Impact of Nonresponse Bias on Forecasts of Average Passenger Occupancy

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The magnitude of the nonresponse bias on the prospective elements of employee transportation surveys is estimated. The prospective components of the surveys are designed to forecast percent change in average passenger occupancy (APO) levels in response to transportation control measures suggested for use by the federal Clean Air Act Amendments of 1990. The stated commuting behavior of employees at the Matsushita Electric Corporation of America headquarters facility in northern New Jersey is reported. The application of stated preference techniques to the estimation of mode shift is described, the survey techniques used to generate the choice data are identified, the way in which forecasts of APO levels achievable from various transportation control measures such as parking management and rideshare adjustments are made is described, and an estimate of the magnitude and source of the nonresponse bias is made.

There are many situations in which transportation professionals and planners will need to estimate the mode shift potential embodied in transportation demand management policies. The most recent case derives from the passage of the federal Clean Air Act Amendments of 1990 (CAAA). The act implicitly calls for the use of a causal model that can forecast commuter behavior. The model should quantify the degree of mode shift given the introduction of one or more transportation control measures (TCMs) while holding other factors constant. This paper presents a model of the causal process based on random utility theory. Random utility theory applied to the market for discrete commuting choices is used to build the site-specific empirical models. Two approaches to discrete choice analysis exist: revealed preference and stated preference (*1*). Where little or no information on historical patterns of mode choice in relation to the new TCMs exist, the stated preference approach is used.

This paper focuses attention on the survey methods used to estimate compliance with the "demonstrate convincingly" clause found in Section 108(f) of the CAAA. Employee transportation surveys (ETSs) used to meet the CAAA compliance plan requirements will experience varying degrees of nonresponse depending on the care given to their administration. In addition, transportation surveys are known to be sensitive to nonresponse bias. On the basis of their work in Germany, Börg and Meyburg found that nonrespondents to a transportation survey related to mobility issues are more likely to have lower mobility requirements (*2*). This suggests that ETSs designed, for example, to assess the demand for ridesharing will suffer nonresponse bias from employees who feel captive to their current commuting mode or from those who feel antagonistic toward ridesharing. Thus, both the estimate of the current or base level average passenger occupancy (APO) levels and the forecast change in APO can be biased as a function of nonresponse bias. This study focuses on the second consequence of nonresponse to ETSs—that is, the biases caused in the forecasting of APO change.

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THEORETICAL MODEL

The choice of commuting mode by an individual employee is modeled as an indirect utility maximization problem (*3*). The individual utility maximizing model is combined with the concept of the representative utility functions to provide the basis for linking individual behavior with aggregate mode choice probabilities. The mathematical process of describing this behavior takes place in two steps. First, the individual utility function is defined; a generalized version of this function is displayed in Equation 1.

$$U_i = \alpha_0 + \alpha_1 W_1 + \ldots + \alpha_n W_n + \varepsilon_i \quad (1)$$

$$U_i = V_i + \varepsilon_i \quad (2)$$

where

- U = random utility function,
- V = systematic component of the utility function,
- W = attributes of each commuting mode (i) for all employees,
- α = the set of utility coefficients, and
- ε = individual specific deviations between the representative components of utility and Individual q's evaluation of Mode i.

Utility functions of this form are linear in their parameters. The functions can be combined into a relatively simple model describing the probability that Individual q will choose Mode i over another (j) offered by the market. When the error term is assumed to have a Weibull distribution, the logit model for determining the mode selection probabilities is produced. The parameter estimates (α) are derived through a maximum likelihood procedure; this procedure produces scaled coefficients. Whereas several potential solutions are available to quantify the scaling factor, they were beyond the scope of this study (*4*). When only two commuting alternatives are presented to the employee, the choice is modeled as a binomial logit process. The mathematical model is shown in Equation 3.

$$P_i = \frac{e^{V_i}}{e^{V_i} + e^{V_j}} \quad (3)$$

P_i represents the probability that individuals with utility functions V_i and V_j will choose Alternative i. Individual deviations from the systematic utility function no longer appear in the logit equation. The individual deviations from the systematic utility generation process are modeled as being identically and independently distributed error terms with a mean of zero and constant variance.

