

Assessing the Impact of Adopting a Mixed-Mode Design: Examining Respondent Skip Logic Errors in the 2015 Residential Energy Consumption Survey

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Abstract

The 2015 Residential Energy Consumption Survey (RECS) is a household level survey used to estimate energy consumption behaviors of U.S. residents. Initially, the 2015 RECS was administered solely using Computer-Assisted Personal Interviewing (CAPI). However, mid-way through the collection process, it became evident that relying on CAPI as the only collection method was not prudent, so a mixed-mode approach was adopted, adding Computer Assisted Web Interview (CAWI) and Paper and Pencil Interviewing (PAPI) alongside CAPI. This research discusses the impact a last-minute switch to a mixed-mode design may have had on the 2015 RECS. Specifically, we investigated to what extent complex skip patterns increased skip logic error rates. This paper also considers how the layout of the PAPI instrument may have played a role. The findings and opinions of this paper are solely that of the authors and do not necessarily reflect the beliefs of the U.S. Energy Information Administration.

Key Words: mixed-mode, skip logic errors, skip patterns, survey design, Residential Energy Consumption Survey, RECS

1. Introduction

The 2015 Residential Energy Consumption Survey (RECS) was initially going to be administered solely using Computer-Assisted Personal Interviewing (CAPI). However, collection difficulties necessitated adopting a mixed-mode approach, resulting in the inclusion of Computer Assisted Web Interview (CAWI) and Paper and Pencil Interviewing (PAPI) survey tools alongside the CAPI.

During the imputation process for the 2015 RECS, a team of statisticians at RTI International noticed a fair number of respondent skip logic errors present. There was thought that this may be related to last-minute switch to a mixed-mode design. Perhaps because the 2015 RECS was initially a CAPI only design, and since CAPI surveys benefit from having computer automated skip logic, and in-person interview, little concern was put on the effect complex skip patterns have on respondent error rates. While the RECS pilot study used PAPI and CAWI collection tools, we hypothesized that a few of the skip patterns used in the CAPI tool might be too complicated for the PAPI instrument to emulate easily, resulting in confusion and errors among PAPI respondents.

Dillman, Smyth and Christian (2014, p. 106) note that one of the most difficult scenarios for using paper surveys is when a respondent must navigate a survey with complex skip logic or eligibility criteria.

2. Methods

Skip logic errors were tallied for all questions shared across the three survey modes (CAPI, CAWI, and PAPI). If our hypothesis was true, then we expected that survey items with more complex gateway questions would be more susceptible to skip-logic errors than survey items with relatively few gateway questions.

2.1 Types of Skip Logic Errors

Dillman, Smyth and Christian identify two principle types of skip-logic errors, *errors of commission* and *errors of omission* (p.106). While this research focusses on errors of omission, understanding one is useful for understanding the other.

Errors of commission occur when a respondent answers a follow-up question which should have been skipped, had the skip pattern of the survey been correctly followed. An example of this type of error would be when a respondent indicates that they currently live in a mobile home, but they provide a response to the question, *is your apartment located on the basement floor of your building?*

Errors of omission occur when a respondent provides a valid answer to a question, but their response to the corresponding gateway question(s) is incomplete or missing. An example of this type of error would be when a respondent fails to indicate what type of home they live in, but they provide a valid answer to the question, *is your apartment located on the basement floor of your building?*

To reiterate, this research focusses on errors of omission. A response was considered a skip logic error of omission if a respondent provided a valid answer to a survey item, for which they did not provide an answer to one or more of the corresponding gateway question(s).

3. Results

3.1 Overview

As previously mentioned, data for the 2015 RECS was collected using three different survey modes, CAPI, CAWI, and PAPI. Of the 5,686 instruments completed, 2,417 were CAPI respondents, 2,122 were CAWI respondents, and 1,147 were PAPI respondents.

On individual survey item level, there were 3,491 individual instances where respondents made skip logic errors of omission. About 93% or 3,265 instances came from the PAPI version of the survey. As expected, the CAWI and CAPI tools were much less susceptible to the errors of omission with 164 instances coming from CAWI and 62 instances from CAPI respondents.

