough information to quantify "some." Moreover, the branching structure gathered additional information only for the mode used in the most recent trip to work, rather than for other modes used, even if they were the more usual means of traveling.

While we continue to ask a number of questions about the most recent trip to work, including mode, we set up a branching structure to ask about any mode used by the respondent in the preceding two weeks. (That time period is used in a number of our retrospective items.) At the end of the first section of the instrument, respondents were asked at the end of the first section whether they had traveled to work ANY day in the past two weeks by, respectively, solo driving, ride sharing, or transit. The first mode for which they answered yes branched them to a detailed section. The solo driving section is first; it ends by asking whether the respondent ever ride shared or used transit in the past two weeks. A "yes" answer branches to the appropriate section. Similarly, the ridesharing section branches those who ever used transit in the past two weeks to that section.<sup>7</sup> Within each section, respondents are asked the number of days they used that mode within the two week period.

Table 5 reports some of the mode split results from wave 5. The top half shows the mode split for most recent trip to work, in percentage terms, separately for respondents who carpooled at least once in the preceding two weeks, those who carpooled 5 or more days in that time, and those who drove solo 5 or more days in the preceding two weeks. Observing only the most recent work trip can be misleading. Some 13 percent of the usual carpoolers nonetheless drove alone on the most recent work trip. Close to a third (30.4%) of persons who carpooled one or more times drove solo on the most recent trip. The bottom half of the table shows the distribution of days carpooled among those who did so at least one day; although the modal response is effectively fulltime, the majority of ridesharers do so less frequently. Even solo drivers can be misclassified, although in lower proportions; 4.3% of persons who usually solo drive shared a ride on the most recent trip. Over one-fifth of the people who drove alone at least one day in the preceding two weeks had also rideshared at least one day. For cross-sectional studies these misclassifications are not devastating, but they add a nasty source of error to attempts to understand dynamic changes in mode choice. An apparent switch between modes may, for a substantial fraction of the sample, represent normal, and stable, fluctuation.

### **Contextual Measures**

Some of the key exogenous variables in explaining commuter mode behavior are contextual. The most important of these are at the level of the firm. They include firm size and, most importantly, incentives or disincentives offered by the firm for one or another choice of commuting mode. Brownstone and Golob (1992) found that some employer incentives could significantly impact the choice of mode. That paper was based on items in the instrument which

ask employees which in a list of incentives their employer offers, as well as whether or not HOV lanes exist along their commute route. However, we realized that employees may not correctly perceive the incentives offered by employers and, moreover, that their perceptions may be correlated with mode choice. Brownstone and Golob found a way to correct for this in their analysis, but nonetheless it became clear that independent information from the employer would be useful, even recognizing the employers' motivations to overstate their programs.

An attempt to go back to the IBC to interview employers of sample members floundered on the difficulty of obtaining addresses and access personnel for the firms after a few years. Quite a few firms had moved. The clear lesson from this is the need to obtain the contextual information promptly.

The opportunity to interview in the Irvine Spectrum arose at the time we were thinking about employer surveys. Partly by design and partly for administrative reasons, we began with the employer survey there. Forty firms responded out of fifty who were sent the survey. (This response required multiple follow-ups to the ETCs from both ourselves and especially the very helpful staff of Spectrumotion.) The employer survey was addressed to the ETCs. It asked about the firm's sector, number of employees at the site, parking charges, and, for a list of specific incentives, whether or not they are offered and, if yes, since when. Eleven of the forty firms gave us permission to contact their employees. As noted above, 561 employees agreed to be in the panel. The instrument they and all other wave 5 and later respondents received contained the same list of incentives as in the employer survey (a list expanded from earlier waves), asking them "Does your employer encourage carpooling, vanpooling, bus, train or trolley use by providing any of the following: (Check ALL that you know about)."