The data used to specify the arguments in Equation 3 are derived from stated choice (SC) experiments. SC, a subset of stated preference analysis, is a relatively new approach to discrete choice analysis (*5*). It is most commonly used in situations where a data base consisting of actual choices among transportation alternatives does not exist (*6*). Essentially, SC presents a decision maker with the choice among alternative modes. Each mode must be carefully described and embedded in a hypothetical choice scenario known as a choice task. The independent variables or attributes are designed to realistically create the transportation choice situation facing the subject. Each subject responding to an SC experiment will examine a number of choice situations. Each choice situation is created by selecting reasonable values for the mode-specific attributes. The attributes are usually designed such that the matrix of attribute values forms an orthogonal space (*7*). Focus groups, simulations, and pilot tests are built into the research design to ensure that the design attributes, the values selected for each attribute, and the structure of the instrument depicting the hypothetical choice situation are understandable and reasonable and that the logit model is capable of recovering estimators of the underlying parameters.

DATA GENERATION PROCESS

Data used to generate SC models are taken from sample surveys. In the case of studies involving compliance plans for the CAAA, a sample of employees working at a given site is taken from the employer. These individuals will receive the ETS instrument.

This paper focuses on research performed at the headquarters facility of the Matsushita Electric Corporation of America (MECA). The firm also has a site in southern California; thus, its management is familiar with the need to plan for the upcoming CAAA compliance process. The choice of the research site was essentially determined by the presence of a cooperative management team. Management did not limit the number of times that researchers could contact employees, nor did management place any barriers on the contents of the survey instrument. On the other hand, management permitted more than three dozen employees to take time during work hours to engage in focus group meetings preliminary to preparing the survey instrument. It was during these sessions that the attributes and their value ranges were established. Comfortable meeting rooms with refreshments were provided for the focus groups. Before the execution of the SC instruments, management permitted the researchers to execute 16 pilot tests in group sessions permitting immediate feedback to the researchers. The research design is described elsewhere (*8*).

Three survey instruments were created for the study; each was designed for a mail-back self-completion form of administration. The first instrument to be distributed to employees was a traditional ETS. It contained questions relating to the current commute to work, attitudes and intentions toward ridesharing, and some socioeconomic information. Table 1 indicates that the questionnaire was sent to 1,948 employees in spring 1991. By the end of that spring, 750 employees had responded with completed and usable instruments. The rate of nonresponse to the ETS was 61.5 percent. Since there was only one response enhancement technique used to increase the number of responses (a thank-you letter), the response rate was well within the range of experience for other ETSs administered in the region. However, a nonresponse rate of over 60 percent leaves much room for bias.

The two other survey instruments were used to measure the magnitude of the nonresponse bias. Each of the second wave survey instruments contained a 16-choice-set SC experiment. The first SC experiment was given to a random sample of 300 employees selected from the respondents to the ETS survey. Given the results of Börg and Meyburg, the mode choice probabilities derived from this sample were hypothesized to be biased toward higher rates of mode shift to ridesharing than will actually occur. To estimate the magnitude of the nonresponse bias, a second SC experiment was given to a random sample of nonrespondents to the original ETS survey. The responses to both instruments are needed to measure the magnitude of nonresponse bias. Table 1 summarizes the response frequencies for the three surveys.

TABLE 1 Response Frequencies for Stated Choice Experiments Held During Fall 1991 and Spring 1992

Category of Employee	Spring 1991 ETS Survey	Fall 1991 SC Experiment	Spring 1992 SC Experiment
Total number of surveys administered	1,948	300	400*
Surveys returned	750	160	145
Surveys completed with compensatory behavior	na	141	107
Surveys completed with non-compensatory behavior	na	19	38
Only SOV chosen	na	14	26
Only Rideshare chosen	na	5	12

na: not applicable.

* The additional 100 instruments over the number administered in the fall were prepared and administered to randomly selected employees from the non respondent sample. However, these instruments did not contain the name of the employee. The hypothesis was that anonymity would encourage an increase in the response rate. Eleven responses were returned from this process and combined with the other instruments returned during the remainder of the spring survey. As a practical matter, the hypothesis was rejected and all remaining instruments were administered with the name of the employee clearly identified on the front page.

