Cashing in on ABS GOLD? Exploring the Utility of ABS Frame Appended Auxiliary Data for Potential Nonresponse Bias Assessment and Adjustment

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Abstract

Address based sampling (ABS) is a viable sampling methodology due to its near universal coverage of residential households with latest numbers placing coverage at 95% of households (Link and Lai 2011; AAPOR Cell Phone Task Force, 2010). The frame itself provides an alternative sampling solution for coverage issues related to cell phone only homes and hard to reach demographic subgroups (i.e., 18-34 year olds, blacks and Hispanics) Moreover, ABS frame data are rich and provide options for stratification, oversampling and nonresponse adjustments that extend way beyond what is available for RDD sampling designs. In this paper we present results from a mixed-mode sample survey from an ABS frame that employed vigorous nonresponse follow-up protocols.   All randomly selected households were mailed a survey and a subset of nonresponding households received a follow-up in-person survey attempting to gain participation. Here we assess nonresponse biases for both a continuous measure of media consumption and a binary measure of media access by comparing responses on these outcomes between responding and nonresponding households. We will explore characteristics of responding and nonresponding households that are based on both standard survey household demographic variables as well as ABS auxiliary variables that are measured at the block group. We will further assess the degree to which these variables are related to the survey outcomes and determine the degree to which nonresponse biases can be mitigated using propensity models based on a combination of survey demographic and ABS frame variables. Specifically we will assess the utility of ABS frame auxiliary variables in mitigating nonresponse biases by comparing nonresponse adjusted estimates based on both logistic and random forest propensity models derived using only collected survey demographics as well as those based on both survey demographic and ABS frame variables.

Key Words: Address based sampling (ABS), non-response, block group data and auxiliary data

1.0 Introduction

Surveys are important for understanding what a population thinks, feels, and knows, and they can be used to collect different kinds of data including health behaviors, product awareness, and political opinions. Each survey is unique to the researcher's goals, but a survey is only as good as how much it gets at the statistics of interest within the desired population. Coverage, in the survey context, is defined as "how well the sampling units included in a particular sample frame account for a survey's defined target population" (Davis 2008, p.159). If a survey is missing individuals because they are not on the frame, and these individuals are different in regards to variables of interest impacting survey statistics, the survey has coverage error (Groves 1988). Overcoverage occurs when people have more than one chance of being selected on a sampling frame or are erroneously included on the frame (Davis 2008). When portions of the target population are missing from the sampling frame undercoverage exists (Groves et al. 2009).

Addressed Based Sampling (ABS) is "the use of residential mailing addresses as a sampling frame for surveys of US civilian non-institutionalized population" (Iannacchione 2011, p. 558). ABS, when compared to random digit dialing (RDD) landline telephone sample, has become a viable alternative as a sampling methodology, especially given the issues commonly associated with the use of RDD (i.e., exclusion of cell phone only homes, issues related to number portability, and decline in participation of younger hard-to-reach demographic). Previous research has examined differences in coverage between addressed based (ABS) and random-digit dialing (RDD) methods (see Link et al. 2008; Peytchev, Ridenhour, & Krotk 2010).

 The ABS frame itself (i.e., frame based on address listing) offers clear advantages from other sampling frames in the mere fact that because it is address based it lends itself well to easily append other types of information commonly available including demographic information from sample vendors   (Link et al 2008). Also, census type data readily available at the block group (CBG data) level can be appended to the frame that offers a vast array of information at the neighborhood level for each given address within that block group.   To list a few, CBG data provides data points and insights related to income, marital status, owner – renter status, ethnic and racial groups and occupational status (Burks & Link, 2012). Moreover, ABS frame data are rich and provide options for stratification, oversampling and nonresponse adjustments that extend way beyond what is available for RDD sampling designs.

