

## 2010 Census Nonresponse Followup Contact Strategy Experiment<sup>1</sup>

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### **Abstract**

One of the most expensive operations in the 2010 Census was Nonresponse Followup, for housing units that did not respond by mail. An enumerator collected the census information, using personal visits or phone calls, and sometimes took up to six contact attempts to obtain an interview. The objective of this experiment was to understand the effects of reducing the maximum number of contact attempts in order to save costs in Nonresponse Followup. Two experimental questionnaires, with a maximum of either four or five contact attempts, were systematically distributed in with the standard six-contact forms prior to the start of Nonresponse Followup. All other content on the forms was the same. Results showed that reducing the maximum number of contact attempts enumerators are expected to make appears to have no noticeable negative effects. There was no impact to the rate of successfully completing interviews, no increase in the use of proxy respondents (neighbors or other non-household members), and no increase to item nonresponse or overall form completeness. Further, significant high end cost savings are possible. Though these results are encouraging, an area-level study is recommended before full scale implementation is considered.

**Key Words:** Nonresponse Followup, Cost Savings, Decennial

### **1. Introduction**

A total of 131,704,730 housing units were enumerated in the 2010 Census. Of those in mailout/mailback areas approximately one-third (33.5 percent) did not respond to the initial or replacement mailings (Letourneau 2011). This left approximately 47 million housing units in the Nonresponse Followup (NRFU) workload (Jackson et. al. 2011). These housing units required an enumerator to collect the Census information as part of the NRFU operation<sup>2</sup>.

The objective of this experiment was to understand the effects of reducing the maximum number of NRFU contacts in a census environment. This study was motivated by the potential for cost savings through a reduction in contact attempts to nonresponse households. Historically, enumerators have been required to make up to six contact attempts (not to exceed three personal visits and three telephone attempts) with the household before resorting to “final attempt” procedures, such as contacting a neighbor or landlord. The goal is to determine whether it is possible to maintain a similar level of data quality and realize cost savings while reducing the maximum number of NRFU contacts.

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<sup>1</sup> This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress. Any views expressed on statistical, methodological, technical, or operational issues are those of the authors and not necessarily those of the U.S. Census Bureau.

<sup>2</sup> This study did not include other enumerator operations such as Update/Enumerate and Remote Alaska.

## 2. Background

In Census 2000, over 1 billion dollars was spent on NRFU field work<sup>3</sup>, at an average cost of \$26.91 per case (Moul 2002). In the 2010 Census, over \$1.5 billion was spent on NRFU field work, at an average cost of \$33.65 per case (Jackson et. al. 2011). The procedure for NRFU traditionally requires an enumerator to make up to six contact attempts (three personal visits and three telephone attempts) (Burt and Mangaroo 2003). Previously, there has been no formal test to determine whether this maximum number of contact attempts is optimal or whether it provides the best data for the effort expended. Reducing the total number of contact attempts could reduce the cost of the NRFU operation by millions of dollars. After Census 2000, senior census managers and the Office of Management and Budget requested an evaluation to determine if the number of contact attempts could be reduced while maintaining a similar level of data quality.

Researchers used the 2000 Master Trace Sample (MTS) Database to study contact success in relation to contact attempts. As would be expected, completed cases were reduced with each successive contact attempt; however there was an increase in the percentage of cases completed at the sixth and final attempt (Tancreto and Bentley 2004). This could have been due to increased effort on the part of the enumerator, an increase in the use of proxy respondents, or an increase in undocumented attempts (such as an enumerator continuing to make further attempts which are recorded on an info-com or not recorded due to lack of space on the form). Regardless of the reason, it was expected that this same increase in successful cases on the last attempt would occur on the last contact attempt, regardless of the maximum number of attempts on the form. The MTS study was purely an observational one and the authors concluded an experiment would be necessary in order to study the effects of reducing the maximum number of contact attempts.

As part of the 2010 Census Program for Evaluations and Experiments (CPEX), an experiment was developed to compare the results from two experimental enumerator questionnaires. For a random sample of NRFU enumerator questionnaires, the “record of contact” section had a maximum of either five contact attempts or four contact attempts. The standard production form (the control group for purposes of analysis) had the traditional maximum of six contact attempts.