ESTIMATION OF NONRESPONSE BIAS IN THE MODE CHOICE MODEL

The logit estimators derived from the first SC survey are hypothesized to be subject to nonresponse bias. The approach used to estimate the magnitude of the bias is based on the analysis of covariance. The analysis pools the responses from the two SC surveys, uses a dummy variable to distinguish between the two samples, and estimates a logit model. The coefficients estimated from the pooled samples can be compared with those derived from the non-ETS respondent subset. The analytical model is shown in Equation 4.

$$V_i = \alpha_0 + \alpha_1 W_{i1} + \ldots + \alpha_m W_{im} + \gamma_0 d + \gamma_1 dW_{i1} + \ldots + \gamma_n dW_{in} + \varepsilon_i \quad (4)$$

where d represents the dummy variable assigned the value of 1 for the nonrespondent sample, and 0 otherwise. The remaining terms are the same as defined for Equation 2.

All of the independent variables are included in the pooled data set; their contribution to the utility of an alternative is represented through the set of parameters $\{\alpha_m\}$. Data obtained from employees responding to the original fall 1991 survey, the sample that may be susceptible to nonresponse bias, are given the opportunity to exhibit a significant difference from the spring 1992 sample through the set of parameters $\{\gamma_0, \gamma_n\}$. When elements of this set of parameters are found to be statistically significant, nonresponse bias is presumed to be present within the original sample.

Microeconomic theory provides the logical support for the inclusion of attributes to a utility function that represent surrogates of price and income terms. However, where other factors representing individual taste determinants of demand or choice are absent, random parameter estimates can be inadvertently produced. The common solution to this problem is the use of a set of socioeconomic characteristics that stabilize the values of the estimators of the mode-specific attributes (*4*).

The set of independent variables is partitioned into the two classes: socioeconomic characteristics and mode-specific attributes (*9*). Socioeconomic variables such as gender, age, employment status, availability of cars, possession of driver's licenses, marriage and family status, and occupation of spouse are used to specify systematic increments to the utility function. This set is augmented with a set of attitudinal and intentional dimensions underlying the employees' choice of commuting mode (*10*). Attitudes toward ridesharing in general are elicited through a dichotomous seven-step variable representing the pleasantness of ridesharing. Similarly, the intention to rideshare, believed by social psychologists to be the precursor to the act of ridesharing, is a dichotomous variable indicating the likelihood of ridesharing in the fall following the study.

Attributes of the commuting modes form a second class of independent variables. Among these variables are policy variables such as parking charges, the existence of preferential parking, flexible work hours, and rideshare incentives including payment mechanisms and guaranteed ride home programs. In specifying incentive programs it was found essential to incorporate realistic constraints on the program reflecting comfort, convenience, security, frequency of service, and so forth, as appropriate. This study has used the time cost of travel as the specified constraint for each ridesharing alternative or attribute.

ESTIMATES OF THE LOGIT PARAMETERS

The model consisting of Equations 3 and 4 was estimated through the use of the binomial logit module contained within the ALOGIT program (*11*). Table 2 gives the logit equation and several goodness of fit statistics. The variables whose coefficients were found to be statistically significant at the 0.05 level are reported along with the utility equation in which they were placed. The pooled component of the model was estimated through the use of 3,664 observations. The observations derived from employees who were nonrespondents to the original ETS numbered 1,646. The spring 1992 sample produced the coefficient estimators found in the nonrespondent section of Table 2.

Goodness of fit of the overall model is judged on the basis of the rho bar squared statistic. The value of 0.24 is well within the range 0.2 to 0.3 considered to be satisfactory (*12*). Seventeen variables fit to the pooled sample's observations produce coefficients that are statistically significant at the 0.05 level. Seven variables taken from the spring 1992 sample were also found to be significantly different from zero. However, because of small changes in the survey instrument between the fall 1991 and spring 1992 administrations, several of these variables cannot be used as clear evidence of nonresponse bias. For example, the week of the year that the survey was administered is a one-time-only seasonal indictor. The spring 1992 values do not represent the identical underlying phenomenon contained within the fall 1991 indicator. Similarly, two variants of a guaranteed ride home program and a business day trip vehicle were added to the attribute space for the spring 1992 survey. However, the remaining socioeconomic variables indicate that nonresponse bias is present.