Nonresponse occurs when data is not collected from people who are sampled for a survey (Goyder 2008). If nonrespondents differ from respondents on variables of interest, nonresponse leads to nonresponse error (de Leeuw, Hox, & Dillman 2008) Response rates are a measure typically reported with a survey as a way to understand the survey's quality. A high response rate does not necessarily mean low nonresponse error due to systematic differences; response rates have become a proxy measure of nonresponse bias because of the difficulty to do research comparing respondents and nonrespondents directly (Dillman 1991).

Reasons for nonresponse include: failure in locating the sample unit; failure in contacting the sample unit; the sample unit refusing to participate; the sample units is unable to participate; the sample unit and data collector fail to be able to communicate; accidental loss of data after it has been collected (Lynn 2008). Whole unit nonresponse may occur due to the social environment, survey design, interviewers, and respondent choices (Groves et al. 2009). The failure to deliver a survey request is noncontact nonresponse; when a contacted person declines the request to participate in the survey, it is noncooperation or refusal nonresponse (Groves et al. 2009). Research suggests as the probability of nonresponse increases data quality decreases (Fricker and Tourangeau 2010). Nonresponse is coped with though attempts at reducing it through survey design and by adjusting for nonresponse through statistics after data has been collected (de Leeuw, Hox, & Dillman 2008)

1.1 Statistical Theories of Nonresponse

Groves (2006) presents two different theories of nonresponse which can be viewed as either deterministic or stochastic. When nonresponse is deterministic it is assumed to be fixed over replications, $Bias(\bar{y}_r) = \left(\frac{M}{N}\right)(\overline{Y_r} - \overline{Y_m})$ (p. 648). The deterministic theory assumes the difference between the mean for respondents in the target population and the mean of nonrespondents in the target population,$(\overline{Y_r} - \overline{Y_m})$, is constant since being a respondent is a fixed property of the individual. (Groves 2006). To combat deterministic nonresponse, total sample sizes are increased.

Stochastic nonresponse theory views nonresponse as a random variable (Groves 2006). Each person "has an unobservable 'propensity' (a probability or likelihood) of being a respondent or nonrespondent" (p.648). The likelihood of responding varies over conceptual replication. Nonresponse bias is a function of how correlated the survey variable is to the propensity to be measured in the target population" (p. 649). Nonresponse typically is seen as a function of motivational variables" (Fricker and Tourangeau 2010, p. 935). When nonresponse is considered stochastic, survey design decisions may impact a person's propensity to respond to a survey request.

1.3 Social Context of Survey Nonresponse

The social environment and survey design can impact nonresponse (Lynn 2008). The social environment influences "the degree of social responsibility felt by a sampled person and the persuasion strategies and decision making strategies used by interviewers and respondents respectively" influencing a potential respondent's wiliness to be interviewed (p.42). Reciprocation, liking, authority, consistency, scarcity, and social validation are psychological principles that apply to a survey participation request (see Groves, Cialdini, Couper 1992). Nonresponse may occur because of a surveys topic, cognitive burden place of respondents, topic sensitivity, or personal risk associated with participation (Lynn 2008). When respondents are asked to participate in a survey they weigh the potential benefits and drawbacks of participating; the goal of the survey researcher is to highlight the benefits and de-emphasize the disadvantages of survey participation.

Data collection choices can affect survey response under the stochastic model under both the leverage salience theory and social exchange theory (see Groves, Singer, and Corning 2000; Dillman 2007). Because people have a propensity, it can be affected through the researcher's actions. Data collection decisions can increase cooperation which will decrease levels of noncooperation/refusal nonresponse. "The survey design can be changed by altering, for example, the survey length (size of request) or the incentive amount (motivation)" (Peytchev, Baxter, & Carley-Baxter 2009, p.786). Both leverage salience theory and social exchange theory attempt to influences people's propensity to respond to the survey request.