Employee and employer perceptions do diverge in this sample. For almost every incentive, more employees claim the incentive is not offered when the employer says that it is than the converse case -- i.e., employees saying it is offered when the employer says it is not. (The exceptions are items that none of the employers claim to offer, subsidizing carpool costs, and offering paid time off or additional pay for non-solo drivers.) The incentives for which the perception is most widespread among employees that there are *more* incentives than the employers claim to offer include employer provision of transit information or on-site sale or subsidy of transit passes, employer subsidy of vanpool or carpool costs, employer provision of time off or additional pay or workday transportation for non-solo drivers. The items for which employers receive the least credit (i.e. less than half of the employees perceive them in firms where employers claim to offer them), include provision of on-site facilities; subsidies for transit passes or carpool costs; provisions of snacks; offering a compressed work week, flexitime, or telecommuting; guaranteeing backup transportation home; and offering rides during the workday. We have not yet determined how estimations differ as a function of using employer versus employee perceptions, but there is enough variation to suggest the usefulness of collecting both types of information.

### **Accounting and Timing Problems**

Several accounting and timing issues came up in the course of running the panel. Initially, the time between waves was set at three months. After the first four waves, we realized that dynamic changes were happening more slowly than we expected. At the same time, we were concerned about possible respondent fatigue and very concerned about nonhypothetical researcher fatigue; the three month schedule left little time for preparation between waves. In addition, a

longer interval let us stretch the study over a longer time at the same cost. We thus shifted to a six month schedule, with the slow pace of change in sample behavior being the most important of the considerations. In the process, we also wanted to shift the original, refreshment, and Spectrum samples to the same timing with the same instrument; that finally happened with wave 7 original, 6 refreshment, 2 Spectrum, all of which went out in late July early August 1992. A disadvantage of stretching the time between waves is increasing the chances of losing panel members, for example, those who move. That concern argues against lengthening the interval beyond six months.

Keeping track both of waves and of respondents is nontrivial, as in any panel study. One small choice we made early on has proven quite useful; with one exception<sup>8</sup>, each wave's questionnaire has been printed on different color paper. Some of the problems with tracking respondents were discussed above in the section on instrument modification. One tactic that has helped substantially in analyses has been the assignment to each respondent of an "idflow" variable. This appeared in Table 3, above. The variable has as many places as there are completed waves, and takes on the value 0 in any place for which the respondent did not complete a questionnaire, and 1 (for the original sample) or 2 (for the refreshment sample) for waves when questionnaires were completed. The variable can then be used for sorting respondents into those who answered any desired combination of waves.

Finally, even a fairly small sample, such as this, produces a huge amount of data after a few repetitions, with obvious resulting problems for file management and analysis.

## Conclusions

Use of a panel design for this study highlighted some important features of commuter behavior that we might otherwise not have seen. The most significant of these was the mixed pattern of solo driving and ridesharing behavior exhibited by part of the sample. Proper assessment of this required fairly major modifications to the instrument. One disadvantage of the panel design is that change in these behaviors is slow. Thus, in order for the panel to be useful, it needs to be low maintenance and low cost so that it can be kept going over multiple waves. In turn, as the number of waves increases, the size and complexity of the data file multiplies, making full exploitation of the panel structure in analysis difficult.

Overall, employer-based sampling was an acceptable approach, although it entailed more difficulties than anticipated. Cooperation is not easy to obtain and, unless randomly distributed, its lack may introduce biases. Employer-based sampling works best, both administratively and statistically, where some population of firms is definable, as in our IBC and Spectrum samples.

Attrition is always a problem with panels. We found that recontacting dropouts from previous waves produces a high enough return to justify using the procedure, especially since reinstated dropouts are more valuable to the panel than new refreshment individuals, given the availability of some history on them. Minimally, people should be kept in the panel when they miss a single wave, given our rate of success in obtaining later responses from them.