ANALYSIS OF THE LOGIT MODEL

Table 2 gives the final commuting choice model for MECA employees. The first section of the table indicates the attributes or variables obtained from the pooled sets of samples; the second section indicates the coefficient estimators for the variables obtained from the spring 1992 sample. For the pooled sample, 11 socioeconomic and attitudinal variables were used in the final model. In interpreting the coefficients, the mode-specific utility function in which the variables were placed must be known. The utility generated in the SOV equation is shown to increase for clerical workers as they grow older. However, utility for the rideshare option shifts upward when the employee's spouse is a homemaker. Finally, the season during which the employee completes the survey also affects the choice. As the week of the survey enters the fall and moves toward winter, there is a slight but statistically significant increase in the utility for the SOV option. This process unwinds during the spring.

The attitudinal and intentional indicators for the pooled samples are shown to be important and significant determi-

TABLE 2 Binomial Logit Equation for Commuting Choice Decisions Made by Employees of MECA, Fall 1991 and Spring 1992

Pooled Samples

Attribute	Mode* Specific Utility Equation	Logit Coefficients
Socioeconomic Attributes		
Age of Clerical Employees	SOV	0.016 (5.0)
Household size of female Employees	RS	0.051 (1.5)
Week of survey for fall survey	SOV	0.039 (8.4)
Employee's spouse is a homemaker	RS	0.29 (2.5)
Intention to Rideshare		
Slightly likely	SOV	-0.48 (2.5)
Quite unlikely	SOV	0.56 (4.7)
Extremely unlikely	SOV	0.86 (8.3)
Attitude toward Ridesharing		
Extremely unpleasant	RS	-0.27 (1.6)
Quite unpleasant	RS	-0.45 (3.1)
Slightly unpleasant	RS	-0.22 (1.9)
Quite Pleasant	RS	0.37 (2.8)
Commuting Attributes		
Parking Charge	SOV	-0.81 (13.1)
Parking Charge Squared	SOV	0.047 (5.7)
Extra time lost	RS	-0.041 (12.1)
Rideshare subsidy	RS	0.29 (4.4)

Non Respondents to Employee Transportation Survey

Attribute	Mode* Specific Utility Equation	Logit Coefficients
Rideshare subside squared	RS	-0.018 (1.7)
Guaranteed Ride Home (unconstrained response)	RS	1.32 (12.0)
Socioeconomic Attributes		
Household Size of female employees	RS	-0.33 (6.1)
Cars per household	SOV	0.29 (3.4)
Week of survey for spring survey	SOV	-0.025 (5.1)
Commuting Attributes		
Parking Charge	SOV	0.058 (1.4)
Guaranteed Ride Home 25 minute wait time	RS	0.99 (1.8)
Guaranteed Ride Home 55 minute wait time	RS	0.39 (2.4)
Business day trip vehicle	RS	0.49 (2.7)
Initial Likelihood		-2539
Final Likelihood		-1922
Rho bar squared		0.24
Number of Observations (pooled samples)		3664
ETS respondents (fall 1991 sample)		2018
ETS non respondents (spring 1992 sample)		1646

*SOV: single occupant vehicle commuting option, RS: rideshare commuting option.

nants of mode choice. As the attitude regarding ridesharing increases from quite unpleasant to quite pleasant, the utility exhibited in choice behavior toward the ridesharing option increases significantly. Similarly, when the elicited intention toward ridesharing at a future time becomes increasingly unlikely, the incremental utility exhibited for the SOV option increases strongly.

The TCMs evaluated by the employees included flexible starting time, preferential parking, parking charges, guaranteed ride home, business day trip vehicle, and the rideshare adjustment. Preferential parking was not found to produce significant coefficients for any of the logit models; the flexible starting time under certain specifications of the model would generate significant positive coefficients linked to the single occupant vehicle alternative. However, in the final model the coefficients, though positive, were not significant at the 0.05 level and therefore were omitted from the table.

The imposition of a parking charge significantly reduces the utility found in the drive-alone option. The quadratic form of parking change is reported in the final equation. For the range of parking charges ($0.00 to $7.00 per day), the coefficients show a diminishing marginal disutility for each dollar increase in parking fees.