1.4 Mode and Nonresponse

"The level of nonresponse can vary greatly between surveys, depending on the nature of sample units, the mode of data collection, the field work procedure used and societal and cultural factors" (Lynn 2008, p.35). Interviewers bring in their own experiences and training which may affect their abilities to gain cooperation and contact. Interviewers may serve as motivators for respondents to respond (de Leeuw and Hox 2008). Interviewers may bring try to bring forth highly salient items as a way of tailoring to their respondents (Groves, Singer & Corning 2000). In self-administered surveys, potential reasons for nonresponse include illiteracy and inability to read the language of the text of the questionnaire (Lynn 2008). Special efforts may need to be made in mail surveys to induce people to respond including visual design and systematic reminders of the survey task (de Leeuw and Hox 2008). "Mixing mode allows one to optimize resources to improve cooperation" (Groves et al. 2009).

1.5 Nonresponse Studies

Unit nonresponse happens when the sample unit is not surveyed either because of refusal to participate or noncontact (Dixon and Tucker 2010). Nonresponse follow-up surveys re-sample nonrespondents to compare to initial respondents, which can be useful in detecting nonresponse bias. However, such studies are costly and time consuming. Iannacchione et al. (2005), in their abbreviated nonresponse follow-up, first contact was a mail survey while the nonresponse follow-up was over the telephone. In a nonresponse bias study for a travel survey, using a telephone survey with a mail follow-up, face-to-face interviews were not considered due to extreme costs (Russell et al. 2004). Bates and Mulry (2007) studied characteristics of initial non-responders in 2000 Census finding reluctant respondents were disproportionately economically disadvantaged, unattached and/or mobile singles, and found in high-density areas with ethnic enclaves. Fricker and Tourangeau (2010) point out bringing in low-propensity respondents may contribute to measurement error and may produce noisy data.

1.6 Models of Response Propensity

Groves (2006) presents five idealized causal models of response propensity. When nonresponse is missing completely at random researchers can consider it "ignorable" (see Little and Rubin 2002). For this research, nonresponse can be seen to follow Groves (2006) "common cause model" where interest in the survey topic is a causal factor of a decision to participate. The topic of the survey in this study was *Household Television and Media Related Survey*. This survey measures consumption of television and access to media content. If a person spends more time at home consuming television and a statistic of interest for this study is television consumption that variable itself may make some people more likely to participate potentially resulting in large nonresponse bias. This type of nonresponse is "nonignorable" because it is potentially directly related to characteristic of interest following the "survey variable cause model". In this paper, the level of nonresponse bias on sets of demographic variables is explored.

2.0 Methodology

The data used for this paper was based on a media survey questionnaire study (i.e., ~40 survey questions) that was conducted in the summer of 2012 where the focus of the survey was to learn more about the equipment that respondents typically used with their television, frequency and the type of content that was watched. For this study, an address based sample frame was used and comprised of 20,735 initial sample records from the following geographic regions—Dallas, TX; Albuquerque e– Santa Fe, NM; Paducah, KY; Cape Girardeau, MO; Harrisburg, IL.

2.1 Survey Mailing

For the mail survey recruitment phase, all sampled householders were initially mailed a pre-recruitment postcard, five days later the media survey was mailed to respondents which included a $10 cash non-contingent incentive and a reminder postcard was mailed seven days later. The data collection period for this survey was three weeks (late June – early July) though surveys received after this date continued to be processed several months after the survey close date. The response rate for the mail recruitment phase of this study was 29.6% (5,471 retuned mail surveys).

2.2 InPerson Recruitment

For the inperson recruitment phase, a subset of nonresponders (N = 1,283) were further sampled for an inperson interview with the goal of achieving 500 completed interviews. During the interview, respondents were ask to complete the media survey with the research interviewer and in return that received a $25 cash incentive for their participation. These interviews were conducted from July – November, 2012. The response rate for the inperson recruitment phase of this study was 53% (682 completed interviews)
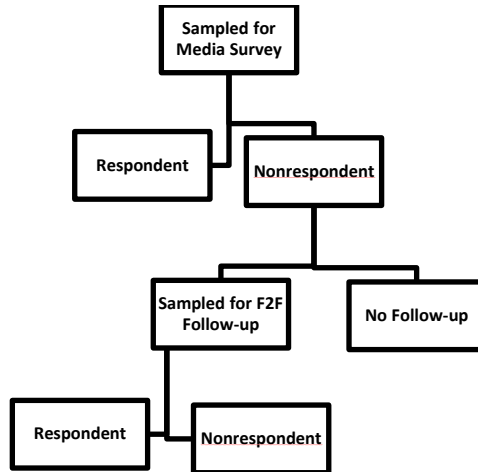
Figure 1. Methodology

