

# **An Independent Analysis of the Nielsen Diary Nonresponse Bias Study**

## **A Report to the Council for Research Excellence**

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## Executive Summary

- The design of the Nonresponse Bias Study for the Diary Survey made use of innovative research methods (e.g., follow up of respondents and nonrespondents, multiple modes of data collection, and different incentives for different groups); it followed state-of-the-art practices.
- The Michigan-Maryland team used a variety of statistical analytic techniques to explore the potential for nonresponse bias in the Nielsen Diary Survey. We did several sensitivity analyses to test the robustness of our assumptions. We tried different coding of the analytic variables, different target populations, and different forms of the estimators. Multivariate analyses were used to model the effect of Nielsen postratification adjustments. Overall, we feel comfortable with the robustness of our conclusions.
- We found no evidence of nonresponse bias in viewing estimates for 11 of the 14 dayparts we analyzed. We found no evidence of nonresponse bias in viewing estimates for 9 of the 16 channels we analyzed (ABC, A&E, AMC, CNN, ESPN, FOX, TLC, TNT, and USA).
- In studying the likely effect of Nielsen postratification adjustments we focused on 7 of the 10 viewing estimates that showed nonresponse bias in the bivariate analyses. We conclude that the Nielsen postratification adjustments would successfully dampen nonresponse bias for 2 of the 7 measures we analyzed. However, there was evidence of nonresponse bias after controlling for poststratification variables in for viewing estimates involving CBS, NBC, UNIVISION, BET, and HBO.
- We also modeled the effect of using additional adjustment variables in an attempt to remove the nonresponse bias in the viewing estimates for the 5 remaining channels. Our preliminary results indicate that bias is unlikely to be removed for 4 of the 5 channels. The use of additional nonresponse adjustments procedures, as a bias reduction technique, should be carefully evaluated given these preliminary results.
- We performed an initial evaluation of whether the above conclusions from the NRB study themselves might be subject to problems due to low response rates to the NRB mailed questionnaire in some groups. Overall, we see little evidence of problems arising from this.

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## **1. Overview of the Study**

### **1.1 Description of the Study Rationale and the Role of the Michigan-Maryland Team**

The Nielsen sample survey utilizing self-report diaries has been a key component of audience measurement for several decades. As is true for almost all major sample surveys in the western world, response rates in the Nielsen diary survey have fallen in recent years. These lower response rates have raised concerns about potential nonresponse biases.

Nonresponse rates measure the percentage of eligible sample units that provide usable data. If the Nielsen diary nonrespondent houses have different viewing behavior than respondent homes, then Nielsen viewing estimates might be subject to over or under-estimation. Nonresponse rates alone, however, do not indicate that such estimation problems exist. Hence, the special Nonresponse Bias Study (NRB) was mounted to determine whether respondents and nonrespondents to the diary survey might differ on key statistics. This is a report on the results of that study.

It is important for the reader to note that it focuses almost exclusively on nonresponse bias issues. Nonresponse is only one quality dimension of the Nielsen estimates. Others include the fact that households without telephones cannot participate in the survey because telephone sampling is used to recruit diary respondents. Additionally, measurement errors due to the failure to report accurately the viewing that took place for each television set can affect Nielsen estimates. A full picture of the quality of Nielsen estimates requires attention to these and other issues simultaneously. Thus, while the nonresponse bias study targets an important property of the diary survey, the nonresponse issue needs to be considered within the context of all of the quality dimensions of survey data.

This is a report to the Council on Research Excellence. It summarizes work done for the Council by a team from the University of Michigan (Groves, Bowers) and University of Maryland (Kreuter, Casas-Cordero), with assistance from Professor Peter Miller of Northwestern University. This group was employed to provide an independent examination of the results of the nonresponse bias study. That study was designed and conducted by Nielsen, with ongoing input from the Michigan-Maryland group. However, all data collection and data file preparation tasks were the responsibility of the Nielsen staff. The designated role of the Michigan-Maryland group was to:

1. Report to the Council nonresponse subcommittee on key issues in the design (power analysis for the NRB study, sample design, questionnaire design, neighborhood observation forms and call record forms),
2. Observe the training of Nielsen and RTI interviewing staffs,
3. Participate in many telephone conference calls with Nielsen staff during the data processing and analysis planning stages,
4. Replicate Nielsen analyses as an auditing of their findings, and
5. Conduct an independent analysis seeking insights into the magnitude and character of nonresponse bias in viewing estimates.

## **1.2 Overview Judgments of the Michigan-Maryland Team**

In response to a request by the nonresponse subcommittee of the Council, the Michigan-Maryland team provides the following statement of our key judgments about the Nonresponse Bias Study.

1. We believe the NRB was a state-of-the-art implementation of a nonresponse bias study design; while the NRB did not succeed in measuring all the Nielsen nonrespondents sampled, there do not appear to be severe weaknesses of the study because of that.
2. The key statistical results suggest that, for a large set of estimates of audience behavior, there are only small nonresponse bias magnitudes.
3. There are, however, some estimates that appear to suffer from nonresponse bias (both over and under-estimates); these biases seem robust to alternative ways of estimating them.
4. For some of the biased estimates, the current Nielsen adjustments appear to be capable of reducing them; for others, our exploratory analysis suggests that traditional adjustments may not be successful.

## 2. Oversight and Replication

### 2.1. Study Implementation

Our work primarily involved analysis of data collected by Nielsen during the course of the nonresponse bias study (Tables 1 and 2). These data included responses to the Diary Questionnaire and a number of auxiliary datasets. UMI-UMD developed fluid communication with the CRE and the Nielsen group. The data cleaning and file preparation process took longer than expected. There were delays in the delivery of the preliminary Diary Questionnaire dataset and in the delivery of the validation data (still pending). However, the delivery of auxiliary datasets was timely for: the original call records (M86 and Call History files), the geographic data (Claritas and Prizm files), and the NRB data collection (Tracking file, Call Records file, Neighborhood Observations file).

A complete list of major activities is summarized in appendices. See Appendix A for tables summarizing major project activities and response rates. See Appendix B for memorandums and presentations sent to the CRE and Nielsen.

**Table 1. Delivery of Documentation to the CRE and Nielsen, File Format.**

<b>Documents</b>	<b>Delivery Date</b>
<i>Sent to CRE</i>	
Power Analysis 1, DOC	10/04/06
Power Analysis 2, DOC	11/01/06
Preliminary Analysis Plan UMI-UMD, PPT	06/15/07
Analysis Plan UMI-UMD, PPT	01/14/08
Preliminary Analysis Diary, PPT	12/03/08
Subgroup Analysis Diary and Meter, PPT	01/26/09
Draft Analysis Report Diary, DOC	03/09/09
<i>Sent to Nielsen</i>	
Questionnaire content, DOC	10/15/06
Sample Design, DOC	02/13/07
Review Result Codes (In Person mode), DOC	07/17/07
Neighborhood Observation Form (In person mode), DOC	Jun-Aug08
Call Record Form (In Person mode), DOC	Jun-Aug08
Quality Recording Phone Training, DOC	04/22/08

Note: PPT = Power Point Presentation, DOC = Word Document.

**Table 2. Tally of Datasets for Analysis of the Diary, Dates When Nielsen Delivered the Datasets.**

Datasets	Date Nielsen delivered to UMI-UMD
<i>Diary Questionnaire</i>	
Questionnaire, version 0 (mail only)	03/18/08
Questionnaire, version 1	09/25/08
Questionnaire, version 2	10/22/08
Questionnaire, version 3	11/18/08
Comments (open questions)	10/01/08
Other stations (open question)	08/20/08
<i>Weighting variables</i>	
Selection weights, version 1	03/26/08
Selection weights, version 2	06/06/08
Selection weights, version 3	10/23/08
Respondent weights, version 1	10/22/08
Respondent weights, version 2	10/29/08
Postratification Total weights	12/19/08
Postratification Intab weights, version 1	12/19/08
Postratification Intab weights, version 2	02/09/09
<i>Geographic Data</i>	
Geographic identifiers, version 1	12/22/08
Geographic identifiers, version 2	03/02/09
Claritas	04/21/08
Claritas (additional variables)	03/09/09
PRIZM	09/25/08
County & Territory	11/19/08
<i>NRB Data Collection</i>	
Tracking File (all modes)	11/21/08
Case Control File (In Person)	07/11/08
Neighborhood Observations File (In Person)	07/11/08
<i>Call Record &amp; Call History</i>	
M86 File - Feb'07	12/19/08
M86 File - Nov'06	01/22/09
<i>Diary Ratings</i>	
Ratings & Demographics (Intab only)	End of Q1-2009

There are many follow-up studies of survey nonresponse that attempt to contact and measure samples of nonrespondents, after the survey is complete. By measuring the nonrespondents and comparing their characteristics to respondents, estimates of nonresponse bias in the original survey can be derived. A key issue in such follow-up studies is how successfully the original nonrespondents can be contacted and measured.

