Center for <u>T</u>eaching <u>O</u>ld <u>M</u>odels <u>Ne</u>w <u>T</u>ricks (TOMNET)

A USDOT Tier 1 University Transportation Center

PROJECT PROPOSAL: 2020-2021

Title: Response willingness in consecutive travel surveys

Principal Investigator: Patricia L. Mokhtarian, Susan G. and Christopher D. Pappas Professor, School of Civil & Environmental Engineering, Georgia Institute of Technology

Co-Principal Investigator: Kari E. Watkins, Professor, School of Civil & Environmental Engineering, Georgia Institute of Technology

1. Introduction/Problem Statement

High-quality survey data provide the foundation for research and policymaking across many fields. While novel data sources are actively being examined for use in transport applications, both currently and for the foreseeable future, traditional travel surveys will continue to play an irreplaceable role in providing critical data for use in travel demand modeling, regional planning, and policymaking. However, survey response rates are in continuous and significant decline, thus requiring increased efforts toward respondent recruitment. Further necessitating these increased efforts is the fact that low response rates and their accompanying nonresponse biases can threaten the validity of survey data, and thus contingent research findings (National Research Council, 2013).

Survey teams have employed a range of efforts aimed at increasing response rates and improving survey data quality. One of the most common tools is the use of passive datasets such as GPS records (Bohte and Maat, 2009), targeted marketing data (Shaw et al., 2019)), novel survey formats (e.g., interactive surveys; Collins et al., 2012), and targeted sampling frames (e.g., online panels; Circella et al., 2016), to name a few. Among these efforts, another approach, which is the focus of this study, is to *recruit survey respondents who had expressed willingness to be contacted again in a previous survey*; this approach has been shown to produce a significantly higher response rate and lower cost per valid response relative to random sampling (Amarov and Rendtel, 2013; Kim et al., 2019; Circella et al., 2020).

This recruitment method is similar to the approach used in panel studies in that both recruit respondents from preceding surveys. The differences, however, reside in the survey purpose, contents, or outcome. Specifically, panel surveys focus on repeated observations on a set of variables for the same sample unit over time (Lavrakas, 2008), which allows the tracking of specific variables or study interests. Moreover, since panel surveys recruit the same respondents periodically, it also introduces attrition biases. In contrast, recruiting respondents from a previous survey is not a periodical behavior. The use of this recruitment method: (1) increases the survey response rates obtained on follow-up surveys; (2) reduces the financial burden for local transportation agencies and researchers; and (3) facilitates the *expansion* of the variable set of the preceding survey and enables data fusion across datasets (Shaw et al., 2020).

However, in the transportation domain, this recruitment method has not been widely adopted nor carefully examined. A major potential drawback of recruiting respondents based on their willingness expressed in a preceding survey is the non-representativeness that may be inherent in that sample (Couper et al., 2007). The proposed study plans to explore the extent and nature of that non-representativeness.

2. Project Objectives

The proposed study plans to answer the following questions: (1) Who is more likely to respond to a follow-up survey? (2) How does recruiting respondents based on their willingness expressed in a preceding travel survey bias the follow-up survey sample? (3) What survey sample could we expect if we recruited respondents from the 2017 NHTS respondents in different geographic regions in the U.S.?

3. Proposed Methodology and Data

The study proposes to do the following:

(1) Analyze the two-stage self-selection/non-response biases simultaneously (i.e., willingness to participate in a follow-up survey and actual response behavior) for respondents *recruited from a previous travel survey* (the National Household Travel Survey, NHTS), using a probit with sample selection (PSS) model, which could remedy the model coefficient biases. We also propose several standardized PSS model performance measures to enable model comparisons.

(2) Apply the PSS model to a holdout sample to decompose biases (e.g., dataset bias, self-selection bias, non-response bias) accumulated along the way and further analyze the representativeness of the recruited survey respondents by comparing sample and population marginal distributions for various variables.

(3) Predict follow-up survey samples from different geographic regions in the U.S. as another PSS model application example, and check the model's generalizability.