3.0 Findings

Groves (2006) presents several ways to go about assessing nonresponse bias. This research falls under the umbrella of studying the variation with the existing survey through nonresponse follow-up studies. According to Groves (2006), the strength of this method is its flexibility in being able to use it on diverse survey modes, topics, and populations. "The weakness of this method is that it offers no direct information about the nonrespondents to the survey" (p.656) providing more of a "continuum of resistance". Other methodologies for nonresponse studies use record data to have "truth" for nonrespondents (see Olson 2006), use post-survey adjustment techniques (see Little and Vartivarian 2005; Raghunathan 2004), or use high-quality gold standard data to compare estimates.

A common source of data for comparisons between respondents and nonrespondents is data attached to the sampling frame (Dixon and Tucker 2010). "Even for household surveys, geospatial data on the frame can be used to obtain information from other sources, such as Census information aggregated to the block, block-group, tract, or zip code level" (p.609). In this paper analysis uses data from the mail survey and the face-to-face follow-up survey. Analysis also looks at ABS block group data for those who responded to either the mail or face-to-face survey and those who did not respond at all.
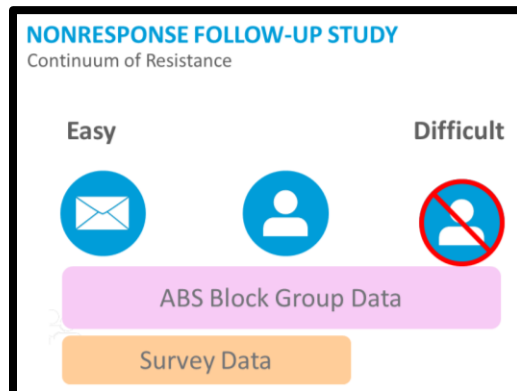

Figure 2. Continuum of Resistance

To understand how respondents to the first mail survey differ from in-person follow-up respondents, survey demographic variables and media variable are examined.   Appendix 1 presents the demographic differences with bias estimate where there were statistically significant differences for 16 demographic variables. Nonrespondents were more male, working full-time, single, Non-White, Hispanic, and bilingual. Respondents were likely to have a Bachelor's Degree or higher education level, $50,000+ household income and older (see Appendix 2 for demographic distributions).

3.2 Media Access and Media Consumption

When looking at the two survey outcomes (i.e., media consumption and media access), findings indicated that responders where more likely to watch more TV and were more likely to have access to media equipment (i.e., cable, directTV, fios, etc.). Respondents were 1.8 times to have media access than compared to Nonrespondents. [1]

Outcome	Estimate from Respondents [SE] (n)	Estimate from Non-respondents* [SE] (n)	Difference (respondent − nonrespondent) (p-value for difference)	Combined Estimate	Bias
Mean Number of Minutes of TV watched in a given day	307.48 [4.63] (5006)	226.46 [9.14] (678)	81.02 t(5654)=7.91; p-value<0.0001	245.61 [7.19] (5684)	+61.87
Proportion of Households with Media Access	84.6% [0.7%] (5204)	75.3% [2.4%] (670)	9.3 t(5844)=4.164*; p-value<0.0001	77.5% [1.9%] (5874)	+7.1

Figure 3. Estimates of Outcomes of Interest by Response Subgroup.

