An Investigation of the Potential Effects of Nonresponse on the BTS Omnibus Household Survey

Pheny Z. Weidman
Bureau of Transportation Statistics/Research and Innovative Technology Administration, U.S. Department of Transportation, 1200 New Jersey Avenue, SE, Washington, DC 20590

Abstract

The Bureau of Transportation Statistics' Omnibus Household Survey (OHS) is a Customer Satisfaction Survey using a list-assisted random digit dialing (RDD) methodology. It assesses the general public's perception of, expectations from, and satisfaction with the nation's transportation system by interviewing persons in randomly selected telephone households. The response rate for the OHS has been around 50% since its inception in 2000, raising concerns about the generalizability of its results.

This study examined if and how nonresponse introduces bias into the OHS estimates. It used a modified form of nonresponse follow-up approach that compared response rates of early versus late respondents to investigate the potential effects of nonresponse on major OHS estimates. It was relatively cheap. The results and methods used in this study can provide useful information to other government agencies regarding the conduct of nonresponse bias studies to meet the Office of Management and Budget's requirements for their own RDD surveys.

Key Words: Survey nonresponse, nonresponse bias, RDD survey

1. Introduction

Survey nonresponse bias is defined as the departure of the expected value of an estimate from its true value due to nonresponse (Groves, 2006). For any given survey, two types of nonresponse may occur--unit and item nonresponse. Unit nonresponse occurs when a sampled unit such as a person, household, or organization fails to respond to a survey. Item nonresponse refers to the situation in which a unit response is obtained, but the respondent omits answers to some questions on the survey (Dillman et al., 2002).

It has been well-documented that response rates to social and behavioral surveys have been declining in recent decades (Johnson et al., 2006; Abraham et al., 2006; de Leeuw and de Heer, 2002; Curtin et al., 2005; Atrostic et al., 2001). This phenomenon has caused growing concern among survey researchers regarding the quality of survey data. Although government survey response rates generally tend to be higher than those for private surveys, U. S. federal statistical agencies nonetheless have experienced increasing difficulty in obtaining household survey interviews (Abraham et al., 2006). The Bureau of Transportation Statistics (BTS)' Omnibus Household Survey (OHS) is a case in point. Despite the survey's official imprimatur and an extensive follow-up effort, the OHS response rate has been around 50 percent. It has naturally raised concerns within the BTS regarding whether and how the data obtained can be generalized to the target population.

The OHS employed the list-assisted random digit dialing (RDD) method to draw a national probability sample of households from the United States non-institutionalized adult population (18 years of age or older). For this mode of data collection, there is no information available regarding nonresponse households other than their telephone numbers and a call history maintained by the interviewers. This makes the study of effects of nonresponse extremely challenging.

A review of the literature on nonresponse in household survey research revealed several methodologies commonly employed to investigate the potential effects of nonresponse on survey estimates from RDD surveys. One of the common methods for analyzing nonresponse bias is to compare the respondent-based estimate with those from another source considered to be more accurate (Groves, 2006). In the case of household surveys, this approach compares the distributions of age, gender, race, and other sociodemographic variables among respondents with those from the most

recent census of the population. The limitations of this approach are that the key survey variables of the study often do not exist in the other source; that different forms of measurement may be used by the focal survey and the benchmark data source or survey; and that the coverage and nonresponse characteristics of the benchmark data source or survey are not completely known. In the case of the 2006 OHS, the most recent decennial census data available were collected more than six years ago and would be too out-of-date to use as variables predictive of survey nonresponse.

Another class of nonresponse bias studies is the nonresponse follow-up study. It is a two-phase survey approach, which tries to conduct follow-up interviews with persons not responding to the initial survey (Johnson et al., 2006; Lahaut et al., 2002; Gmel, 2000; Hill et al., 1997). Some studies investigate variation within the existing survey. This class of techniques actually consists of modified forms of the nonresponse follow-up study. Examples of this include comparing estimates of early respondents to those of late respondents (Johnson et al., 2006; Voigt et al., 2003; Etter and Perneger, 1997; Triplett et al., 1996; Kristal et al., 1993; Lavrakas et al., 1992), comparing estimates from early cooperators with those from the full respondent data set (Groves, 2006; Curtin et al., 2000, 2005; Lin and Schaeffer, 1995; Dunkelberg and Day, 1973), comparing respondents in the first phase sample with those in both the first and second phase samples (Groves and Wissoker, 1999), and comparing observations made during data collection on both respondents and non-respondents (Groves and Couper, 1998). These approaches are limited by the question of how representative responses from the follow-up or reluctant respondents are of all nonrespondents, and by the frequent use of multiple or different data collection methods during the follow-up phase of study that may confound nonresponse error with measurement quality (Johnson et al., 2006). In addition, there usually is additional, some time even very expensive, cost associated with conducting the follow-up phase of study.