The study will use two datasets: the NHTS, and a Georgia DOT (GDOT)-sponsored follow-up survey developed by the research team of the PI for the proposed project. The National Household Travel Survey (NHTS) is a repeated cross-sectional travel survey conducted by the Federal Highway Administration, and is widely used by regional planning agencies across the United States. The NHTS typically obtains household, individual, vehicle, and trip information using several survey instruments; these include a recruitment survey, a retrieval survey, travel logs, and a vehicle odometer mileage form. In 2017, for the first time, NHTS allowed states to opt into including a question regarding respondents' willingness to participate in follow-up travel surveys, and Georgia was one of the six states/regions that chose to do so. We will focus on the Georgia subset of the NHTS for the model estimation process.

The final working dataset will contain about 8,400 Georgia respondents to the NHTS, nearly 5,000 of whom indicated a willingness to participate in a follow-up survey. That willingness was put to the test with the GDOT survey (Kim et al., 2019). The GDOT survey is a 15-page attitudinally-rich travel survey with an emphasis on the impacts of emerging technologies on travel behavior. Our research team mailed the GDOT survey to the Georgia NHTS respondents in September 2017. Ultimately, about 1,400 of the 5,000 "willing" NHTS respondents replied to the GDOT survey. We note that for the purpose of this study, the GDOT survey was used only to determine respondents' decision to complete the follow-up survey; all other respondent data was obtained from the NHTS. In the study, we will separate the final working dataset into a training set (60%) and a test set (40%) to enable appropriate model evaluation.

After finalizing the model, we will apply it to the entire US NHTS sample, as well as to NHTS subsamples for selected states, to assess how well it generalizes to regions other than Georgia.

4. Work Plan (Project Tasks)

The proposed project can be divided into the following tasks.

Task 1: Literature review.

We will monitor the literature on survey response and probit with sample selection for the duration of the project.

Task 2: Data preparation.
As mentioned above, the study relies primarily on the Georgia subsample of the NHTS, but also uses the full NHTS dataset, the subsets for several other states, and knowledge of whether Georgia NHTS respondents who expressed willingness to complete a follow-up survey actually did so. Accordingly, quite a bit of manipulation will be required to format the data appropriately.

Task 3: Estimate and evaluate the PSS model.
The probit with sample selection model has two components: a selection model (reflecting whether a respondent expresses willingness to complete a follow-up survey or not) and an outcome model (reflecting whether or not willing respondents actually do complete a subsequent survey). We will identify and apply several different model performance measures, including final log-likelihood compared to benchmarks (all zeros, constants only), McFadden's pseudo R^2, information criteria (AIC and BIC), point-biserial correlations, root mean squared error (RMSE) between the actual choice and the predicted probability), and success table.

Task 4: Validate (inside Georgia) and apply (outside Georgia) the model.
First, we will apply the model to the holdout sample among the Georgia NHTS respondents to predict participation in the follow-up survey, and compare the marginal distributions of several selected variables with the corresponding population distributions derived from the 2018 American Community Survey five-year estimates (https://www.census.gov/programs-surveys/acs). By analyzing the divergence in those distributions between the follow-up survey respondents and the population, we will be able to summarize the potential biases residing in the sampling method, i.e., recruiting respondents from a preceding travel survey. We will identify different sources of bias (e.g., dataset bias and self-selection bias), and will analyze the role of each source in the divergences observed, as well as the total extent of divergence using a measure of effect size (Cohen, 1977). A small distribution divergence indicates that the follow-up survey sample is expected to be representative of the population, which is a positive sign that recruiting respondents from a preceding survey is efficient and reasonable. Otherwise, a large divergence indicates that a biased follow-up survey sample is expected, which may call for some sampling remedies to improve its representativeness.

Next, we will test the transferability of the PSS model to different populations, by checking the representativeness of follow-up survey respondents for selected states in diverse geographic regions of the US (west to east: California, Minnesota, North Carolina, New York and Massachusetts) and the full 2017 NHTS national sample. Specifically, we will apply the model estimated for Georgia to the NHTS (sub)samples in each of those regions, and use the effect size measure to evaluate divergence between the expected demographic distributions of follow-up survey respondents and the associated population distributions.