3.3 DMA Geographic Differences (Bird's Eye View)

The geographical areas where the survey was fielded were examined to assess any variation between the respondents and nonresponders at the block group level. Data suggest (i.e., as note by red and green coloring) that block group level data can be used to explain noted differences between the two groups. In figure 4, red represent nonrespondents (inperson), green represents the responders (mail) and blue are both responders and nonresponders (inperson & mail).

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[1] Test of differences represents a test of equality of odds of media access by respondent status. The difference in percentages translates into estimated odds of media access among respondents.
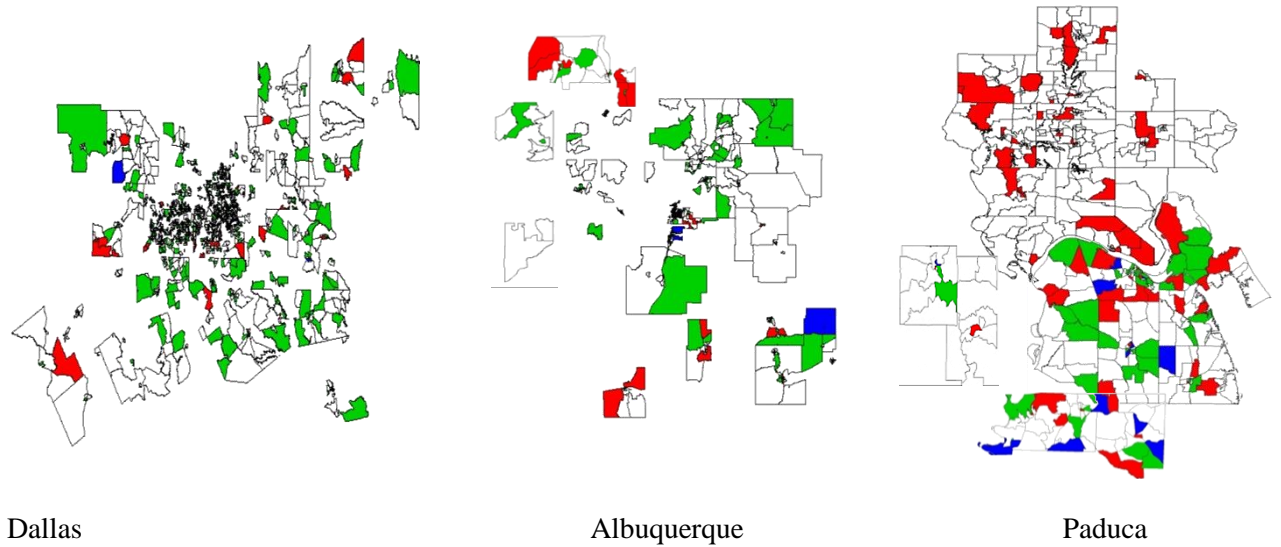
Dallas   Albuquerque   Paduca

Figure 4. A Bird's Eye View of Response at the Block Group Level.