In our judgment the Nielsen nonresponse bias study implemented a successful method for recruiting participants with elaborate follow-up strategies, high monetary incentives, and multiple

modes of data collection. We observed quite high quality training for In-Person and Phone interviewing follow-up modes.

The study reached a high response rate (83.56 %) for originally Accepting, Refusing and Noncontacted Mailable cases (those for which addresses could be obtained linked to the sampled phone number) but a low response rate among the corresponding Unmailable cases (11.35%). We note that many Unmailable cases have historically found to be nonhousehold numbers (nonworking or other numbers outside the household population). See Table 3.

**Table 3. Sample Distribution and Response Rates by NRB Strata.**

Mailing Status	NRB Strata		Number of Cases		Response Rates	
	Intab Status	Call Status	NRB Sample	NRB Respondents	Unweighted (1)	Weighted (2)
Mailable	Intab	Accepting	500	474	98.80	93.94
Mailable	Intab	Refusing	1,000	909	90.90	91.61
Mailable	Intab	Noncontacted	500	461	92.20	92.92
Mailable	NoGood	Accepting	1,000	856	85.60	85.46
Mailable	NoGood	Refusing	1,000	670	67.00	66.30
Mailable	NoGood	Noncontacted	1,000	756	75.60	76.57
Mailable	NoReturn	Accepting	500	409	81.80	82.69
Mailable	NoReturn	Refusing	1,000	751	75.10	75.51
Mailable	NoReturn	Noncontacted	500	364	72.80	74.84
UnMailable	-	Refusing	1,000	272	27.20	26.75
UnMailable	-	NoContacted	1,000	62	6.20	5.35
<b>Total</b>			<b>9,000</b>	<b>5,984</b>	<b>66.49</b>	<b>59.91</b>

Notes: (1) Unweighted response rates reflect the ratio (NRB respondents/NRB sample) for each strata.

(2) The Weighted response rate weights each case by its corresponding selection probability. See a description of the calculation of these response rates in Appendix A.



## 2.2. Replication of Nielsen Analysis

Nielsen presented their analysis in two steps (see Nielsen presentation of results). We were able to replicate the first step without any discrepancies from their findings.

The second step of the Nielsen analysis asked how the postsurvey adjustments for nonresponse and coverage that Nielsen implements routinely for their published data affect estimates of nonresponse bias from the NRB. Nielsen statisticians use data from Claritas (often based on Census provided estimates of population characteristics) to weight respondent cases to reproduce the population aggregate distribution on those variables. Post-survey adjustment is a standard practice in sample surveys. Adjustments can be performed in a variety of ways.

The Michigan-Maryland team raised three concerns about the Nielsen postsurvey adjustments. In order to weight the respondent sample, the Census variables must be measured on all respondent cases. When there is item missing data on a poststratification variable on a respondent case, it is often imputed or the case is assigned to a poststratum in some other fashion. Rarely, if ever, in practice, are poststratified estimates based on small subsets of the respondent pool because poststratification variables are missing. Nielsen chose to drop many respondent cases from the poststratified estimation because of missing data. In the judgment of the Michigan-Maryland team, this raises serious issues about the interpretation of the poststratified estimates.

Second, poststratification generally requires putting cases into groups sharing values on the poststratification factors. When the sample size is small (as is the case for the NRB diary sample), some of the poststratification cells may have only a few cases in them or even no cases. Common practice in such instances is to combine adjacent poststrata in order to preserve population totals. Currently we do not have enough information to evaluate such collapsing done by Nielsen.

Third, it is standard practice to let the share of poststratification weights be determined by the multivariate raking process. Currently we do not understand Nielsen's decision to force the share of the poststratification weights in NRB selection strata to conform to the share of the selection weights in those strata.

For these three reasons, the Michigan-Maryland team did not replicate the second step in the Nielsen analytic plan.

### 3. Independent Analysis

The Michigan-Maryland team conducted an independent analysis of the NRB study data, seeking insights into the magnitude of and character of nonresponse bias in the Nielsen viewing estimates. The five parts of this independent analysis are presented in this section.

- Section 3.1 offers tests for differences on key statistics of TV viewing between *Intabs* and *NonIntabs* – respondents to the NRB study who originally participated in the Nielsen diary measurement and respondents who did not participate. The results from this analysis should signal potential for nonresponse bias in the TV viewing measures. (By “Intabs” we mean cases that were used in the estimation of Nielsen published viewing estimates; “NonIntabs” are the complement set of sampled telephone numbers.)
- Section 3.2 provides estimates of nonresponse bias in the TV viewing measures given the differences between Intabs and NonIntabs found in 3.1.
- Section 3.3 tests for differences on several demographic measures between Intabs and NonIntabs. The results from this analysis should signal whether differences in the covariates between Intabs and NonIntabs can explain any observed viewing differences.
- Section 3.4 tests for differences on attitudinal measures between Intabs and NonIntabs. The results from this analysis should signal whether differences in the covariates between Intabs and NonIntabs can explain any observed viewing differences.
- Section 3.5 further examines the results of 3.1. Here estimates are provided for the differences on key statistics between Intabs and NonIntabs after controlling for multiple covariates. This analysis gives insights into the potential effectiveness of poststratification weights for removing the nonresponse bias in Nielsen viewing estimates.

To guard against interviewing different households than those initially recruited for the diary survey, the NRB study questionnaire included two questions about the length of time the household members have lived at the current address (Questions 108 and 109) and a question on whether or not the respondent remembers a Nielsen diary placement telephone call. In our analyses we included only those cases that had

- (1) at least one household member living at the current address for at least 1 year; this includes the time of the Nielsen placement call (see Nielsen report), or those that

(2) declared having received the Nielsen diary placement call, resulting in ~5,660 cases that comply with either or both of these two conditions. Nielsen employed a smaller case base based only on criteria (1).

We should also point out the NRB study the questionnaire was to be completed by the head of the household, defined as someone living in the household who owns, is buying or rents the home (see Nielsen report). Throughout the report we will point out which TV viewing measures refer to reports about the entire household and which ones about respondent level viewing.

A complete list of the development of the analytic variables, the weighting variables, and the variance estimation procedures is summarized in Appendix C. The standard errors were estimated using Jackknife Repeated Replications (20 replications). All analysis used the nonresponse adjusted selection weights (referred to as “Respondent Weight” in the appendices). All the analyses presented here were conducted with Stata 10.

### **3.1. Comparison of Intabs versus NonIntabs on Viewing Measures**

We analyzed two measures of TV viewing: the percentage of households that reported watching TV during a given day part (“Dayparts”), and the percentage of households responding that they typically watch a given station daily or weekly (“Stations”). For broadcast stations the estimation sample consists of ~5,660 cases. For non-broadcast stations the estimation sample includes only those households that reported subscribing to cable or satellite service, resulting in roughly ~4,900 cases. The variation in sample size ( $n$ ) observed in some of the tables is explained by item missing data particular to each measure.

#### Day parts

- At the household level, we found a difference between Intabs and NonIntabs in 1 of the 7 Dayparts under study. NonIntabs reported watching more Late News (11pm-2am) than Intabs. See Table 4.
- At the person level, we found differences between Intabs and NonIntabs in 2 of the 7 Dayparts. NonIntabs reported watching more Late News (11pm-2am) than Intabs. NonIntabs reported watching less Early News (4pm-8pm) than Intabs. See Table 5.

**Table 4. Percentage of Households Watching TV Yesterday.**

Daypart	Intab		NonIntab		n	p-value
	%	SE	%	SE		
5am-9am	46.5	1.66	48.6	2.78	5,658	0.5144
9am-4pm	57.1	2.24	58.4	2.65	5,657	0.7052
4pm-8pm	76.0	1.41	71.8	2.45	5,659	0.1203
8pm-11pm	82.4	1.94	77.5	1.57	5,659	0.0703
11pm-2am	32.8	2.39	39.1	2.01	5,659	0.0446
2am-5am	7.5	1.13	11.6	1.74	5,659	0.0728
12am-12am	93.6	1.08	93.2	0.65	5,657	0.7911

**Table 5. Percentage of Persons Watching TV Yesterday.**

Daypart	Intab		NonIntab		n	p-value
	%	SE	%	SE		
5am-9am	33.6	1.63	34.5	2.06	5,659	0.6967
9am-4pm	41.9	1.94	38.7	1.89	5,659	0.1626
4pm-8pm	63.4	1.62	56.3	1.74	5,660	0.0092
8pm-11pm	71.2	1.99	68.5	1.32	5,660	0.2966
11pm-2am	22.7	1.85	29.7	2.17	5,660	0.0176
2am-5am	4.9	0.77	7.4	1.85	5,660	0.1839
12am-12am	89.1	1.37	88.8	0.81	5,659	0.8694

### Stations

In the NRB study station viewing was only measured at the person level (Question 31, see Nielsen report). Thus all results presented here are on the person level.