Task 5: Document the results for dissemination.
We will incorporate the results into a master's thesis, and prepare a paper for submission to a high-quality peer-reviewed journal. In addition, we plan to present the paper at one or more professional conferences (see Section 7).

5. Project Schedule

	Task Name	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Literature review	�	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦	▦
2	Data preparation	▦	▦	▦									
3	Estimate and evaluate the PSS model			▦	▦	▦	▦						
4	Validate (inside Georgia) and apply (outside Georgia) the model						▦	▦	▦	▦			
5	Document the results for dissemination										▦	▦	▦

6. Relevance to the Center Theme/Mission

TOMNET's mission is to advance data and methods to reflect the role of attitudes, perceptions, values, and preferences in travel behavior models. While passive data sources such as GPS traces and farecard usage measure travel *behavior*, the measurement of *attitudes* (and the like) generally requires administering a survey instrument of some kind. For the resulting data to be most useful, the sample needs to represent the population as completely as possible. The proposed study investigates an auspicious approach to sample recruitment: one that promises to reduce costs and improve sample sizes, but also threatens to diminish representativeness. By understanding the dataset biases that can result when respondents are recruited from a preceding survey (e.g., NHTS), researchers/practitioners can better assess the tradeoff between data quality and resource constraints associated with respondent recruitment. Moreover, understanding these biases will allow survey developers to adjust their invited sample – for example, by oversampling underrepresented groups in the follow-up surveys.

7. Anticipated Outcomes and Deliverables

As indicated in the Introduction, it has become increasingly difficult to recruit survey respondents, and yet hearing from a representative cross-section of society is critical to monitoring trends and assessing responses to new technologies and policies. Recruiting survey respondents from among those who had expressed willingness to be contacted again in a previous survey has been shown to produce a significantly higher response rate and lower cost per valid response relative to random sampling. However, such a recruitment strategy is likely to introduce or exaggerate biases in the resulting sample, and this issue has not been well-studied, particularly in transportation. Accordingly, in terms of *research outcomes/benefits*, this study will help survey developers assess the representativeness and cost-effectiveness of recruiting respondents from a pool of willing respondents to a previous survey, which in turn will suggest adjustments to the sampling frame that can improve the representativeness of the new sample. These findings will contribute to improving the quality and reducing the cost of future transportation surveys. Even outside of the the transportation field, the contributions of this study will have general findings and implications for researchers using the approach of recruiting respondents from prior surveys.

With respect to *tangible outcomes/deliverables*, we expect this project to contribute to the student's master's thesis (to be completed "on the way" to the PhD), to produce a paper that will be submitted to a peer-reviewed journal, and to be presented at one or more conferences, such as the 2021 Annual Meeting of the Transportation Research Board.

8. Research Team and Management Plan

Principal Investigator **Patricia Mokhtarian** is an internationally-known travel behavior scholar, who has specialized in measuring and modeling attitudes and incorporating them into models of travel-related behaviors. In particular, she directed the design, administration, and prior analysis of the follow-up survey data that plays a peripheral role in this project. She will be responsible for the overall direction of the project, and will be directly engaged with its ongoing progress. Co-PI **Kari Watkins** is also a well-known and -respected travel behavior scholar, specializing in transit planning and operations, traveler information, mode choice, and complete streets design.

In addition, **one PhD student** will be responsible for the day-to-day execution of substantive project tasks.

The project team will meet weekly for in-depth reports on progress and tactical planning. All members are local, so communication will be straightforward, of course including online video meetings and e-mail. An internal project website will serve as a working repository for literature, presentations prepared by the project, data, and analyses. Milestone products, including papers, presentations, and reports will be provided to the central TOMNET repository

9. Technology Transfer Plan

The project leadership has proven track records of scholarly productivity and research dissemination. In July 2020, we will prepare a paper to be submitted for presentation at the Annual Meeting of the Transportation Research Board in January 2021, and for publication in a peer-reviewed journal. Based on past history, we expect multiple opportunities to present project findings throughout the life of the study and beyond, and we will seek out and volunteer for such opportunities as appropriate.