3.4 Propensity Modeling

In general the modeled propensity offers a summary of over 47 variables – the resulting quintiles are highly associated with actual response with larger numbers of respondents hailing in the upper quintiles compared to lower quintiles. In general, the distribution of predicted probabilities from this model is quite high and is negatively skewed – in large part- due to the relative size of respondents to nonrespondents in this small study. [2]
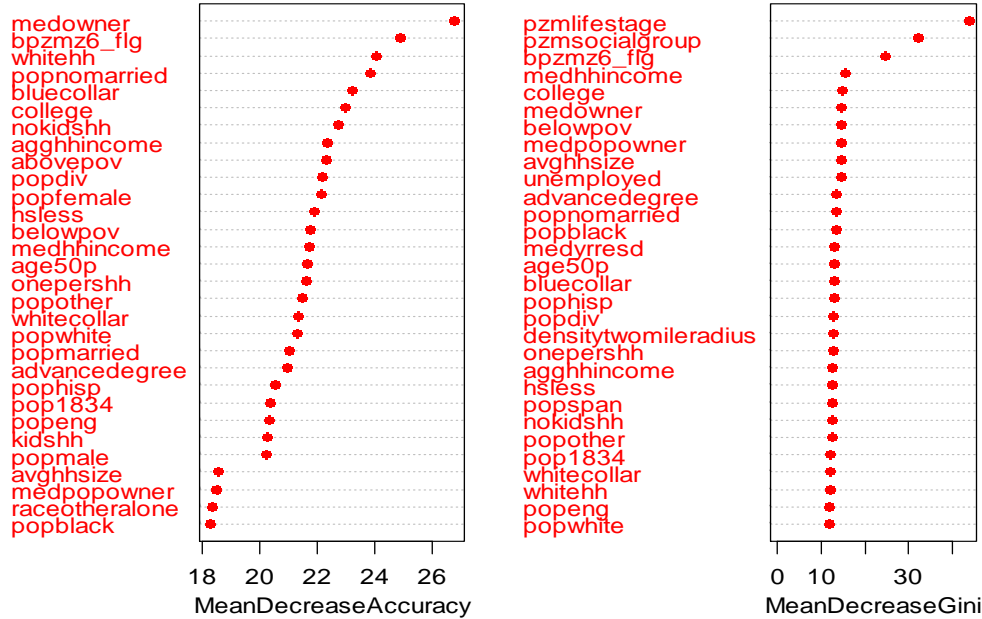

Figure 5. Variables of Importance for Nonresponse.

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[2] These data are only looking at the mail respondents and the in-person respondents- who are treated as nonrespondents.

There was a significant association between response propensity quintile and Media Access (p-value <.01). In general, the proportion of media access tends to increase with response propensity quintile. We would expect gains from the nonresponse adjustments here. The media consumption access variable and response propensity (either as a continuous variable or as categorical variable) did not exhibit a significant relationship with the outcome, so the utility of the RF response propensity as a basis for nonresponse adjustment for estimating the media consumption variable may not be able to reduce the bias.
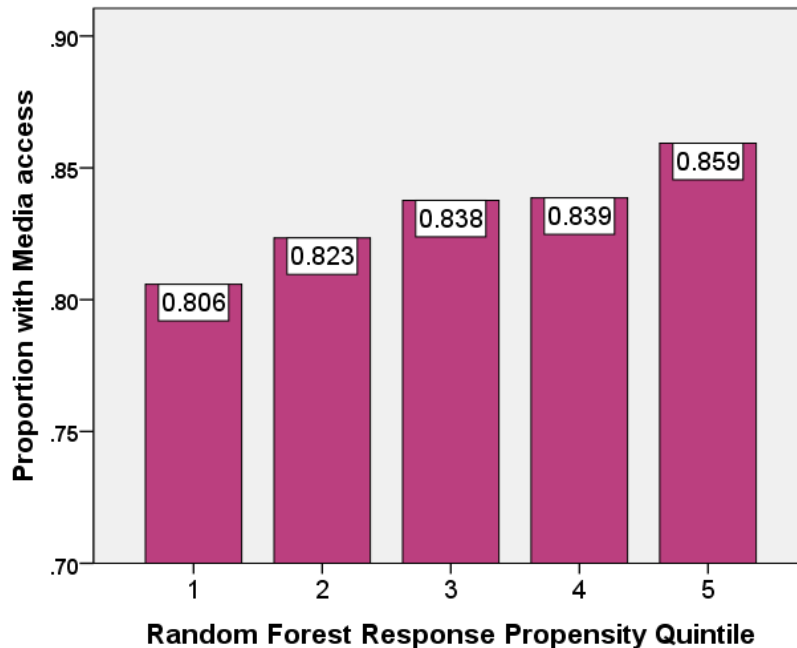

Figure 6. Foreshadowing Nonresponse Bias Adjustments: Relationship between Media Access and response Propensity Quintile