The rideshare equation for the pooled samples was specified with three attributes: time lost picking up the rideshare partner, the value of the rideshare subsidy expressed in a quadratic form, and the existence of an unconstrained guaranteed ride home program. Time lost while picking up the rideshare partner produces a strong disutility for the rideshare option across all employees. The rideshare adjustment, expressed in the form of a coupon representing cash for a daily lunch at the cafeteria, produces a positive but diminishing rideshare utility. Over the range of values studied in the experiments ($0.00 to $3.50), the results indicate a diminishing marginal utility with increasing value of the rideshare coupon.

The nonrespondent sample (spring 1992 sample) produced three socioeconomic variables that were significantly different from the pooled sample. The household size of female employees is a significant factor influencing the use of the SOV option by nonrespondents to the ETS survey. Similarly, as the number of cars per household increases, their role in increasing the probability that the respondent uses the SOV increases.

The role of the nonresponse phenomenon in affecting the performance of the TCM is shown in the section of Table 2 labeled Commuting Attributes. None of the TCM that were found significant in the pooled model had significantly different coefficients in the nonrespondent sample's model.

The guaranteed ride home program was presented to employees in several forms. In the fall 1991 survey, the program was described as free of charge to employees needing it; no effort was made to specify its performance attributes. Early analysis of the results indicated that the respondents viewed this type of program as a relatively even substitute for their personal automobile. Since this is not the case in practice, it is hypothesized that the coefficient was affected with unconstrained response bias. Adjustments were made in the spring 1992 survey. Performance constraints were placed on the guaranteed ride home program; these characteristics specified the time, type of vehicle used, payment for vehicle services, and reimbursement procedures. The program was specified as one in which the employee had to obtain permission from a supervisor to trigger the reimbursement provisions of the program, then the employee had to call an approved cab company and wait a specified number of minutes for the vehicle to arrive at the site. The time parameters were set at 25- and 55-min waits.

The logit model shows that the unconstrained guaranteed ride home coefficient has a strongly positive impact on the utility associated with the rideshare option. The guaranteed ride home programs constrained by time, comfort, and convenience characteristics have smaller marginal utility coefficients than the unconstrained version of the program. When the appropriate elements of the variance covariance matrix of the estimators are incorporated in the difference of the estimators analysis, each coefficient is statistically different from the other at the 0.05 level of significance.

The final TCM studied in the analysis is the business day trip vehicle. The business day trip vehicle is constrained to be one for which approval of a supervisor is required and a 10- to 15-min wait time would be needed to bring the car to a convenient location. The presence of the business day vehicle program produces a strong and statistically significant increase in utility derived by the rideshare option.

DERIVATION OF THE APO LEVEL FOR THE MAJOR EMPLOYER

The performance indicator used to measure compliance with the CAAA's employer trip reduction provisions is the APO level. Essentially, a site's APO is its employment level divided by the number of vehicles used to bring employees to the site. Compliance with the 1996 goals of the act will require the site to meet the region's target APO. For the average site, the goal will be approximately 25 percent greater than the baseline or current APO.

The baseline APO for the MECA site is taken from the ETS. The forecast change in APO caused by the new TCM is taken from the logit equation. The probability that a class of individuals will choose a commuting alternative depends on their membership in one or the other sample, their socioeconomic characteristics, and the values of the TCM attributes incorporated in the model. This can be seen in several ways. First, the estimated parameters of the logit model show that there are slight differences in the marginal utilities of the mode-specific attributes. Second, the socioeconomic characteristics of the members of the samples are significantly different. Third, the weighting factors through which the total employment APO value is calculated differ across the samples.

In the case of a single sample, such as that obtained in fall 1991, a one to one weighting practice can be used to calculate the site's APO. Equation 5 shows the probability that employees will choose to drive alone to work conditioned on their socioeconomic characteristics and the specific values placed on each of the design attributes.

$$\overline{P}_s = \sum_{q=1}^{Q} P_{s,q}/Q \tag{5}$$

where Q is the number of employees in a sample and P is the probability of driving alone to work. When $s = 1$, individual probabilities are aggregated within the sample of employees who were respondents to the original ETS (the fall survey); when $s = 2$, individual probabilities are aggregated within the sample of employees who were nonrespondents to the original ETS (the spring survey); and when $s = T$, the individual probabilities are aggregated within the pooled samples of employees.