Since Pace used it in 1939, comparisons of early versus late respondents to survey requests had been accepted and used by statisticians and survey researchers as an analytical method of studying survey nonresponse bias. In this approach, researchers usually classify survey respondents into either early or late responders by using indicators of difficulty of eliciting a response. Early studies that employed this method were almost exclusively based on data from postal surveys (Lynn et al., 2002; Dunkelberg and Day, 1973; Filion, 1976; Hawkins, 1975; Ellis et al., 1970; Larson and Catton, 1959; Hilgard and Payne, 1944; Reid, 1942; Shuttleworth, 1940; Suchman and McCandless, 1940; Pace, 1939). The number of mailings or elapsed days prior to response was used as the indicator in these studies. In more recent studies based on telephone interview surveys, researchers typically used the total number of interviewer call attempts as the indicator of difficulty (Lynn et al., 2002; Cheng, 1998; Traugott, 1987; Thomsen and Siring, 1983; Fitzgerald and Fuller, 1982; Drew and Fuller, 1980). Because of the limitations of the OHS design mentioned in the first section of this paper, the method of nonresponse bias study that is appropriate for OHS is restricted to this class of approaches.

2. Data and Method

The OHS is conducted by the BTS with joint funding from the Transportation Security Administration (TSA). It assesses the general public's perception of, expectations from, and satisfaction with the nation's transportation system. Data were collected from households in the U.S. using a Random-Digit-Dialed (RDD) telephone methodology. The survey was first conducted in 2000. The analysis this study reports is based on OHS data collected during Nov. 2006.

2.1 Sample Design

The target population for the OHS is the noninstitutionalized population aged 18 years or older who are currently living in the United States. To ensure that a sample of telephone numbers is geographically representative, telephone prefixes are stratified by their associated Census Bureau divisions and metropolitan status (Bureau of Transportation Statistics, 2006). The rates at which households are sampled for the OHS differ across these strata. In the last stage of sample selection, one randomly selected person age 18 or older in each sampled household is designated for participation in the OHS. The list-assisted random digit dialing methodology was employed to generate the desired sample. List-assisted refers to the use of commercial lists of directory-listed telephone numbers to increase the likelihood of dialing household residences. This method gives unlisted telephone numbers the same chance to be selected as directory-listed numbers.

The 2006 OHS interviews were conducted between the first and the last day in November, 2006. If a selected person could not be contacted or was not available, an interviewer would try to call back later at a different time. Although the maximum number of calls back to a non-contact person was set as 60, the highest number recorded in our data was 80. The disposition of each call was recorded by the interviewers.

The OHS final analysis weight is the product of five components: 1) Base sampling weight**;** 2) Adjustment for unit nonresponse; 3) Adjustment for households with multiple telephone numbers; 4) Adjustment for selecting an adult within a sampled household; and 5) Post-stratification adjustments to the target population.

2.2 Methods

To examine the potential effects of nonresponse, first 2006 OHS interview history and disposition data were merged with the OHS data file. Indicators of the level of difficulty of eliciting a response based on each sample's calling history were then constructed for the 1,095 sample units in the 2006 OHS. Initially, each OHS sample was classified into one of three categories: respondent, difficult to contact, and refusal. Because the OHS total sample size was so small, in order to ensure enough sample size for subsequent analyses of nonresponse bias of key OHS estimates, only two categories -- respondent and late respondent/refusal -- were used in final analyses. Individuals who completed telephone interviews by no later than the 4^{th} phone call were classified as respondents. Those who completed telephone interviews only after either initially refusing to participate or repeated (at least five) phone calls were classified as late respondents/refusals. Individuals with missing call history information were randomly assigned into one of the two categories.

When survey nonresponse bias is studied by investigating variation within the existing survey, such as comparing estimates of early respondents to those interviewed only with great effort, an important assumption is made or implied. It is assumed that those reluctant respondents are representative of non-respondents (Johnson et al., 2006; Voigt et al., 2003; Etter and Perneger, 1997; Triplett et al., 1996; Kristal et al., 1993; Lavrakas et al., 1992). Based on this assumption, we created a second set of weighted OHS data. The unit nonresponse adjustment component in the new OHS' final weight reflected the assumption implied by the analytical method. That is, those late respondents/refusals were treated as nonrespondents when adjusting for unit nonresponse. When assumptions about data were true, for each OHS measure, the differences between OHS estimates derived from weighted samples using original and new final analysis weights were due to survey nonresponse bias.

Nonresponse bias was estimated in five core OHS measurement areas: A) mode of transportation used for journey to work, B) method used to improve commute, C) Telework, D) opinion on traffic congestion, and E) opinion on traffic in general. The specific core OHS measures included in this study were:
(1) percentage of population worked outside home;
(2) percentage of population used non-company vehicle alone for journey to work;
(3) percentage of population used non-company vehicle with others for journey to work;
(4) percentage of population used carpool or vanpool for journey to work;
(5) percentage of population used buses for journey to work;
(6) percentage of population walked to work;
(7) percentage of population changed schedule/work hours to improve commute;
(8) percentage of population moved closer to work to improve commute;
(9) percentage of population worked at home to improve commute;
(10) percentage of population used a toll road/lane to improve commute;
(11) percentage of population whose work could be done at home;
(12) percentage of population for whom Telework was an option;
(13) percentage of population worked at home last week;
(14) people's opinions on traffic in general; and
(15) people's opinions on traffic congestion.