The relationship between response propensity quintile and the media consumption variable is relatively weak – note that there were severe outliers in quintiles 3, 4 and 5 that were in the range of 2000-7000 minutes per day. The lack of relationship here suggests that the rf propensity approach may not be as useful as it would be for media access- we know that response propensities are related to response, but they don't seem to be related to the media consumption variable. Perhaps media access can be considered an affluence property – that can be explained by larger geographical proxy variables like those included at the block group level (percent educated, number of cars, affluence categories, etc.). But media consumption itself is a more personal variable with variability from person to person even within a block, so the block group level variables are too coarse to explain this type of variability. May need more person or household specific information- or at least at a lower level than block group here to fully compensate for the bias.
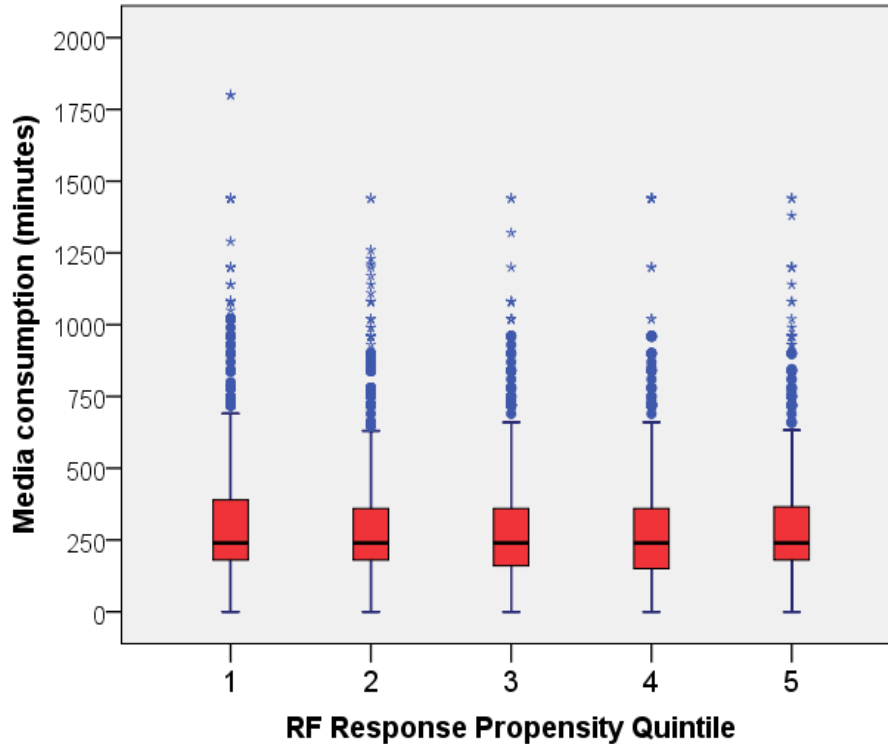
Figure 7. Response propensity quintile and media consumption

4.0 Conclusions

While the relationship between media access and response propensity is statistically significant, the reduction in bias was rather small, but in the expected direction (i.e. reduction). A significant relationship between response propensity stratum and response itself was not sufficient to lower the observed bias in the media consumption variable using either 4 or 5 RP strata. In fact, we actually saw the bias estimate increase slightly (though the values of the estimates by using the base and propensity adjusted weights were well within the sampling error bounds). In part this could be because the response propensity was not related to the media consumption variable. Also, media access could be considered a HH-macro attribute and hence can be explained by measures of affluence or other socio-economic or larger geographical proxy variables like those included at the block group level. Media consumption, on the other hand, might be a more HH-micro attribute with variability from person to person within a block group. Also, block group level variables are too coarse to explain this type of variability which may require more person or household specific information (or at least at a lower level than block group here to fully compensate for the bias). In summary, the use of block group data offered some utility to compensate for bias but not completely and in fact more detailed level data (smaller than data at the block group) needs to be examined to see if this offers improvements to fully compensate for the bias.

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