**Table 6. Percentage of Persons Watching Broadcast Stations Daily or Weekly.**

Station	Intab		NonIntab		n	p-value
	%	SE	%	SE		
ABC	75.5	1.75	73.2	1.77	5,664	0.3530
CBS	76.9	1.40	71.6	2.06	5,664	0.0202
FOX	72.9	1.37	70.7	1.94	5,664	0.2989
NBC	79.4	1.12	72.8	2.23	5,664	0.0143
UNIVISION	3.1	0.54	5.7	0.76	5,664	0.0019

- Differences between Intabs and NonIntabs were found for 7 of the 16 stations included in the questionnaire. See Table 6.
- NonIntabs reported watching more BET, CARTOON, HBO, MTV and UNIVISION than Intabs. NonIntabs reported watching less CBS and NBC than Intabs.

**Table 7. Percentage of Persons watching Non-Broadcast Stations Daily or Weekly.**

Station	Intab		NonIntab		n	p-value
	%	SE	%	SE		
A&E	35.22	2.03	32.80	2.39	4,904	0.4514
AMC	23.74	1.57	22.56	1.87	4,904	0.6505
BET	4.86	0.93	11.71	1.05	4,904	0.0001
CARTOON	15.00	1.43	22.23	1.79	4,904	0.0089
CNN	41.77	2.39	40.51	2.31	4,904	0.7156
ESPN	39.41	1.58	43.24	2.49	4,904	0.1090
HBO	15.85	1.32	27.80	1.95	4,904	0.0000
MTV	12.58	1.22	16.78	1.26	4,904	0.0193
TLC	37.09	2.42	35.44	1.59	4,904	0.5596
TNT	46.05	1.45	50.04	3.42	4,904	0.2490
USA	44.06	1.08	46.77	2.46	4,904	0.3475

We ran sensitivity analyses using different estimation samples and different Intab groups. The main results remain stable. When splitting the NonIntab group into “NoGoods” (those who returned at least one questionnaire but one of insufficient completeness to use in estimation) and “NoReturns” (those not returning a questionnaire), we see different viewing patterns for the different NonIntab groups. Future research could benefit from looking closer into these mechanisms. See Appendix D for more detailed discussion of the sensitivity analyses.

### 3.2. Estimates of Nonresponse Bias on Viewing Measures

The difference between Intabs and NonIntabs studied in 3.1 merely indicates potential for nonresponse bias in key statistics. Thus we create estimates of such nonresponse bias for the diary sample using the following estimator  $\hat{\theta} = (\hat{y}_{intab} - \hat{y}_{total})$ , where  $\hat{y}_{intab}$  is the estimate of key statistics estimated from ~1,840 responding Intab cases, and  $\hat{y}_{total}$  is the estimate based on all ~5,980 responding cases (Intabs + NonIntabs). An estimate of zero for  $\hat{\theta}$  indicates absence of nonresponse bias when using the Intab sample to make inferences to the Total sample. A significant positive value indicates that the Intab sample overestimates the viewing of the Total sample. A significant negative value indicates that the Intab sample underestimates the viewing of the Total sample.

In addition we used two alternative nonresponse bias measures: A relative nonresponse bias measure expressed as  $RelBias = (\hat{y}_{intab} - \hat{y}_{total}) / \hat{y}_{total}$ , and a ratio measure expressed as  $\hat{R} = (\hat{y}_{intab} / \hat{y}_{total})$ ; results from those analyses are provided in Appendix D.

### Day parts and Stations

- Across all 30 key statistics examined here, evidence for nonresponse bias can be found for 10. Table 8 presents the estimates for these ten viewing measures.
- Figure 1 illustrates the estimates of the nonresponse bias for all the 30 viewing measures.

**Table 8. Estimate of Nonresponse Bias in Diary Samples (Intab-Total).**

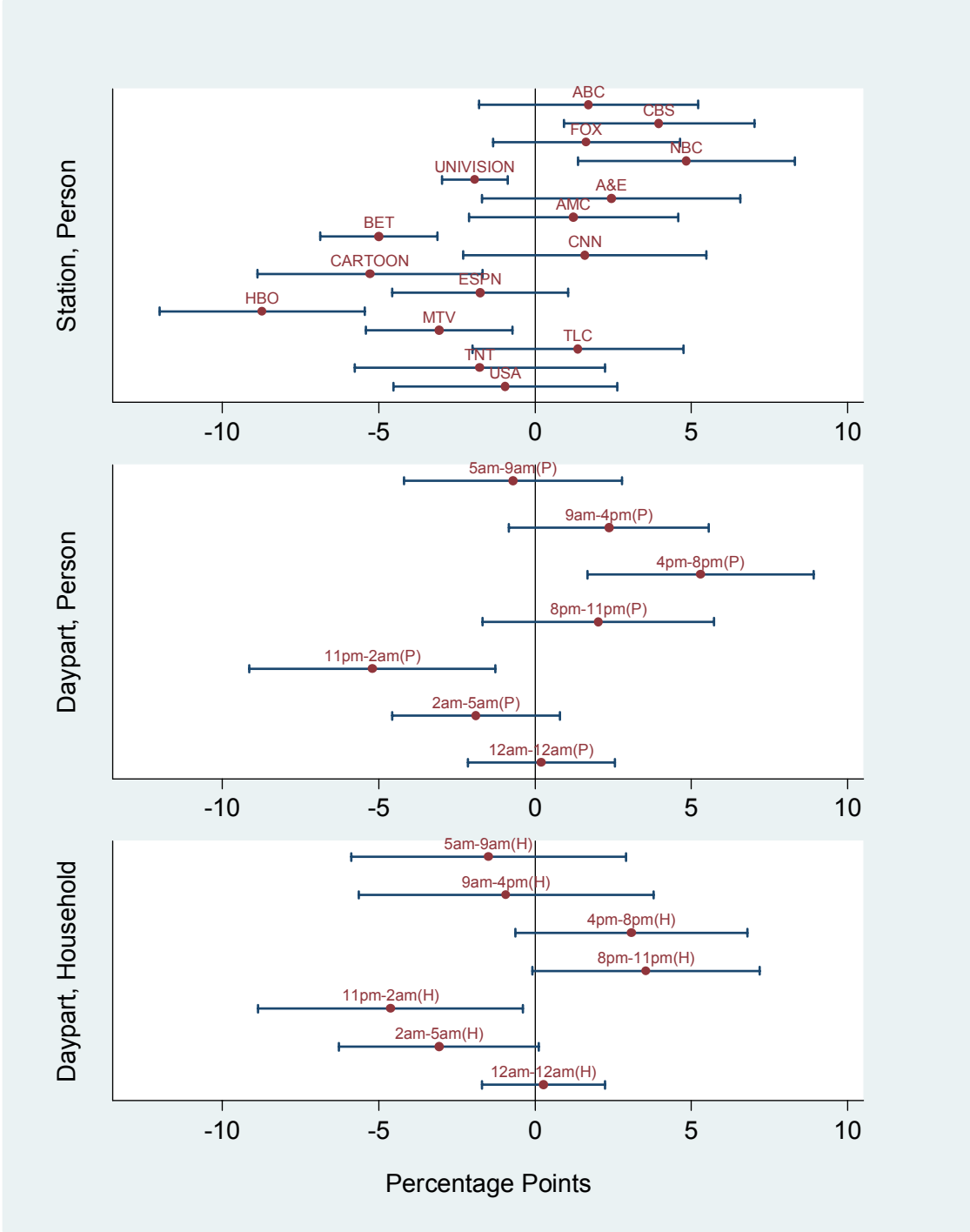
Daypart & Stations	Intab		Total		Bias		n	p-value
	%	SE	%	SE	%	SE		
Late News_HH	32.81	1.94	37.43	1.85	-4.62	2.16	5,659	0.0322
Early News_P	63.45	1.99	58.16	1.83	5.29	1.85	5,660	0.0042
Late News_P	22.67	1.71	27.88	1.86	-5.21	2.01	5,660	0.0095
CBS	76.95	1.75	72.98	1.44	3.96	1.56	5,664	0.0108
NBC	79.38	1.59	74.53	1.40	4.85	1.77	5,664	0.0061
UNIVISION	3.11	0.64	5.03	0.69	-1.92	0.53	5,664	0.0003
CARTOON	15.00	1.56	20.28	1.71	-5.28	1.83	4,904	0.0040
MTV	12.58	1.49	15.65	1.19	-3.07	1.19	4,904	0.0102
BET	4.86	0.82	9.86	0.91	-4.99	0.96	4,904	0.0000
HBO	15.85	1.63	24.57	1.99	-8.72	1.67	4,904	0.0000

### Conclusions:

Intabs cases watch less Late News both on the household and on the person level measure. Measured on the respondent level, Intabs cases watch less CARTOON, MTV, UNIVISION, BET and HBO than All cases. For example, according to Table 8, the percentage of households that declared viewing BET daily or weekly is 4.8 percentage points lower for Intabs in comparison to All households. In other words, estimates derived from the Intab cases only, underestimate the percentage of households that watch BET Daily/Weekly.