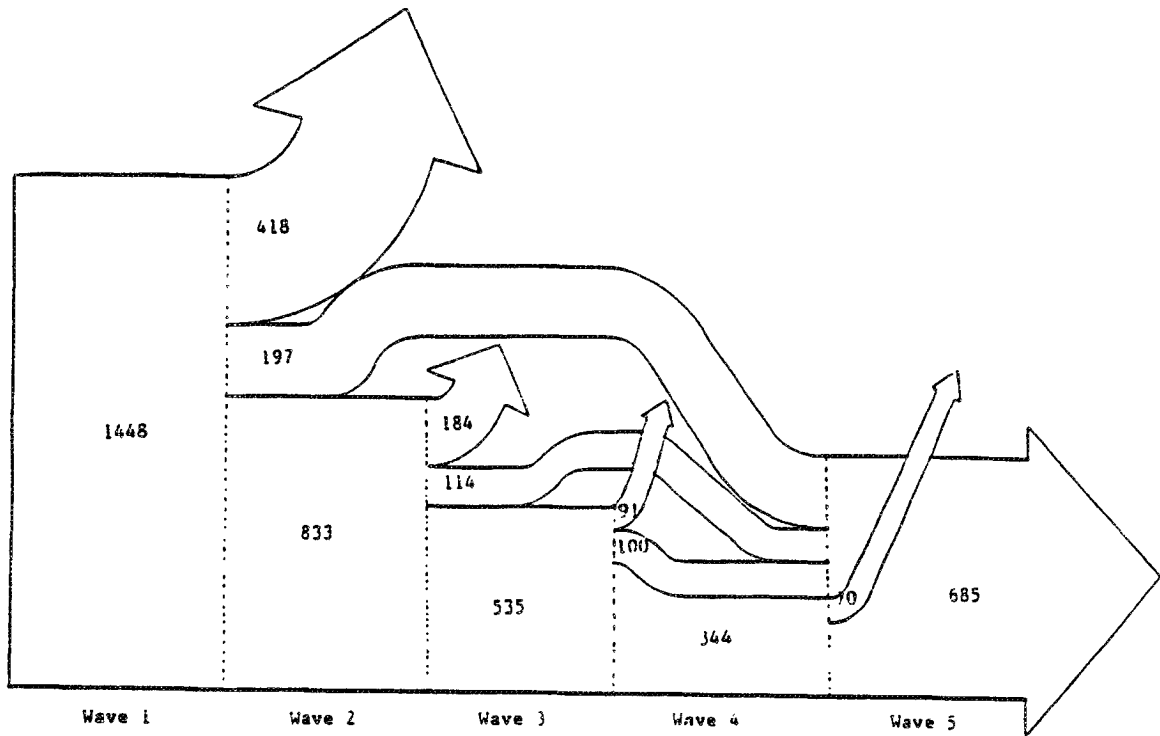
Whether the money and time expense of implementing and maintaining the panel is justified or not is a question that can only be answered by looking at the analyses based upon it.