10. Workforce Development and Outreach Plan

The PI, co-PI, and PhD student associated with the proposed project are all women. The leadership team is devoted to the careful mentoring of female graduate students, including with respect to career-life balance, a major reason why female PhD students do not choose academia (Mason et al., 2009). Research has shown that mentoring and positive role models can make a big difference in the attraction of women to STEM fields (Hill et al., 2010). This project will contribute heavily to the professional development of this female PhD student, who in turn is already serving as a role model to other women.

11. References

Amarov, B. & Rendtel, U. (2013). The recruitment of the access panel of German official statistics from a large survey in 2006: Empirical results and methodological aspects. *Survey Research Methods, 7*, 103-114.

Bohte, W. & Maat, K. (2009). Deriving and validating trip purposes and travel modes for multi-day GPS-based travel surveys: A large-scale application in the Netherlands. *Transportation Research Part C, 17*, 285-297.

Circella, G., Tiedeman, K., Handy, S., Alemi, F. & Mokhtarian, P. (2016). *What Affects Millennials' Mobility? PART I: Investigating the Environmental Concerns, Lifestyles, Mobility-Related Attitudes and Adoption of Technology of Young Adults in California.* UC Davis: National Center for Sustainable Transportation. Available from the authors and at https://escholarship.org/uc/item/6wm51523.

Circella, G., Lee, Y. & Mokhtarian, P. (2020). *Comparison of Alternative Survey Recruitment/Deployment Methods*. Presentation at The ABCs (Attitudes – Behaviors – Choices) of Future Mobility Webinar, June 12. Webinar records and slides available at https://tomnet-utc.engineering.asu.edu/leadership-webinar-series/

Cohen, J. (1977). *Statistical Power Analysis for the Behavioral Sciences*. Academic Press, Inc.

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Hill, C., Corbett, C., & St. Rose, A. (2010) *Why So Few? Women in Science, Technology Engineering and Mathematics*. American Association of University Women. http://www.aauw.org/files/2013/02/Why-So-Few-Women-in-Science-Technology-Engineering-and-Mathematics.pdf.

Kim, S. H., Mokhtarian, P. & Circella, G. (2019). *The Impact of Emerging Technologies and Trends on Travel Demand in Georgia: Final Report.* Georgia Department of Transportation. Available from the authors and at http://g92018.eos-intl.net/G92018/OPAC/Index.aspx.

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Mason, M.A., Goulden, M., & Frasch, K. (2009). Why graduate students reject the fast track. *Academe, 95(1)*, 11-16.

National Research Council. (2013). *Nonresponse in Social Science Surveys : A Research Agenda*. Washington, DC: The National Academies Press.

Shaw, F. A., Wang, X., Mokhtarian, P. & Watkins, K. (2019). Supplementing transportation data sources with targeted marketing data: Applications, integration, and validation. Paper submitted to *Transportation Research Part A*. Available from the authors.

Shaw, F. A., Wang, X., Mokhtarian, P. & Watkins, K. (2020). Using machine learning to enrich transportation surveys through variable transfer: with a sample application for psychometric variables. Paper in preparation. Available from the authors.

12. Qualifications of Investigators (One-page CV per Investigator)

Appears after the budget page.

13. Budget Including Non-Federal Matching Funds

Institution: Georgia Institute of Technology
Project Title: Response Willingness in Consecutive Travel Surveys
Principal Investigator: Patricia Mokhtarian

Budget Period: 8/1/2020 - 07/31/2021

CATEGORY	Budgeted Amount from Federal Share	Budgeted Amount from Matching Funds	Explanatory Notes; Identify Source of Matching Funds
Faculty Salaries	$16,260	$26,750	Georgia Tech faculty salary
Other Staff Salaries	–		
Student Salaries	$28,800		
Fringe Benefits	$6,717	$7,972	Georgia Tech faculty overhead
Total Salaries & Benefits	$51,778	$34,722	
Student Tuition Remission	$24,991		
Operating Services and Supplies	$250		
Domestic Travel	$1,500		
Other Direct Costs (specify)			
Other Direct Costs (specify)			
Total Direct Costs	$78,519	$34,722	
F&A (Indirect) Costs	$30,939	$20,069	Georgia Tech faculty salary
TOTAL COSTS	$109,458	$54,791	

PATRICIA L. MOKHTARIAN, Ph.D.