Compared to all cases, Intabs watch more Early News, CBS and NBC. For example, according to Table 8, the percentage of households that reported viewing to CBS daily or weekly is 3.96 percentage points higher for Intabs in comparison to all households. In other words, estimates derived from the Intab cases only, overestimate the percentage of households that views CBS Daily/Weekly.

Figure 1. Estimates of Nonresponse Bias in Percentage Points for all TV Measures Under Analysis.



Notes: (1) The red points in the graph represent the point estimates of the nonresponse bias. (2) The blue lines represent a confidence interval for the estimate of the nonresponse bias. (3) The black line at the zero mark serves as point of reference for the absence of nonresponse bias.

### 3.3. Comparison of Intabs versus NonIntabs on Demographic and Geographic Characteristics

In addition to estimating potential nonresponse bias in the key viewing statistics, we examined differences in the demographics between Intabs and NonIntabs. Those might not result in nonresponse bias of TV viewing but can signal potential for nonresponse bias on demographic variables. In this section we compare Intabs and NonIntabs on 20 binary measures of demographic characteristics and 9 categorical measures of demographic and geographic characteristics. To the extent possible we followed Nielsen’s National Audience Demographics Report when selecting variables and creating categories (see Appendix C).

#### Household Level

- At the Household level Intabs and NonIntabs show statistically significant differences in 5 of the 7 demographic characteristics studied. See Table 9.
- Compared to Intabs, NonIntabs are more likely to have children under the age 18, are more likely to have children under the age of 6 and tend to have larger households. NonIntabs are less likely to own their housing unit.
- We also found differences in the distribution across territory for Intabs and NonIntabs cases. See Table 10

**Table 9. Household Demographic Characteristics by Intab Status; Binary and Categorical Variables.**

Demographic variables	Intab		NonIntab		n	p-value
	%	SE	%	SE		
Has Child<18	31.1	1.96	43.3	2.34	5,422	0.0019
Has Child<6	11.6	1.08	18.0	2.37	5,387	0.0097
Has Income<\$40k	38.4	2.04	32.4	2.33	4,842	0.0564
Has Income<\$80k	81.8	1.63	81.0	2.28	4,842	0.8087
Owens housing unit	89.2	1.21	83.2	1.60	5,577	0.0021
<i>Household Size</i>						
0 HH members	0.7	0.42	0.4	0.18	5,532	0.0007
1 HH member	19.2	1.37	15.9	1.55	--	--
2 HH members	42.0	2.17	32.2	1.93	--	--
3 HH members	14.7	1.36	17.2	1.46	--	--
4 HH members	14.7	1.83	17.6	1.61	--	--
5 or more HH members	8.8	0.99	16.7	1.54	--	--
<i>Household Size</i>						
1 HH member	19.3	1.37	16.0	1.55	5,497	0.0005
2 HH members	42.2	2.20	32.4	1.94	--	--
3 or more HH members	38.4	1.77	51.7	1.67	--	--



**Table 10. Geographic Characteristics by Intab Status; Categorical Variables.**

Geography variables	Intab		NonIntab		n	p-value
	%	SE	%	SE		
<i>County Size</i>						
A	10.6	1.47	11.4	1.78	5,664	0.8964
B	41.7	1.99	42.8	2.72	--	--
C	23.9	1.52	22.1	1.73	--	--
D	23.9	1.48	23.7	1.96	--	--
<i>Territory</i>						
Northeast	11.8	1.17	9.3	1.04	5,664	0.0086
East Central	17.5	1.36	14.1	1.75	--	--
West Central	25.2	1.80	17.9	1.72	--	--
Southeast	22.4	1.57	28.5	2.90	--	--
Southwest	8.7	0.83	12.8	1.69	--	--
Pacific	14.5	1.41	17.3	2.27	--	--

Person Level

- At the Person level, we found differences between Intabs and NonIntabs in 11 of the 20 demographic characteristics we studied. See Tables 11-13.
- Looking at the race categories, there are more with Hispanic ancestry, Black, Native American, and Other racial groups among NonIntabs. NonIntabs are more likely to list Mexican origin
- Intabs are more likely to be Non-Hispanic and Non-Black.

**Table 11. Percentage of Respondent Demographic Characteristics by Intab Status; Binary Variables.**

Demographic variables	Intab		NonIntab		n	p-value
	%	SE	%	SE		
Has 50+ yrs	61.7	1.66	49.4	3.25	5,415	0.0037
Male	36.4	1.85	42.4	2.69	5,511	0.1206
Has Hispanic Ancestor	4.3	0.75	10.2	1.60	5,539	0.0060
Hispanic	5.0	1.06	8.4	1.30	5,533	0.0747
Race Asian	1.1	0.43	4	0.27	5,524	0.5281
Race Black	5.1	0.85	10.6	1.48	5,524	0.0033
Race Hawaiian	0.4	0.30	5	0.17	5,524	0.6569
Race Native American	1.3	0.28	2.7	0.48	5,524	0.0076
Race Other	2.2	0.57	4	0.65	5,525	0.0022
Race White	91.2	0.99	82	1.46	5,524	0.0000
Non-Hispanic and Non-Black	90.8	1.18	81.8	1.79	5,451	0.0011
Has Cuban origin	5.1	2.85	5.8	1.97	405	0.8372
Has Mexican origin	45.0	11.11	70.6	5.44	405	0.0351
Has Other origin	44.7	12.95	22.7	4.85	405	0.1098
Has Puerto Rican origin	5.8	2.93	8.8	2.52	405	0.4138

NonIntabs have more respondents of younger age compared to Intabs.

NonIntabs work more full time, and are more likely to have a spouse working full time than Intabs.

**Table 12. Distribution of Respondent Demographic Characteristics by Intab Status; Categorical Variables.**

Demographic variables	Intab		NonIntab		n	p-value
	%	SE	%	SE		
<i>Age Categories</i>						
>=34 years	8.9	1.20	19.1	3.36	5,415	0.0000
35-49 years	29.5	1.34	31.6	1.76	--	--
50-64 years	31.8	1.70	32.4	2.25	--	--
<=65 years	29.9	1.66	17.0	1.64	--	--
<i>Marital Status</i>						
married/cohabitate	66.3	1.65	64.9	2.21	5,584	0.1870
divorced/separated/widow	25.9	1.55	23.8	1.92	--	--
single/never married	7.8	1.29	11.3	1.72	--	--
<i>Education Respondent</i>						
Less than HS	5.5	0.93	10.4	1.09	5,554	0.1189
HS Diploma	27.1	2.28	23.6	1.36	--	--
Some College	22.8	1.52	22.1	2.28	--	--
Associate/Bachelor	31.1	1.33	32.0	3.06	--	--
Graduate/Professional	13.6	1.56	11.9	1.81	--	--

**Table 13. Distribution of Respondent Demographic Characteristics by Intab Status; Categorical Variables.**

<i>Occupation Respondent</i>						
working fulltime/vacation	45.5	1.90	57.2	1.78	5,587	0.0001
Part-time work	10.6	1.23	10.1	1.02	--	--
retired	31.8	2.02	17.4	1.76	--	--
unemployed/others	12.1	1.47	15.3	1.70	--	--
<i>Occupation Spouse</i>						
working fulltime/vacation	58.6	2.18	69.2	1.87	3,336	0.0136
partime work	8.2	1.20	7.3	1.32	--	--
retired	21.9	2.01	13.3	1.37	--	--
unemployed/others	11.3	1.81	10.2	1.46	--	--

### 3.4. Comparison of Intabs versus NonIntabs on TV Equipment, Respondents' TV Viewing Behavior

The NRB study questionnaire contained a series of questions about the Nielsen diary household's TV equipment, as well as questions about the respondents' TV viewing behavior. We compared Intabs and NonIntabs on those items, using a total of 12 binary measures of TV Equipment, 12 categorical measures of TV Attitudes and Behavior, and 8 measures of hours spent at home or on leisure activities.