The Taylor series linearization method for a Stratified Without Replacement (STRWR) sample design was used for variance estimation in this study.

3. Findings and limitations

3.1 Findings

The analyses results in table 1 present the relative nonresponse biases for OHS estimates of the thirteen dichotomous OHS core measures (1) through (13). The relative nonresponse biases of these OHS estimates ranged from zero when estimating the "percentage of population used non-company vehicle with others for journey to work" to 4.82% when

estimating the "percentage of population for whom Telework was an option." The signs in the relative bias column indicate the directions of the biases. A positive relative bias indicates an overestimate of the target population value whereas a negative relative bias indicates an underestimate. For example, a 4.82% relative bias for the measure of percentage of population for whom Telework was an option meant that the estimate of this measure based on unadjusted respondent data (original OHS sample) had overestimated the target population value by about 4.82%.

Table 1: Nonresponse Bias in the 2006 BTS Omnibus Household Survey

Selected core transportation measurements/questions	New Sample Estimate	Standard Error	Sample Estimate	Standard Error	Relative Bias (%)
(1) Worked outside home	59.24	2.24	57.85	1.81	-1.39
Mode of transportation used for journey to work					
(2) Non-company vehicle alone	78.15	2.30	78.43	2.07	0.28
(3) Non-company vehicle with others	13.22	1.84	13.22	1.65	0.00
(4) Carpool or vanpool	5.27	1.27	4.54	1.03	-0.73
(5) Bus	5.77	1.38	5.54	1.20	-0.23
(6) Walk	9.16	1.72	9.32	1.53	0.16
Method used to improve commute					
(7) Changed schedule/work hours	17.82	2.02	18.80	1.83	0.98
(8) Moved closer to work	10.44	1.87	9.41	1.41	-1.03
(9) Worked at home	9.98	1.62	10.63	1.45	0.65
(10) Used a toll road/lane	5.40	0.97	5.88	0.94	0.48
Telework					
(11) Work could be done at home	25.29	2.68	23.75	2.17	-1.54
(12) Telework was an option	60.10	6.48	64.92	5.16	4.82
(13) Worked at home	32.44	6.60	32.02	5.63	-0.42

Table 2: Opinions on Traffic and Congestion

	Percent of Reporting				
Opinions on	New Sample Estimate	Standard Error	Sample Estimate	Standard Error	Relative Bias (%)
(14) Traffic					
Much better	2.78	0.7	2.97	0.71	0.19
Better	6.81	1.46	7.37	1.38	0.56
Unchanged	62.59	2.5	62.41	2.26	-0.18
Worse	16.86	1.84	17.06	1.70	0.20
Much worse	10.96	1.56	10.19	1.35	-0.77
(15) Congestion					
Very congested	17.19	2.11	16.62	1.82	-0.57

Moderately congested	30.86	2.54	30.06	2.17	-0.80
Slightly congested	21.49	2.1	21.80	1.92	0.31
Not at all congested	30.46	2.29	31.51	2.12	1.05

Table 2 presents the results of relative nonresponse biases analyses in estimates of two core OHS measures that are polychotomous, (14) and (15). These two OHS measurements were designed to measure people's opinions on traffic in general as well as on traffic congestion specifically. The results in Table 2 indicate that the relative nonresponse bias in the estimate of each measurement category was very small, ranging from 0.18 to 1.05.
Overall, our analyses show that nonresponse biases of all key OHS estimates are very small. In most cases, the size of the nonresponse bias was around 1%. The measurement of "whether Telework is an option" had the largest nonresponse bias, 4.8%, when analyzed with our method.

3.2 Limitations of the Study

There are several limitations in this study. They can be classified as being associated with either the analytical method or data used by the study.

3.2.1 Method Limitations

Limitations of nonrespondense follow-up studies have been briefly discussed previously in this article. The main weakness of the approach used is that non-respondents to the survey are excluded from the study. This approach is also limited by the question of how representative reluctant respondents are of all non-respondents (Johnson et al., 2006).

3.2.2 Data Limitations

There are two major limitations associated with the 2006 OHS data used in this study. It is a very small sample with only 1,095 cases. Whether this is large enough to make any estimates of the U.S. population is questionable. In addition, for this particular study, the missing data rate was very high. About 17.5% of the cases didn't have call history information.

Despite its limitations, this study provided nonresponse bias of key OHS estimates for the first time since the survey's inception in 2000. It was relatively cheap. Although findings of the study were in the survey's favor, it is recommended that more nonresponse bias studies are needed. The author suggests that future studies of nonresponse bias in the OHS use multiple methods simultaneously whenever possible and /or multiple years of data.

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