## NOTES

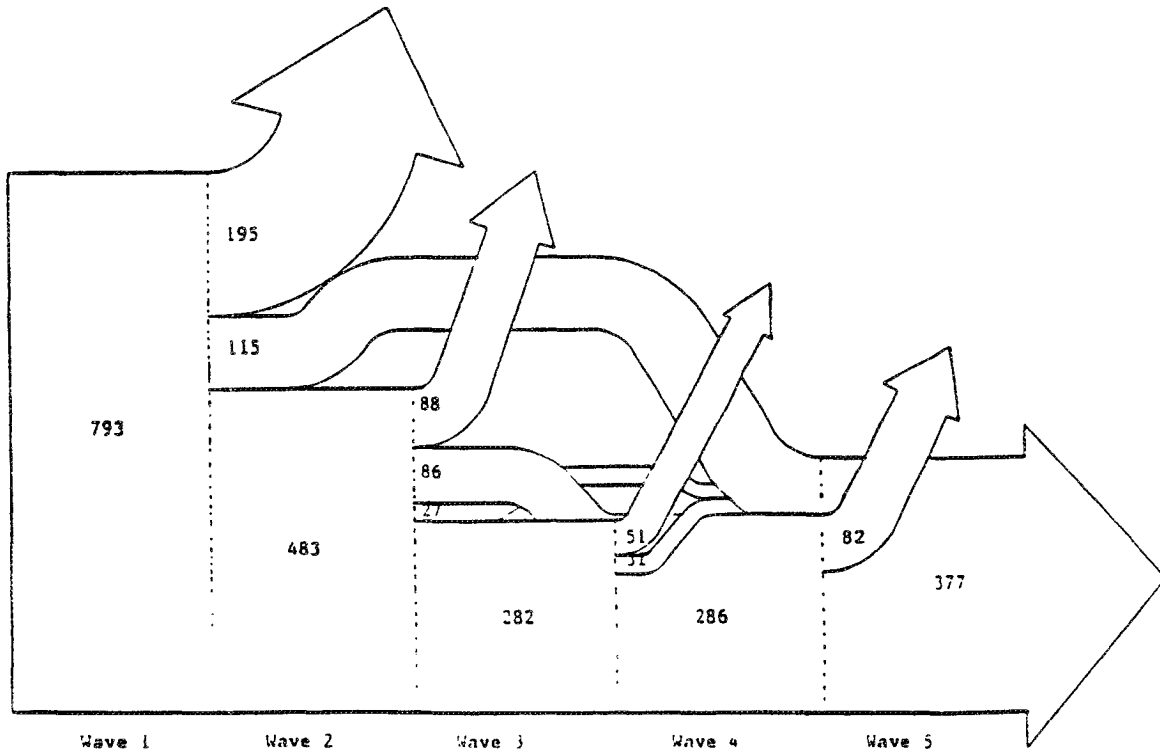
1. The co-principal investigators on this project are David Brownstone and Thomas F. Golob, both of UC Irvine. They and the first author have been involved in the project since its inception in 1988. The survey instrument was initially developed by Jacqueline M. Golob and Thomas F. Golob. Doug Levine, formerly of UC Irvine, was extensively involved in the implementation of the panel during its first three years. The second author joined the project in 1990.
2. While the benefits of this for reducing attrition are obvious, it does raise questions about the representativeness of panel survivors. That issue is addressed in Brownstone and Chu, 1992.
3. Adding the Spectrum workers to the sample did just this; as explained above, there were additional motivations for this sample expansion.
4. We would not have deliberately designed quite so complex a structure. It turned out that the mailing of wave 4 refreshment questionnaires to all who had responded to wave 2 (but not those who responded to wave 1 and missed wave 2) was accidental.
5. We are continuing to recontact. Wave 6 was sent to those who responded to wave 5; wave 7 in the original sample went to all these people again.
6. The prize form requests the respondent's telephone number, so that they can be contacted if they win a prize. We do not request telephone number in the instrument itself out of a concern that it might diminish response. In previous phases, the prize forms were not collated with the questionnaire responses. Once out of the envelope, they are virtually impossible to match up (given variations in how people report their names and overlaps in names). In the phase currently in the field, they are being coded so that we could do an experiment with telephone interviewing.
7. The branching would be easier in a CATI format telephone interview. Figuring out how to make it noncumbersome in a mailback context took substantial thought.
8. Both the wave 5 and wave 6 questionnaires were printed on pink paper; they differed only in a date on the front page and the wording of one brief question. Since the date did appear on the front, it is easy to distinguish the versions.



Figure 1



Original Sample



Refreshment Sample

Figure 2

## REGISTER TO WIN!

*Because we are grateful for your help we are giving you  
the chance to win one of two*

### \$100 PRIZES IN CASH!

Donated by



*Your chances to win are great, but you must return this form  
and your completed survey to us as soon as possible*

**Don't delay, return your survey today!**

Name: _____
Address: _____
_____
_____
Daytime Phone Number: _____
<b>Return this form with your completed survey in the envelope provided. No stamp is needed.</b>

*Congratulations to the two lucky prize winners from the last survey. One works in the Irvine Spectrum and commute up from San Diego County; the other works for an electronics firm and lives in Fountain Valley. Please return your survey and this form for your chance to be a winner, too.*

Figure 3

The following questions help us understand how changes in household characteristics affect your commuting choices.  
 (Please fill in completely, even if there have been no changes in your household.)