#### Household Level

- Intabs and NonIntabs differ in 10 of the 12 measures of TV equipment (Table 14).
- NonIntabs are more likely than Intabs to have a big screen TV, have Digital Cable, have satellite reception, have a DVR, have a DVR provided by cable/satellite, have a computer at home, have high speed internet, and watch TV over the internet than Intabs. NonIntabs are less likely than Intabs to have cable.

**Table 14. Percentage of Households with TV Equipment by Intab Status.**

TV Equipment variables	Intab		NonIntab		n	p-value
	%	SE	%	SE		
Has Big Screen	30.7	1.50	39.3	2.76	5,632	0.0328
Has Cable	65.3	1.91	56.2	2.39	5,632	0.0115
Has Digital Cable	43.5	2.97	58.4	2.76	3,499	0.0007
Has Satellite	29.1	1.57	35.6	2.59	5,609	0.0427
Has DVD	87.1	1.13	88.7	1.32	5,582	0.3053
Has DVR	16.7	0.96	25.5	3.69	5,609	0.0310
Has DVR provided through Cable/Satellite	22.9	1.35	34.1	4.10	4,447	0.0108
Has Computer at home	74.4	1.68	81.4	1.35	5,559	0.0008
Has High speed Internet	68.2	1.86	73.3	2.03	3,914	0.0457
Can watch TV over the Internet	64.7	2.83	76.2	2.56	2,579	0.0096
Has 3+ TVs	56.3	1.59	62.3	2.70	5,664	0.0995

- We also found differences between Intabs and NonIntabs in 3 of the 6 measures of TV behavior (Table 15)
- NonIntabs are more likely to have their TV on all the time, rather than only when some is watching.
- NonIntabs are more likely to watch TV in groups at night.
- NonIntabs are more likely to have had visitors watching TV at home in the last 30 days.

**Table 15. Mean Score on TV Behavior and Attitudes by Intab Status; Household Level.**

TV Behavior and Attitude variables*	Scale	Intab		NonIntab		n	p-value
		mean	SE	mean	SE		
Household won't miss watching TV for 1 week (=5)	(1,5)	2.35	0.04	2.26	0.06	5,549	0.2505
TV only on when someone watching (=7)	(1,7)	5.08	0.08	4.62	0.08	5,513	0.0017
Household watches TV in groups at night (=1)	(0,1)	0.59	0.02	0.65	0.01	5,543	0.0130
Has moved TV equipment around the house last 30 days (=1)	(0,1)	0.07	0.01	0.08	0.01	5,581	0.4561
Has had visitors watching TV at home last 30 days (=1)	(0,1)	0.56	0.02	0.64	0.02	5,574	0.0238
Has had visitors bringing TV equipment at home last 30 days (=1)	(0,1)	0.03	0.01	0.03	0.01	5,572	0.9454

Note: (\*) For each statement, the number in parenthesis indicates the end point of the scale that the statement endorses. For the first statement, for example, a value of “5” indicates that “Household won't miss watching TV for 1 week”, whereas a value of “1” indicates the opposite end point “Household will miss watching TV for 1 week”.

### Person Level

- At the Person level, we found no statistical differences between Intabs and NonIntabs in the 6 measures of attitudes towards TV we studied (Tables 16).
- We did find differences between Intabs and NonIntabs in 5 of the 8 measures of leisure activities. (Table 17).
- NonIntabs spent more time on the internet, and listening to radio than the Intabs.
- NonIntabs spent less time at home yesterday, during weekdays, and during Saturdays than Intabs.

**Table 16. Mean Score on TV Behavior and Attitudes by Intab Status; Respondent Level.**

TV Behavior and Attitude variables*	Scale	Intab		NonIntab		n	p-value
		mean	SE	mean	SE		
Person don't plan watching TV in advance (=7)	(1,7)	3.29	0.08	3.50	0.10	5,567	0.0598
Person watches whatever is on TV (=7)	(1,7)	2.90	0.08	3.06	0.08	5,579	0.0596
Person also do other things while watching TV (=7)	(1,7)	4.16	0.09	3.99	0.10	5,576	0.2650
Person switches between several programs at same time (=7)	(1,7)	2.82	0.08	2.96	0.11	5,582	0.2136
Person unlikely to turn TV on for company (=4)	(1,4)	2.68	0.04	2.57	0.06	5,618	0.2109
Person won't miss watching TV for 1 week (=5)	(1,5)	2.69	0.05	2.64	0.06	5,623	0.6018

Note: (\*) For each statement, the number in parenthesis indicates the end point of the scale that the statement endorses. For the first statement, for example, a value of “7” indicates that “Person don't plan watching TV in advance”, whereas a value of “1” indicates the opposite end point “Person plans watching TV in advance”.

**Table 17. Mean Hours of Leisure Activity by Intab Status; Respondent Level.**

TV Behavior and Attitude variables	Intab		NonIntab		n	p-value
	mean	SE	mean	SE		
Personal Hrs on Internet at home, last 7 days	1.80	0.13	2.38	0.14	5,388	0.0060
Personal Hrs reading paper Newspaper, last 7 days	1.27	0.06	1.09	0.08	5,546	0.0828
Personal Hrs reading paper Magazines, last 7 days	0.82	0.04	0.99	0.08	5,519	0.0838
Personal Hrs hearing Radio, last 7 days	2.44	0.18	3.00	0.14	5,529	0.0285
Personal Hrs spent at Home Mon-Fri, last 7 days	9.77	0.20	9.14	0.20	5,473	0.0158
Personal Hrs spent at Home most recent Saturday	9.72	0.15	8.86	0.21	5,508	0.0078
Personal Hrs spent at Home most recent Sunday	10.00	0.20	10.03	0.27	5,507	0.9300
Personal Hrs spent at Home Yesterday	9.54	0.23	8.41	0.17	5,419	0.0022

### Conclusions

NonIntab households are more heavily invested in TV equipment than *Intab* households.

- If the availability of TV equipment is associated with certain pattern of viewing, then this could be an indicator of nonresponse bias. This could be the case, for example, if people with big screen TVs are more likely to watch sports events than those with regular screens.

NonIntab households exhibit irregular patterns of TV viewing behavior . They're more likely to watch TV in groups at night, and they're more likely to have visitors coming to watch TV.

- This type of behavior could indicate, for example, potential for measurement error in the diary keeping task. It could be relatively more difficult to accurately keep track of who's watching TV when having visitors or when watching TV in groups.

### 3.5. Nonresponse Bias Analysis Using Multivariate Approaches

The key statistical results in the sections above suggest that, for a large set of estimates of audience behavior, there are only small nonresponse bias magnitudes. There is, however, a subset of ten estimates that appear to suffer from nonresponse bias (Table 8 in section 3.2); these biases seem robust to alternative ways of estimating them. However, given the difference between Intabs and NonIntabs found on demographic, geographic and TV equipment variables (sections 3.3-3.4), some of the biased estimates might be reduced by adjusting the Intabs on those variables. The analyses presented in this section will address this point. In particular we will examine to which extent variables used in the Nielsen post-survey adjustment procedures at the national level successfully reduce the estimated nonresponse bias found in the NRB study and explore additional covariates that could improve such endeavors.

#### Multivariate Models

In this exploratory analysis we run for each key TV viewing statistic four logistic regression models. The models are nested within each other, Model 1 is the baseline model, and the rest are built by adding additional covariates.

Model 1 is a simple binary logistic regression with the TV viewing measure as dependent variable and Intab status as covariate. Thus the regression coefficient in each of the models indicates how Intabs differ from NonIntabs on that particular viewing measure. Model 1 resembles the bivariate analysis presented in section 3.1

Model 2 adds the Nielsen Diary poststratification weight as covariate in the logistic regression model. This model attempts to mimic the effect of the post-survey adjustment typically implemented by Nielsen at the national level. A successful poststratification would reduce the coefficient of Intab status towards zero.

Model 3 adds additional covariates that our exploratory analyses suggested as candidates for adjustment variables. Those are demographic and geographic variables as well as TV equipment measures. This model mimics the effects of poststratification on this set of covariates. A successful poststratification on these variables would reduce the coefficient of Intab status towards zero.

Model 4 adds interaction effects of Intab status and selected variables as additional covariates. The interactions in this more complex model serve the purpose of identifying potential for violation of the

missing at random (MAR) assumption, and thus signaling the potential for nonresponse bias. This model serves as check for Model 3. A significant interaction effect between Intab status and the covariates indicates that in the subgroups formed by the covariates used here Intabs and NonIntabs differ in their viewing. Hence caution should be executed when considering these covariates as additional adjustment variables.