## 3. Methodology

### 3.1 Experimental Questionnaires

The production enumerator questionnaire consisted of questions designed to procure the same data as the 2010 Census mailout/mailback questionnaires, as well as a “record of contact” section to document information about each contact attempt. In particular, the front page of the questionnaire had space to provide data for up to six contact attempts including mode (personal visit or telephone), date, time, and outcome. Two experimental questionnaires were modified to provide data for up to either four or five contacts, respectively.

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<sup>3</sup> Total NRFU field work costs include training, travel, production, and miscellaneous expenses for enumerators, crew leaders, crew leader assistants, and field operation supervisors.

Figure 1 shows the record of contact panel for the production six-contact questionnaires or D-1(E). Record of contact sections for the experimental five-contact D-1(E)(X1) and four-contact D-1(E)(X2) panels are in Figures 2 and 3, respectively. Other than to the record of contact section, there were no changes on the experimental enumerator questionnaires. All content questions were the same as those found on the standard enumerator questionnaires.

**Figure 1. Standard 2010 Census Enumerator Questionnaire Record of Contact Question (D-1(E))**

The form is titled "RECORD OF CONTACT" and contains six identical rows for recording contact attempts. Each row includes fields for "Type" (Personal or Telephone), "Mo", "Day", "Time", "a.m./p.m.", and "Outcome". The first row has the "Personal" type selected with an 'X'. Below the rows, the text reads: "OUTCOME CODES: NV = Left Notice of Visit NC = No Contact RE = Refusal CI = Conducted Interview OT = Other".

**Figure 2. Experimental 2010 Census Enumerator Questionnaire Record of Contact Question for Five-Contact Strategy (D-1(E) X1)**

This form is identical in layout to Figure 1, but it is enclosed in a black border. It features six rows for recording contact attempts, with the first row having "Personal" selected. The outcome codes are listed at the bottom: "OUTCOME CODES: NV = Left Notice of Visit NC = No Contact RE = Refusal CI = Conducted Interview OT = Other".

**Figure 3. Experimental 2010 Census Enumerator Questionnaire Record of Contact Question for Four-Contact Strategy (D-1(E) X2)**

This form is identical in layout to Figure 1, but it is enclosed in a black border and contains only four rows for recording contact attempts. The first row has "Personal" selected. The outcome codes are listed at the bottom: "OUTCOME CODES: NV = Left Notice of Visit NC = No Contact RE = Refusal CI = Conducted Interview OT = Other".

Because the bulk of the enumerators' workload consisted of the standard six-contact questionnaires, researchers were concerned that enumerators would miss the experimental questionnaires. One method for mitigating this risk was to print the record of contact section of experimental questionnaires with a black border to draw attention and encourage the enumerator to follow the appropriate experimental procedures.

### 3.2 Summary of Experimental Design

#### 3.2.1 Sample Design

The contact strategy experiment was carried out using a case-level sample design where a sample of the experimental enumerator questionnaires was systematically inserted into the assignment area (AA) binders in 485 stateside Local Census Offices (LCOs) during the assignment preparation activities (Puerto Rico was excluded from the sample). This design was intended to ensure that enumerators would receive one experimental questionnaire within each AA binder assigned to them. The quantity of AAs per LCO varied, as did the number of cases per AA.

Each LCO received one box of five-contact experimental questionnaires and one box of four-contact experimental questionnaires. The LCOs had been instructed that experimental questionnaires were to be systematically inserted with the standard D-1(E) enumerator questionnaires into each binder as it was prepared for an AA. The fifth form in the binder was an experimental questionnaire. To distribute the experimental questionnaires systematically across each LCO, binders for odd numbered AAs included five-contact enumerator questionnaires and even numbered AAs included four-contact enumerator questionnaires. LCO's were instructed to continue using production questionnaires in AA binders once all experimental questionnaires were used.

The case-level design enabled analysis of the impact on data quality and cost savings while minimizing operational logistical issues in the field and removing the risk of geographically clustered data quality problems associated with the use of experimental questionnaires. Any negative impact of fewer contacts on data quality was dispersed across all NRFU cases, thereby eliminating the possibility and/or perception of any clustering (e.g., entire geographic or political regions) of data quality loss.

The final effective sample sizes for each of the three questionnaires are shown in Table 1.