2. Please provide the following information about the people in your household.

	Birthdate Month/Day/Year	Sex		Driving License?		Works Outside home?		Work Zip Code (Write "DK" if you don't know)
		Male	Female	No	Yes	No	Yes	
SELF-->	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____
	____/____/____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	--> _____

Table 1

Surveys Mailed & Returned by Wave & Subsample

Wave	Total		Original Sample	Response Rate ##	Refreshment Sample	Response Rate ##	Spectrum Sample		Response Rate
	Mailed out	Returned					Mailed out	Returned	
Wave 1	4564	2241	2953		1611		561	561	
			1448	49.0%	793	49.2%		339	60%
Wave 2	2236	2236	* 1447		* 789			561	
			833	57.6%	483	61.2%			
Wave 3	1308	1308	826		482				
			535	64.8%	282	58.5%			
Wave 4	1015	1015	533		# 482				
			344	64.5%	286	70.9%			
Wave 5	2236	2236	# 1447		# 789				
			685	79.7%	377	76.0%			
Wave 6	798	798	682		116				
**	475	475	423	77.7%	52	0%			

\* Reduction from "returned" to "mailed out" on following wave primarily reflects respondents who explicitly asked to be dropped from the panel

# Questionnaires were also sent to people who had not responded in the preceding wave but had returned a questionnaire in an earlier wave. For wave 4 refreshment sample, only sent to those who remained in through wave 2. For wave 5, sent to anyone who returned wave 1 questionnaire.

\*\* in process

## Response rate excluding recontacts of earlier dropouts

Table 2

## Surveys Mailed by Wave and Date

	Original Sample		Refreshment Sample			Spectrum Sample		
	Month/ Year	Sub Total		Month/ Year	Sub Total		Month/ Year	Sub Total
wave1	2,3/90	2953						
wave2	6,7,8/90	1447						
			wave1r	8/90	1611			
wave3	9,10,11/90	826						
			wave2r	11/90	789			
wave4	12/90, 1,2/91	533						
			wave3r	3/91	482			
			wave4r	7/91	482			
wave5,5r	7/91	1754						
wave6,6r	2/92	798	wave5r	2/92	482	wave1s	2/92	561
wave7,7r	7/92	776	wave6r	7/92	431	wave2s	7/92	561

Table 3

Number of respondents in combinations of waves 1 through 5

	Respondents in Wave:	idflow	Frequency
Original Sample	1 only	10000	418
	1 and 5	10001	197
	1 and 2	11000	184
	1,2 and 5	11001	114
	1,2 and 3	11100	91
	1,2,3 and 5	11101	100
	1,2,3 and 4	11110	70
	1,2,3,4 and 5	11111	274
	Refreshment Sample	1 only	20000
1 and 5		20002	115
1 and 2		22000	88
1,2 and 5		22002	27
1,2 and 4		22020	34
1,2,4 and 5		22022	52
1,2 and 3		22200	51
1,2,3 and 5		22202	31
1,2,3 and 4		22220	48
1,2,3,4 and 5		22222	152
Total			2241

Table 4

Success of follow-up reminders;  
 Number of questionnaires received by week, Fall 1992  
 (wave 6r, 7, 7r and 2s)

Months	date	1st Mail Out	1st Questionnaires Received	2nd Mail Out	2nd Questionnaires Received	3rd Mail Out	Total Questionnaires Received
August	6	1768					
	10 - 14		479				
	17 - 21		252				
	24 - 28		51				
	28			936			
September	31 - 4		43				
	8 - 11		18		129		
	14 - 18		9		46		
	21 - 25		3		10		
	28 - 2		0		0		
October	5 - 9		3		2		
	Total		858		187		1045
	12					673	

Table 5

Mode for last trip to work	As % of those who ride shared 1 or more times in preceding 2 weeks	As % of those who ride shared 5 or more times in preceding 2 weeks	As % of those who drove alone 5 or more times in preceding 2 weeks
Ride share	67.5	85	4.3
Transit	0.3	0.5	0
Solo drive	30.4	13.3	95.1
Other	1.7	1.1	0.6
Total number of observations	289	180	717

Number of days ride shared in preceding 2 weeks	As % of those who ride shared 1 or more times in preceding 2 weeks
1-2	21.4
3-4	13.9
5-6	13.6
7-8	17.5
9-10	32.1
11+	1.4
Total number of observations	289



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