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Georgia Institute of Technology, Atlanta, GA 30332-0355 Email: patmokh@gatech.edu

Education
PhD,   Industrial Engineering/Management Sciences, Northwestern University, 1981
MS, Industrial Engineering/Management Sciences, Northwestern University, 1977
BA (summa cum laude), Mathematics, Florida State University, 1975

Employment and Professional Experience (last 25 years)
Susan G and Christopher D Pappas Professor (2016-present) / Professor (2013-2016), School of Civil & Environmental Engineering, Georgia Institute of Technology
Full (1999-2013)/Associate (1996-1999)/Assistant (1990-1996) Professor, Department of Civil & Environmental Engineering, University of California, Davis
Chair and Graduate Adviser (1997-2013), Interdisciplinary Graduate Group in Transportation Technology and Policy, University of California, Davis
Acting Director (1999-2000) / Associate Director for Education (2001-2013), Institute of Transportation Studies, University of California, Davis

Fields of Interest and Expertise
(1) Attitude measurement and survey design; (2) Statistical/econometric analysis of transportation data; (3) Impacts of information/communications technology on travel; (4) Attitudes toward travel; (5) Activities conducted while traveling; (6) Impacts of the built environment on travel behavior

Recent Relevant Publications (not already cited in the proposal)
Choi, Sungtaek & Patricia L. Mokhtarian (2020) How attractive is it to use the internet while commuting? A work-attitude-based segmentation of Northern California commuters. *Transportation Research Part A* **138**, 37-50.
Clark, Calvin, Patricia L. Mokhtarian, Giovanni Circella, and Kari Watkins (2021) The role of attitudes in perceptions of bicycle facilities: A latent-class regression approach. *Transp. Research F* **77**, 129-148.
Kash, Gwen & Patricia L. Mokhtarian (in press) What counts as commute travel? Identification and resolution of key issues around measuring complex commutes in the National Household Travel Survey. *Transportation Research Record*.
Kim, Sung Hoo & Patricia L. Mokhtarian (2018) Taste heterogeneity as an alternative form of endogeneity bias: Investigating the attitude-moderated effects of built environment and socio-demographics on vehicle ownership using latent class modeling. *Transportation Research A* **116,** 130-150.
Kim, Sung Hoo, Patricia L. Mokhtarian, & Giovanni Circella (2020) Will autonomous vehicles change residential location and vehicle ownership? Glimpses from Georgia. *Transportation Research D* **82**.
Malokin, Aliaksandr, Giovanni Circella, & Patricia L. Mokhtarian (in press) Do millennials value travel time differently because of productive multitasking? A revealed preference study of Northern California commuters. *Transportation*.
van Herick, David & Patricia L. Mokhtarian (2021) Quantifying the share of total apparent effect that is genuinely due to a treatment: A comparison of methods. *Research in Transportation Economics*.

Graduate Student Supervision/Advising
Graduated: 14 PhDs (including 2 women), 23 MSs (6); **Current (Co-)Supervision**: 4 PhDs (2)

Recent Honors and Awards
Zephyr Foundation Outstanding Industry Contributor Award (2021)
Travel Behaviour and Society Outstanding Paper Award (2019)
National Associate of the National Academies of Sciences, Engineering, and Medicine (2020)

KARI EDISON WATKINS, Ph.D., P.E.