While 3,491 errors of omission may seem like a large number relative given the sample size, it is important to remind ourselves how errors of omissions are tallied. If a respondent skips only one question, but that question serves as a gateway for multiple follow-up items, the impact of that skipped question will be multiplied, as each

corresponding follow-up question answered will be tallied as an error of omission. This will be discussed in more detail later.

3.2 Location

To find out why errors of omission might be occurring, we needed to look at where they occurred in the survey. RECS questionnaire collects information broken down into modules (questionnaire blocks). Those are Air Conditioning, Appliances, Electronics, Energy Assistance, Energy Bills, Energy Programs, Energy Suppliers and Use, Space Heating, Water Heating, and Your Home.

Figure 1 provides a clear answer to the question of where the skip logic errors of omission are occurring. With nearly 3,000 errors in the Electronics portion of the PAPI survey, and fewer than 110 in all other survey modules, it is evident that PAPI respondents were tripped up by something in the Electronics portion of the survey.

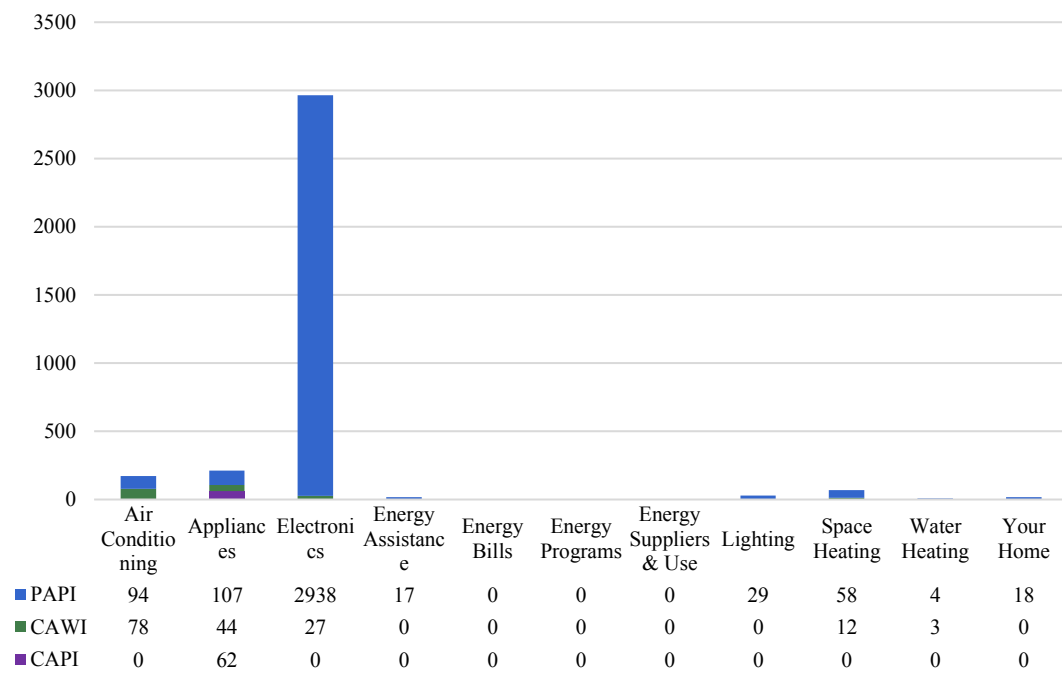


Figure 1: 2015 RECS Skip Logic Errors of Omission by Survey Mode and Questionnaire Module

3.2 Electronics Module

Surprisingly, the Electronics module of the survey only has one gateway question, *How many televisions are used in your home?* As mentioned earlier, gateway questions that have multiple follow-up questions can have a multiplicative effect on the occurrences of skip logic errors of omission. With 16 corresponding gateway questions, we can see this multiplicative effect in action in Table 1.