All of these models are weighted logistic regressions. We used the “Respondent Weight” as the weighting variable. We used Jackknife Repeated Replications (20 replicates) to estimate the standard errors of the regression coefficients. In this section we only present 3 examples of the models fitted (Tables 18-20). See Appendix D for the results of all the regression models.

We should also note that the use of the Nielsen poststratification weights in this exploratory analysis reduces the size of the estimation sample to roughly 4,900 cases. Those are the cases that have in the NRB study complete information on all 15 covariates necessary for the Nielsen poststratification weight. This reduction in sample size reduced the estimated nonresponse bias on two of the three daypart measures resulting in effects that are no longer statistically significant (see Appendix D). The same is true for the nonresponse bias estimate for MTV viewing. Thus in what follows only seven out of the originally ten nonresponse bias estimates are examined further.

One final technical note before we interpret the multivariate models: The selection of covariates for Model 3 was done in two steps. First we identified 16 variables that we expect to be associated with TV viewing: 10 demographics (Owner, Income>40k, Children<6, Children 6-17, Household Size, Hispanic, Race Black, Education, Age, Gender), 4 TV equipment (Number TVs, Big Screen, Cable/Satellite, DVR) and 2 geographic (County Size, Territory). Then we ran stepwise Logistic Regressions of the binary variable Intab Status on the 16 covariates (subgroups) mentioned above. We also ran stepwise Logistic Regressions for the binary variables indicating Station and Daypart viewing. To accomplish parsimony, we selected only up to 7 covariates for our multivariate models. From the regression on Intab Status we selected the 3 covariates that were also retained in the majority of the viewing models. From the regression on each Station (or Daypart) we selected the 3-4 most significant covariates (lowest p-values). The rationale behind the selection of covariates was to include covariates that are correlated with the response propensity (Intab model) and the TV viewing measure of interest (Station/Daypart models). See Appendix C for a detailed methods explanation and Appendix D for the results of the Stepwise Regression models.

## Results

Nonresponse bias is likely to be removed after applying Nielsen's poststratification adjustments for Person viewing Late News (11pm-2am) and CARTOON .

- Table 18 illustrates this case for persons viewing Late News. The variable Intab is statistically significant in Model 1, but it is no longer significant when the Nielsen poststratification weight is introduced as a covariate in Model 2. Models 3 and 4 were estimated only for completeness of the presentation.

Nonresponse bias is likely to be removed after controlling for additional covariates for HBO.

- Table 19 illustrates this case for HBO. The effect of Intab status is still significant after controlling for the Nielsen poststratification weight (Model 2). The effect of Intab status is removed only when covariates like "Having Big Screen" and "Territory" are introduced (Model 3). Model 4 was estimated only for completeness of the presentation.

Nonresponse bias is unlikely to be removed for the remaining 4 Stations (CBS, NBC, UNIVISION and BET) even after controlling for additional covariates.

- Table 20 illustrates this case for CBS. The variable Intab remains statistically significant after controlling for the main effects of poststratification weight (Model 2); Age, Big Screen and Territory (Model 3); Number of TVs, Hispanic, and Children\_6to17 (Model 4); and the interaction effect Number of TVs\* Intab (Model 5).

Finally, we find some evidence of nonresponse bias for CBS, NBC, and UNIVISION.

- As we saw in Table 20 for CBS, the interaction effect Number of TVs\* Intab has a negative sign and it is statistically significant (Model 5). This means that – among those people having 3+ TVs – the amount of BCS viewing is different than among those having 1-2 TVs.
- This is a violation of the basic assumption underlying post-survey adjustments. When doing adjustments, the assumption that Intabs and NonIntabs have the same viewing patterns within each adjustment cell. Here, Intabs and NonIntabs having 1-2 TVs have different patterns of CBS viewing than Intabs and NonIntabs having 3+ TVs.
- We conclude that the use of additional nonresponse adjustments procedures, as a bias reduction technique should be carefully evaluated given these preliminary results.



**Table 18. Logistic Regression of Person Viewing Late News on Subgroups; Estimation Using Weighted Least Square; All Households.**

Predictors	Model 1			Model 2			Model 3			Model 4		
	B	SE(B)	p-value	B	SE(B)	p-value	B	SE(B)	p-value	B	SE(B)	p-value
<i>Intab</i>	-0.36	0.15	<b>0.0246</b>	-0.04	0.14	0.791	0.05	0.16	0.7615	1.01	0.54	0.0776
Yes												
<i>PS weight</i>				0	0	<b>0.0005</b>	0	0	<b>0.0014</b>	0	0	<b>0.0017</b>
<i>Age Categories</i>												
Age <=34 yrs							0.24	0.34	0.4918	0.43	0.4	0.2915
Age 35-49 yrs							0.61	0.2	<b>0.0073</b>	0.77	0.31	0.0246
Age 50-64 yrs							0.35	0.31	0.2775	0.5	0.42	0.2436
<i>Has Big Screen</i>												
Yes							-0.11	0.21	0.5997	-0.1	0.2	0.6225
No Response*							-3.03	1.5	0.0586	-2.8	1.34	<b>0.0505</b>
<i>Territory</i>												
East Central							0.56	0.26	<b>0.0438</b>	0.81	0.26	<b>0.006</b>
West Central							-0.55	0.41	0.2007	-0.63	0.52	0.2378
Southeast							0.23	0.34	0.5138	0.19	0.36	0.6009
Southwest							0.05	0.34	0.8758	0.12	0.38	0.7499
Pacific							0.09	0.33	0.7853	0.29	0.39	0.4704
<i>Has 3+ TVs</i>												
Yes							0.47	0.25	0.0733	0.59	0.29	0.0607
<i>Owns House</i>												
Yes							-0.56	0.27	0.0524	-0.56	0.28	0.0566
No Response*							-1.26	0.43	<b>0.0094</b>	-1.37	0.51	<b>0.0148</b>
<i>Has Children 6-17 yrs</i>												
Yes							-0.33	0.26	0.2282	-0.31	0.26	0.2489
No Response*							0.01	0.64	0.9896	-0.08	0.74	0.9112
<i>Age Category*Intab</i>												
(Age <=34 yrs)*Intab										-0.67	0.48	0.1801
(Age 35-49 yrs)*Intab										-0.47	0.46	0.3106
(Age 50-64 yrs)*Intab										-0.31	0.45	0.4995
<i>Territory*Intab</i>												
(East Central)*Intab										-0.92	0.34	<b>0.0149</b>
(West Central)*Intab										0.14	0.64	0.8307
(Southeast)*Intab										0.17	0.4	0.6754
(Southwest)*Intab										-0.37	0.55	0.5103
(Pacific)*Intab										-1.12	0.55	0.0565
<i>Has 3+ TVs*Intab</i>												
(Yes)*Intab										-0.53	0.36	0.1585
<i>Constant</i>	-0.81	0.12	<b>0.0000</b>	-1.19	0.08	<b>0.0000</b>	-1.35	0.5	<b>0.0137</b>	-1.65	0.61	<b>0.0149</b>
N	4,898			4,898			4,898			4,898		

Notes: The reference categories for the categorical covariates are NonIntab (Intab), Age 65+ (Age Categories), No (Has Big Screen), Northeast (Territory), No (Has 3+ TVs), No (Owns HU), and No (Has Children 6-17). (\*) The category "No Response" was created to avoid dropping cases with missing values in the covariates (Don't Know, Refuse, Blank).