Equation 5 forms the basis for the calculation of the firm's APO under the assumption that the sample of employees on which it is based is representative of the total employment at the site. However, Equation 5 does not account for the nonresponse bias present within the membership of the 1991 sample. Assuming that the spring 1992 sample accurately represents the employees who were nonrespondents to the original ETS survey, an estimate of the employment site's mode choice probability can be derived. This is done by combining the mode choice probabilities derived directly from the logit model with the sampling rates for both samples. Equation 6 shows that the probability of choosing a given mode is the weighted average aggregate mode-specific probability for the two samples.

$$\overline{P}_T = \frac{f_1}{f_T} \cdot \overline{P}_{s=1} + \frac{f_2}{f_T} \cdot \overline{P}_{s=2} \tag{6}$$

where f represents the number of individuals in each sample.

The site-specific probability of driving alone to work must be linked to the policy indicator reflected in the Clean Air Act. To do this, APO is operationally defined in terms of available data to be the number of employees reporting to work at a given site divided by the number of vehicles that bring them to the site. Equation 7 shows the procedure for calculating the value for APO.

$$\text{APO}_s = \frac{n_s}{(n_s \cdot \overline{P}_s) + [n_s \cdot (1 - \overline{P}_s)]/K} \tag{7}$$

where n_s is the size of the sampling frame for Sample s and K is the average number of persons in multioccupant vehicles currently using the firm's parking facility.

Official baseline AVO values have not yet been certified for New Jersey. Therefore, for the purposes of this study, the baseline AVO is set at the value of APO_s appropriate to samples. For the AVO calculation, all mode-specific attributes other than the extra time for ridesharing were set at zero. The rideshare time was set at 15 min. The APO value derived from these attribute values and estimated from the fall stated choice data base is 1.08 employees per vehicle. The ETS administered in spring 1991, describing actual behavior, produces an estimate of the baseline APO of 1.07. This suggests that the scaling factor is probably close to 1.0 and will not significantly bias the conclusions taken from the study. The baseline APO reported by the members of the spring 1992 survey (the nonrespondents to the original ETS) is 1.15. Whereas we do not explore the consequences of the nonrespondent sample's APO versus the respondent sample APO, there appears to be nonrespondent bias in the estimation of the baseline value.

The forecast values of APO are derived by assigning specific values to the design variables: parking charge and rideshare adjustment. For example, when a $1.00 parking fee is placed in Equation 4, a new value for APO_s is generated. The percentage change between the forecast value and the baseline value is taken as an estimate of the impact of the parking fee change in mode shift behavior.

The estimated utility coefficients given in Table 2 indicate that nonresponse bias is present in the original ETS survey and that it is due to the different socioeconomic characteristics of respondents in the fall as opposed to the spring survey. Had a value for the percent change in APO been based on the logit model restricted to the original ETS sample, bias would be present. The magnitude and direction of the bias can be estimated by first forecasting a series of APO values based on the fall 1991 sample. Essentially this means using Equations 5 and 7 with the value of Subscript s equaling 1. A corresponding series estimating the true APO for the firm can be derived by using Equations 6 and 7 with the value of s indexed to T. Given that the baseline AVO is the same for each series, the percent change in APO conditioned on TCM policy and survey sample procedures can be derived. A partial series of these values is given in Table 3.

The first column of Table 3 gives a series of design values for parking changes; the values range from $0.00 to $3.25. The second column represents a series of rideshare adjustment values, which in the case of the Matsushita survey instrument represented payment toward a lunch at the corporate cafeteria. The difference between the third and fourth columns represents the estimated level of error associated with nonresponse bias. In general, nonresponse bias produces erroneously high values for the APO. Adjustment of the nonresponse bias by assuming that all nonrespondents are SOV drivers would clearly result in a bias in the negative direction. This can be seen by examining Equation 6 and inserting the value $\overline{P}_{s=2} = 1$ and recalculating Equation 7.