Table 1: PAPI Skip Logic Errors of Omission Corresponding to the Gate Question *How many televisions are used in your home?*

<i>Order</i>	<i>Follow-up Question</i>	<i>Errors of Omission</i>	<i>Order</i>	<i>Follow-up Question</i>	<i>Errors of Omission</i>
1	Size of most used TV	213	9	# of cable or satellite boxes (w/o DVR)	192
2	Display type of most used TV	153	10	# of cable or satellite boxes (with DVR)	204
3	Hours most used TV is on (weekdays)	206	11	# of separate DVRs	196
4	Hours most used TV is on (weekends)	203	12	# of video game consoles	205
5	Size of 2 nd most used TV	142	13	# DVD or Blu-ray players	204
6	Display type of 2 nd most used TV	113	14	# VCRs	205
7	Hours 2 nd most used TV is on (weekdays)	144	15	# of internet streaming devices	208
8	Hours 2 nd most used TV is on (weekends)	140	16	# of home theater or audio systems	212

An important note: of the 224 PAPI respondents who skipped the gateway question, *How many televisions are used in your home?* **all 224 answered at least one corresponding follow-up questions.** Given this insight in combination with the information provided in Figure 1 and Table 1, we can draw a few conclusions.

1. Of the 224 PAPI respondents who skipped the question, *How many televisions are used in your home?* all likely did so by accident, and they probably have at least one TV in their home.
2. In this instance, the complexity of the survey's skip patterns did not result an increase in skip-logic errors of omission, as the vast majority of these errors came from a section with only one gateway question.

3.3 Survey Layout

So why did respondents skip the question, *How many televisions are used in your home?* The best guess we have is that respondents simply overlooked it. By looking at Figure 2, we can get a better sense of how the layout of the Electronics module of the PAPI instrument may have contributed.

73. About how old is your clothes washer? Your best estimate is fine.

1 Less than 2 years old
 2 2 to 4 years old
 3 5 to 9 years old
 4 10 to 14 years old
 5 15 to 19 years old
 6 20 or more years old

-4 Don't know

74. Does your household have a clothes dryer? Do not include community clothes dryers that are located in the basement or laundry room of your apartment building.

1 Yes
 0 No → **Go to #78**

75. What fuel does your clothes dryer use?

1 Electricity
 2 Natural gas from underground pipes
 3 Propane (bottled gas)

-4 Don't know

76. In a typical week, about how many times is your clothes dryer used? If not used, please enter "0."

times per week

77. About how old is your clothes dryer? Your best estimate is fine.

1 Less than 2 years old
 2 2 to 4 years old
 3 5 to 9 years old
 4 10 to 14 years old
 5 15 to 19 years old
 6 20 or more years old

-4 Don't know

79. What is the size of your most used television?

1 27 inches or less
 2 28 to 39 inches
 3 40 to 59 inches
 4 60 inches or more

80. What type of display does your most used television have?

1 LCD
 2 Plasma
 3 LED
 4 Projection
 5 Standard tube


-4 Don't know

81. Thinking about your most used television's use on weekdays, how many hours is it turned on each day? Include the time it is on even if no one is actually watching it.

hours per day

82. Thinking about your most used television's use on weekends, how many hours is it turned on each day? Include the time it is on even if no one is actually watching it.

hours per day

 **If you have only one television, go to #87**

83. What is the size of your second most used television?

1 27 inches or less
 2 28 to 39 inches
 3 40 to 59 inches
 4 60 inches or more

84. What type of display does your second most used television have?

1 LCD
 2 Plasma
 3 LED
 4 Projection
 5 Standard tube

-4 Don't know

ELECTRONICS

78. How many televisions are used in your home? If none, please enter "0."

televisions → **If you answered "0": Go to #88**

Figure 2: 2015 RECS PAPI Instrument, First Page of the Electronics Module

Notice that the electronics portion of the survey starts at the bottom of the page. Perhaps starting a new section at the bottom suggests to a respondent that this question is not important? Perhaps the arrow at the bottom of the page encourages impatient respondents to jump to the next column?

Another important piece of evidence that layout plays a role can be found by comparing the Appliances module to the Electronics module. The Appliances module starts off by asking how many refrigerators are used in the home, and then proceeds to ask several corresponding follow-up questions, but there are far fewer skip-logic errors of omission. The only noticeable difference we could observe is the Appliance module starts at the top of the page and is prominently positioned.

4. Conclusion

While there are no clear answers as to why the layout of the PAPI survey caused confusion among a few respondents, at least one thing is clear: having an adaptable survey went a long way into turning a challenging circumstance into a success.

References

Dillman D., Smyth J., and Christian L. (2014) "Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method" 4th ed. Wiley Publishing