**Table 19. Logistic Regression of Daily/Weekly HBO Viewing on Subgroups; Estimation Using Weighted Least Squares; Households with Cable or Satellite.**

Predictors	Model 1			Model 2			Model 3			Model 4		
	B	SE(B)	p-value	B	SE(B)	p-value	B	SE(B)	p-value	B	SE(B)	p-value
<i>Intab</i>												
Yes	-0.78	0.17	<b>0.0002</b>	-0.47	0.18	<b>0.0176</b>	-0.29	0.22	0.1893	-0.02	0.5	0.9693
<i>PS weight</i>				0	0	<b>0.0005</b>	0	0	<b>0.0367</b>	0	0	<b>0.0424</b>
<i>Age Categories</i>												
Age <=34 yrs							0.17	0.4	0.6837	0.15	0.39	0.7056
Age 35-49 yrs							0.24	0.23	0.3106	0.23	0.23	0.3353
Age 50-64 yrs							0.33	0.32	0.3112	0.33	0.33	0.328
<i>Has Big Screen</i>												
Yes							0.63	0.25	0.0194	0.64	0.24	<b>0.0163</b>
No Response*							-2.94	1.02	<b>0.01</b>	-2.94	0.95	<b>0.0063</b>
<i>Territory</i>												
East Central							0.12	0.26	0.6386	0.17	0.32	0.6017
West Central							-0.46	0.34	0.1909	-0.56	0.46	0.2412
Southeast							0.23	0.22	0.3149	0.3	0.25	0.2444
Southwest							1.07	0.35	<b>0.0063</b>	1.25	0.38	<b>0.0043</b>
Pacific							0.42	0.36	0.2595	0.53	0.41	0.2074
<i>Race Black</i>												
Yes							1.02	0.37	<b>0.0136</b>	1.04	0.37	<b>0.011</b>
<i>Has 3+ TVs</i>												
Yes							0.38	0.17	<b>0.039</b>	0.38	0.17	<b>0.0412</b>
<i>Has DVR</i>												
Yes							0.69	0.25	<b>0.0138</b>	0.72	0.25	<b>0.0105</b>
No Response*							1.99	4.92	0.6903	1.91	4.95	0.7047
<i>County Size</i>												
B							-0.85	0.31	<b>0.0139</b>	-0.82	0.31	<b>0.0159</b>
C							-1.01	0.29	<b>0.0024</b>	-0.99	0.29	<b>0.0029</b>
D							-0.67	0.42	0.1304	-0.63	0.4	0.1358
<i>Territory*Intab</i>												
(East Central)*Intab										-0.21	0.43	0.6335
(West Central)*Intab										0.42	0.83	0.6203
(Southeast)*Intab										-0.35	0.59	0.5555
(Southwest)*Intab										-1.13	0.71	0.1303
(Pacific)*Intab										-0.5	0.69	0.4807
<i>Constant</i>	-0.89	0.13	<b>0.0000</b>	-1.27	0.14	<b>0.0000</b>	-1.88	0.4	<b>0.0002</b>	-1.98	0.43	<b>0.0002</b>
N	4,264			4,264			4,264			4,264		

Notes: The reference categories for the categorical covariates are NonIntab (Intab), Age 65+ (Age Categories), No (Has Big Screen), Northeast (Territory), No (Race Black), No (Has 3+ TVs), No (Has DVR), and A (County Size). (\*) The category "No Response" was created to avoid dropping cases with missing values in the covariates (Don't Know, Refuse, and Blank responses).

**Table 20. Logistic Regression of Daily/Weekly CBS Viewing on Subgroups; Estimation Using Weighted Least Squares; All Households.**

Predictors	Model 1			Model 2			Model 3			Model 4		
	B	SE(B)	p-value	B	SE(B)	p-value	B	SE(B)	p-value	B	SE(B)	p-value
<i>Intab</i>												
Yes	0.31	0.12	<b>0.0189</b>	0.41	0.13	<b>0.0044</b>	0.36	0.14	<b>0.0175</b>	0.81	0.14	<b>0.0000</b>
<i>PS weight</i>				0	0	0.4854	0	0	0.4502	0	0	0.4509
<i>Age Categories</i>												
Age <=34 yrs							-0.1	0.27	0.7034	-0.11	0.27	0.67
Age 35-49 yrs							-0.19	0.3	0.5205	-0.17	0.29	0.5645
Age 50-64 yrs							0.1	0.25	0.6933	0.12	0.24	0.6214
<i>Has Big Screen</i>												
Yes							0.1	0.18	0.5926	0.08	0.18	0.671
No Response*							-2.28	1.65	0.1828	-2.21	1.57	0.1755
<i>Territory</i>												
East Central							0.32	0.32	0.3218	0.31	0.31	0.3393
West Central							0.31	0.32	0.3361	0.29	0.31	0.3538
Southeast							0.2	0.31	0.5274	0.19	0.31	0.5473
Southwest							0.04	0.48	0.9309	0.03	0.48	0.9534
Pacific							-0.08	0.28	0.7641	-0.1	0.28	0.7215
<i>Has 3+ TVs</i>												
Yes							0.67	0.18	<b>0.0016</b>	0.87	0.22	<b>0.0007</b>
<i>Hispanic</i>												
Yes							-0.91	0.28	<b>0.0041</b>	-0.91	0.27	<b>0.0035</b>
<i>Has Children 6-17 yrs</i>												
Yes							-0.33	0.23	0.1691	-0.35	0.23	0.137
No Response*							-0.29	0.34	0.4057	-0.34	0.34	0.3394
<i>Has 3+ TVs*Intab</i>												
(Yes)*Intab										-0.83	0.33	<b>0.0193</b>
<i>Constant</i>	0.92	0.11	<b>0.0000</b>	0.81	0.1	<b>0.0000</b>	0.47	0.3	0.1338	0.37	0.28	0.201
N	4,902			4,902			4,902			4,902		

Notes: The reference categories for the categorical covariates are NonIntab (Intab), Age 65+ (Age Categories), No (Has Big Screen), Northeast (Territory), No (Has 3+ TVs), No (Hispanic), and No (Has Children 6-17). (\*) The category "No Response" was created to avoid dropping cases with missing values in the covariates (Don't Know, Refuse, and Blank responses).

## 4. Nonresponse Bias in the Nonresponse Bias Study Itself

The NRB study was conducted to assess the potential for nonresponse bias in Nielsen viewing estimates but estimates from the NRB as survey estimates themselves are subject to nonresponse bias and other sources of survey error. Five major sources of survey error are:

- Sampling Error – Error due to only observing a sample of the population rather than the entire population. This error is quantified in the standard error estimate included for each mean, percent and regression coefficient in this report.
- Coverage Error - Error that may be introduced when the list used for sampling does not include persons who should be included (target population) or includes people who should not be included (not part of the target population)
- Nonresponse Error – Error that may be introduced when not all persons sampled for the survey participate (unit nonresponse) or not all survey items are answered (item nonresponse) by a respondent
- Measurement Error – Error due to the measurement process; that is, error introduced by the survey instrument, mode of data collection (e.g., face-to-face, telephone), the interviewer, or the respondent.
- Processing and Adjustment Error – Error that may be introduced in the editing, data entry, data cleaning and post-survey adjustment (e.g., weighting, imputation) phases

Errors due to the survey process have the potential to affect the conclusions that have been presented in this report and these errors should be considered and quantified to the extent possible in order to ensure the validity of NRB findings. The possibility of nonresponse error in the NRB was of particular concern to the CRE. Thus, we have investigated the potential for nonresponse bias in the NRB using Nielsen geography and Census block level demographics and present our findings in this section.

About one-third (3,016) of the 9,000 cases that were sampled for the NRB were nonrespondents. As noted earlier, Nielsen used a well-designed survey protocol to achieve a level of cooperation that was comparable or better than what would have been expected in a study that includes a substantial percent of nonrespondents from a previous study. Nonetheless, it is possible that those who did not respond may be different from those who did and this could introduce nonresponse bias in NRB estimates. A variety of approaches have been used to study nonresponse bias, with the following being some of the most common:

- comparing respondents and nonrespondents on sampling frame variables, interviewer observations, or Census data,
- taking a random sample of nonrespondents, gathering data on key variables and making inferences about all nonrespondents based on data from the subsample
- examining data on key variables for the respondents who require the most effort under the assumption that these respondents who do not participate until later in the survey period are like those who never participate.

The approach we used was to first examine overall differences between NRB respondents and nonrespondents on Nielsen geography variables (Table 21) and Census block group level demographics (Table 22). A Census block group is a group of about 40 Census blocks on average. For the block group level measures, we calculated the percent of households in that area with a particular characteristic (e.g., 1 person household) and then analyzed this variable using quartiles. We note that Nielsen geography variables were available for all 9,000 sampled diary cases. However, only cases for which it was possible to match and geo-code an address (n=7,024) were included in the analysis of Census block group level demographics. It is possible that the results may have looked different if an address had been obtained for all 9,000 diary cases.

As seen in Table 21, there were some overall differences between NRB respondents and nonrespondents. NRB nonrespondents were more likely to live in the larger A and B size counties, and in the Pacific territory. Nonrespondents also tended to live in Census block groups with the lowest and highest percent of households with three or more persons (see Table 22). In general, nonrespondents were more concentrated in areas with larger minority populations. About 35% of nonrespondents lived in a block group with 5.5% or more Hispanic households while only 24% of respondents lived in these more heavily Hispanic areas. A larger percent of nonrespondents (31%) as compared to respondents (24%) resided in areas with the highest concentration of heads of household 15-34 years of age. These differences are consistent with much of the research on nonresponse in household surveys.