Frederick Law Olmsted Associate Professor, Civil and Environmental Engineering
Georgia Institute of Technology, Atlanta, GA 30332-0355, kari.watkins@ce.gatech.edu

Education
PhD, Civil & Environmental Engineering, University of Washington, 2011
MS, Civil & Environmental Engineering, University of Connecticut, 2003
B.C.E. (highest honor), Civil & Environmental Engineering, Georgia Tech, 1997

Employment and Professional Experience
Frederick Law Olmsted Early-Career Professor (2016-present) / Associate Professor (2017-present) / Assistant Professor (2011-2017), Civil & Environmental Engineering, Georgia Institute of Technology
Research Assistant (2007-2011), Civil & Environmental Engineering, University of Washington
Senior Transportation Engineer (1998-2007), Wilbur Smith Associates, Seattle, WA and New Haven, CT

Fields of Interest and Expertise
(1) Perceived and actual safety in active transportation; (2) Transportation infrastructure design; (3) Transit planning and operations; (4) Transportation system user information; (5) Innovative uses of technology for transportation data collection; (6) Natural experiments

Recent Relevant Publications (not already cited in the proposal)
Clark, C. P. Mokhtarian, G. Circella and K. Watkins (2021) "The Role of Attitudes in Perceptions of Bicycle Facilities: A Latent-Class Regression Approach, *Trans Research Part F,* V.77.

Gadsby, A., M. Hagenzieker, and K. Watkins (2020) "An international comparison of the self-reported causes of cyclist stress using quasi-naturalistic cycling", *Journal of Transport Geography*.

Garber, M., L. McCullough, S. Mooney, M. Kramer, K. Watkins, F. Lobelo, D. Flanders (2021) "At-risk-measure Sampling in Case–Control Studies with Aggregated Data", *Epidemiology* 32(1).

MacFarlane, G., N. Boyd, J. Taylor, and K. Watkins (2020) "Modeling the impacts of park access on health outcomes: a utility-based accessibility approach", *Envir Planning B: Urban Analytics*.

Ederer, D., M. Rodgers, M. Hunter and K. Watkins (2020) "Case study using probe vehicle speeds to assess roadway safety in Georgia" *Trans Research Record* 2674 (11), 554-562.

Gadsby, A. and K. Watkins (2020) "Instrumented Bikes and Their Use in Studies on Transportation Behavior, Safety and Maintenance", accepted April, *Transport Reviews,* 40:6, 774-795.

Berrebi, S. and K. Watkins (2020) "Who's Ditching the Bus?", *Trans Research Part A*, Vol. 136.

Garber, M., K. Watkins and M. Kramer (2019) "Comparing bicyclists who use smartphone apps to record rides with those who do not: implications for representativeness and selection bias", *Journal of Transport & Health*, Vol. 15.

Ederer, D., S. Berrebi, C. Diffee, T. Gibbs, K. Watkins (2019) "Comparing Transit Agency Peer Groups using Cluster Analysis", *Trans Research Record*, Vol. 2673.

Brakewood, C., and K. Watkins (2019) "A Literature Review of the Passenger Benefits of Real-time Transit Information", *Transport Reviews* 39(3).

Berrebi, S., S. Crudden, and K. Watkins (2018) "Translating Research to Practice: Implementing Real-time Control on High-Frequency Transit Routes" *Transportation Research Part A*, Vol. 111, pg. 213-226.

Graduate Student Supervision/Advising
Graduated: 5 PhDs (including 2 women), 26 MSs (11); **Current (Co-)Supervision**: 4 PhDs (3)

Recent Honors and Awards
SLS Excellence in Community-Engaged Sustainability Teaching – Honorable Mention – 2020
Class of 1934 CIOS Teaching Award – 2020
Engineering Georgia 100 Women to Know – 2018, 2019
Council of University Transportation Centers New Faculty Award - 2017

Grant Deliverables and Reporting Requirements for UTC Grants (November 2016)

Exhibit F

UTC Project Information	
Project Title	
University	
Principal Investigator	
PI Contact Information	
Funding Source(s) and Amounts Provided (by each agency or organization)	
Total Project Cost	
Agency ID or Contract Number	
Start and End Dates	
Brief Description of Research Project	
Describe Implementation of Research Outcomes (or why not implemented) Place Any Photos Here	
Impacts/Benefits of Implementation (actual, not anticipated)	

Web Links
  • Reports
  • Project Website	