The forecast percent change in APO given either a parking charge or a rideshare adjustment is positive, as theory suggests. However, nonresponse bias appears to be a major factor. When the compliance plans are based on a sample having nonresponse bias, the change is APO is overestimated. For example, Line 4 of Table 3 indicates that an analysis based on a sample having nonresponse bias predicts that a $2.30 parking charge will increase the APO by the necessary 25 percent. In contrast, when nonresponse bias is addressed using samples from both fractions of the site's employee roll, the estimated true percent change in APO is only 19.2 per-

TABLE 3 Percent Change in APO Levels Conditioned by TCMs: Parking Charge and Rideshare Adjustments Given the Presence of Nonresponse Bias

TCM* Policy		Percent change in APO	
Parking Charge	Rideshare Adjustment	Based on sample having non-response bias	Adjusted for non response bias
$0.00	$0.00	Baseline AVO	
$1.00	0.00	8.0%	6.2%
2.00	0.00	19.2	14.3
2.30	0.00	25.1	19.2
3.00	0.00	31.9	23.1
3.25	0.00	35.1	25.3
0.00	$1.00	2.2%	2.0%
0.00	2.00	4.5	4.0
0.00	3.00	6.8	4.5
0.00	4.00	8.9	8.0
$2.00	$1.00	25.0%	18.8%
2.50	$1.25	33.2	25.1

Source: Matsushita Electric Corporation of America, Commuting Management Study, 1992.

*The rideshare commuting option requires employment of a transportation coordinator to aid in the formation of car and van pools.

*Parking charges and rideshare adjustment values are expressed in dollars per day.

cent. Looking further down the table, the appropriate parking charge needed to generate the necessary change in APO is $3.25.

The table also indicates that the rideshare adjustment as described to the Matsushita employees is insufficient in value to generate the necessary change in APO. When the rideshare adjustment is defined as a $4.00 daily coupon for lunch at the corporate cafeteria, the APO adjusted for nonresponse bias increases by 8 percent. This value must not be interpreted as the forecast performance efficiency of the recently enacted $60 Qualified Transportation Fringe for commuter highway vehicles [National Energy Policy Act (P.L. 102-486)]. The product being offered to the employee is different. One is the proverbial free lunch; the other is a free ride. The transit or rideshare subsidy dedicates the entire value of the incentive program to the commuting policy; the subsidized lunch acts indirectly on the rideshare utility function through the utility derived from the MECA cafeteria's lunch and luncheon ambiance. Given no change in the quality of the luncheon experience, the transit/ridesharing subsidy will be more effective in changing APO than the lunch subsidy. However, where the luncheon experience at the site has less utility than an off-site location traveled to by the employee's car, a change in the luncheon experience can increase the site's APO. Ultimately, to estimate the impact of the $60.00 per month transit/vanpool subsidy, the new subsidy program must be explicitly incorporated into a new SC study.

Once nonresponse bias is corrected, the set of programs needed to meet the required 25 percent increase in APO can be derived. In this case a mix of the two TCMs, a $2.50 parking change combined with a $1.25 rideshare adjustment, appears sufficient to meet the site's 1996 goal. Where other TCMs, such as a high-quality guaranteed ride home, were added to the compliance plan, the magnitude of the parking charge could be lowered while still meeting the required 25 percent threshold. Clearly, by combining TCMs into the compliance plan, individual choice is retained. Employees who need to drive alone can do so at a price; those who accept the shift from driving alone to some form of rideshare or transit can be rewarded for the inconvenience they may suffer.

SUMMARY

Major employers in areas found in noncompliance with air pollution regulations will be required to reduce the use of the single-occupant vehicle for commuting purposes. The employers will be required to submit compliance plans showing the policies they will enact to meet trip reduction objectives. ETSs will form the basis for the design of appropriate and effective transportation demand management policies. This work shows that the design and administration of the survey must account for nonresponse bias.

The evidence derived from this study shows that employees who respond to the initial ETS are more likely to be open to new ridesharing alternatives than are the nonrespondent employees. The parking charge erroneously forecast to meet the Clean Air goal is $2.30 per day. After correcting for nonresponse bias, the parking charge rose to $3.25 per day. This finding suggests that response-enhancing survey administration techniques must be used. Alternatively, as was done in this study, a separately prepared sample survey for nonrespondents could be used to adjust the projection model to account for the nonresponse bias derived from the original ETS.

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