However, since most of the analyses from the NRB involved comparisons of Intabs and Non-Intabs, it was not the *overall* differences between respondents and nonrespondents but rather whether Intab-Non-Intab differences held if the NRB nonrespondents were included. To address this question, we ran a series of regression models (multinomial logistic or linear model with selection weights) with the following variables:

- Independent variables: NRB response status (respondent, nonrespondent), diary intab status (intab, non-intab), and interaction between NRB response status and diary intab status
- Dependent variable: each of the Nielsen geography variables and Census block level demographics (% of households with a demographic characteristic, e.g., 1 person household, was entered as a continuous dependent variable)

An interaction term between NRB response status and Diary intab status that was non-zero meant that the relationship between Diary Intab status and the Nielsen geography or Census block level variable was different for respondents and nonrespondents. By not including NRB nonrespondents, we would have failed to obtain an accurate picture of the relationship between Diary intab status and the Nielsen geography or Census block level variable. The last column of Tables 21 and 22 indicates whether there was a non-zero interaction term between NRB response status and Diary intab status.

As seen in Tables 21 and 22, there was evidence of potential nonresponse bias in the comparisons between Intabs and Non-Intabs for four variables: territory, 1 person households, 3 or more person households, and households with a child less than 18. Whether nonresponse bias on these measures portends nonresponse bias on the viewing measures that were presented in this report depends on the magnitude of the correlation between the geography or Census demographic measure and viewing.

**Table 21. Distribution of Nielsen Geography Variables by NRB Participation Status.**

Geography variables	NRB Study Participation Status				N	Potential Nonresponse Bias in Comparing Intabs and Non-Intabs?
	Respondent		Nonrespondent			
	%	SE	%	SE		
<i>County Size</i>						
A	11.2	0.88	12.5	1.04	9,000	N
B	43.8	1.13	49.2	1.30		
C	22.7	0.89	20.9	0.95		
D	22.3	0.89	17.3	0.88		
<i>Territory</i>						
Northeast	11.2	0.70	10.2	0.75	9,000	Y
East Central	16.5	0.83	15.2	0.95		
West Central	21.1	1.00	18.5	1.10		
Southeast	26.0	0.96	23.9	1.08		
Southwest	10.5	0.57	10.2	0.64		
Pacific	14.7	0.87	22.0	1.09		

**Table 22. Distribution of Claritas Block Group Demographics by NRB Response Status.**

Block Group variables (by Quartile)	NRB Study Participation Status				N	Potential Nonresponse Bias in Comparing Intabs and Non-Intabs?
	Respondent		Nonrespondent			
	%	SE	%	SE		
<i>% of HHs - 1 Person</i>						
<=19.1%	27.7	1.07	31.6	2.36	7,024	Y
19.2 - 24.9%	25.9	1.03	22.4	1.96		
25.0 - 32.0%	23.0	0.96	20.9	1.99		
32.1%+	23.3	1.00	25.1	2.01		
<i>% of HHs - 2 Person</i>						
<=30.6%	24.6	1.01	30.3	2.30	7,024	N
30.7 - 34.2%	23.9	0.99	24.4	2.03		
34.3 - 37.8%	26.1	1.03	20.4	1.92		
37.9%+	25.4	1.04	24.9	2.11		
<i>% of HHs - 3 or More Persons</i>						
<=32.1%	22.6	1.01	25.0	2.07	7,024	Y
32.2 - 39.5%	24.3	0.98	19.0	1.77		
39.6 - 46.3%	26.3	1.03	24.5	2.14		
46.4%+	26.8	1.05	31.5	2.32		
<i>% of HHs - American Indian</i>						
<=0.33%	24.9	1.04	29.1	2.17	7,024	N
0.34 - 0.70%	25.7	1.02	23.4	2.06		
0.71- 1.4%	25.0	1.01	23.9	2.04		
1.5%+	24.5	0.99	23.6	2.15		
<i>% of HHs - Asian</i>						
<=0.20%	24.0	0.98	16.0	1.55	7,024	N
0.21 - 0.65%	24.3	0.98	18.1	1.62		
0.66 - 1.7%	25.4	1.04	27.8	2.23		
1.8%+	26.2	1.07	38.2	2.46		
<i>% of HHs - Black</i>						
<=0.45%	25.1	1.02	20.7	1.86	7,024	N
0.46 - 1.9%	24.9	1.02	23.7	2.03		
2.0 - 8.5%	24.9	1.03	29.7	2.34		
8.6%+	25.0	0.99	25.9	2.10		
<i>% of HHs - Hawaiian/Pacific Islander</i>						
0%	66.2	1.12	55.5	2.45	7,024	N
0.01 - 0.23%	16.9	0.89	22.8	2.22		
0.24%+	16.9	0.89	21.7	2.01		
<i>% of HHs - White</i>						
<=81.0%	23.9	0.96	28.7	2.25	7,024	N
81.1 - 93.3%	24.7	1.03	26.9	2.19		
93.4 - 97.8%	25.2	1.02	26.9	2.22		
97.9%+	26.3	1.05	17.5	1.58		
<i>% of HHs - Other Race</i>						
<=0.24%	25.1	1.02	18.5	1.74	7,024	N
0.25 - 0.75%	24.0	0.99	25.1	2.16		
0.76 - 2.7%	27.2	1.06	23.5	1.99		
2.8%+	23.7	0.99	32.9	2.36		

**Table 22. Distribution of Claritas Block Group Demographics by NRB Response Status (cont'd).**

Block Group variables (by Quartile)	NRB Study Participation Status				N	Potential Nonresponse Bias in Comparing Intabs and Non-Intabs?
	Respondent		Nonrespondent			
	%	SE	%	SE		
<i>% of HHs - White, Non-Hispanic</i>						
<=71.8%	23.7	0.96	30.3	2.26	7,024	N
71.9 - 90.2%	24.4	1.02	28.1	2.22		
90.3 - 96.2%	25.7	1.03	23.7	2.13		
96.3%+	26.2	1.05	17.9	1.64		
<i>% of HHs - Hispanic</i>						
<=0.77%	24.8	1.01	20.1	1.84	7,024	N
0.78 - 1.8%	25.1	1.02	22.2	1.92		
1.9 - 5.4%	25.8	1.02	23.1	2.11		
5.5%+	24.3	1.02	34.7	2.38		
<i>% of HHs - With Child &lt; 18</i>						
<=28.2%	22.7	1.01	23.9	1.95	7,024	Y
28.3 - 34.5%	24.2	0.98	23.3	2.06		
34.6 - 40.7%	26.1	1.02	20.3	1.92		
40.8%+	27.0	1.05	32.5	2.37		
<i>% of HHs - With Head of HH 15-34</i>						
<=14.2%	25.1	1.04	25.9	2.16	7,024	N
14.3 - 18.6%	24.1	0.98	20.7	1.79		
18.7 - 24.0%	26.9	1.06	21.9	1.98		
24.1%+	23.9	0.97	31.5	2.35		
<i>% of HHs - With Head of HH 35-44</i>						
<=15.4%	21.6	0.97	23.0	2.02	7,024	N
15.5 - 18.2%	24.2	0.99	20.7	1.88		
18.3 - 21.1%	24.9	0.99	24.3	1.98		
21.2%+	29.3	1.10	32.0	2.40		
<i>% of HHs - With Head of HH 45-64</i>						
<=33.3%	22.4	0.98	25.9	2.13	7,024	N
33.4 - 37.8%	26.4	1.03	22.3	2.00		
37.9 - 43.0%	23.9	0.98	23.2	1.99		
43.1%+	27.3	1.07	28.5	2.26		
<i>% of HHs - With Head of HH 65+</i>						
<=16.9%	28.0	1.07	35.3	2.45	7,024	N
17.0 - 22.3%	25.1	0.99	22.8	1.94		
22.4 - 28.6%	25.4	1.03	20.1	1.84		
28.7%+	21.5	0.96	21.8	1.93		

Overall, we find that for most geography and Census demographic variables shown in Tables 21 and 22, there is little evidence of nonresponse bias. That is, any difference between respondents and nonrespondents did not appear to affect the comparison of Intabs and Non-Intabs on that measure. This lends confidence to the findings from the NRB. However, it is important to keep in mind that the



geography and Census demographic measures that were available for our nonresponse bias analysis are likely only weakly correlated with viewing. Thus, we can only infer that the variables available on NRB respondents and nonrespondents do not suggest our conclusions about the NRB study findings are themselves tainted by nonresponse error.

## **5. Appendices**

### **Appendix A. Diary Nonresponse Bias Study Design and Implementation**

### **Appendix B. Memoranda from Michigan-Maryland Team to Council for Research Excellence and Nielsen**

### **Appendix C. Analytic Methods**

### **Appendix D. Detailed Result Tables**

### **Appendix E. Nielsen Diary Nonresponse Bias Study Proposal and Analytic Plan**