**Table 1. Panel Design for NRFU Number of Contacts Experiment**

Panel	Treatments	Form Type	Effective Sample Size
1	<u>Control</u> : 2010 Census enumerator form (which allows 6 contacts)	D-1(E)	45,411,474
2	<u>5 Contact Attempts</u> : 2010 Census enumerator form revised to allow only 5 contacts	D-1(E) X1	507,404
3	<u>4 Contact Attempts</u> : 2010 Census enumerator form revised to allow only 4 contacts	D-1(E) X2	502,194

#### 3.2.2 Enumerator training

The enumerator training included references to experimental questionnaires and instructed enumerators to use the questionnaire to determine the correct maximum number of attempts (both personal visit and telephone) for each housing unit. That is, if the questionnaire for a case contained six contact fields, they should have made up to six attempts; if the questionnaire contained five contact fields, they should have made up to

five attempts; if the questionnaire contained four contact fields, they should have made up to four attempts. After the maximum number of attempts (personal and telephone) on the form or after the third personal visit, enumerators were instructed to seek a proxy respondent.

## **4. Limitations**

### **4.1 Sample Implementation**

Placement of the experimental questionnaires was performed in the field during the largest field staff mobilization of the decade. Given the complexity of this organization, there is no guarantee that the intended sampling method was followed exactly at every LCO. Reports and discussion with field staff illuminated occurrences of inconsistent form placement, multiple experimental questionnaires in the same AA binder, labeled questionnaires removed before going into the field, among other problems. The predominant effect of this was an increase in randomization in an otherwise systematic sample. In cases where entire binders contained experimental questionnaires, clustering may have occurred. There is no anticipated negative effect from these deviations. For more complete descriptions see Section 3.2.1.

### **4.2 Actual Number of Enumeration Attempts**

Enumerators were trained to make up to the number of contacts specified on the form, but this did not mean that they followed these instructions for the recorded contact attempts after becoming accustomed to six attempts. There is evidence to show that some enumerators made undocumented attempts (such as an enumerator continuing to make further attempts which are not recorded due to lack of space on the form). This study assumes that the number of contact attempts recorded in the record of contact section was the actual number of attempts made. Thus, by definition, the standard six-contact form could have no more than six attempts, the five-contact form could have no more than five attempts, and the four-contact form could have no more than four attempts. It is possible and likely that some enumerators made undocumented attempts that could not be accounted for in the cost analysis. If some enumerators made more attempts than recorded, estimated cost savings reported would be higher than would actually be realized on implementation.

### **4.3 Data Capture of Contact Outcomes**

This study relies completely on the ability of the enumerators to have accurately recorded all data in a manner in which the data capture software was able to record successfully. Any case with ambiguous responses such as an outcome of “CT” or “OI” was treated as an undeterminable response and not recoded to either “CI” or “OT,” for completed interview and other, respectively. It is likely that some of cases with a successfully conducted interview were considered a “No Interview” for this analysis due to the strict criteria of this study.

### **4.4 Cost Estimation**

The NRFU estimated cost per case is an average calculated across all cases (see Section 5.3). This does not take into consideration any differences in cost for telephone calls compared with personal visits, initial compared with subsequent attempts, regional

variability, etc. Detailed cost data by contact were not available for the 2010 NRFU operation.

#### **4.5 Form Selection**

Selection was based on use of the final version of the final form submitted for each NRFU case. This could have lead to discrepancies in the data for experimental cases. Cases that were reworked for any reason would have been completed on a six-contact form, though the case initially was assigned an experimental form. This may not only have lead to reassignment of some cases that should have been experimental, but could have artificially increased data quality on the retained experimental questionnaires. Though analysis of the first data captured questionnaires yielded no differences, it is possible initial questionnaires were never transmitted to Census Bureau Headquarters.

### **5. Results**

#### **5.1. Interview and Outcome Distributions**

Interview completion is the most important measure of success for the experimental treatments. If a reduction in contact attempts resulted in a reduction of completed interviews, this would harm the effectiveness of the NRFU operation. Analysis included all cases with a defined contact attempt.

Table 2 shows the total number of contact attempts made for all cases with a defined interview (as described in Section 3.2.3). This is separated by form with four, five, or six contact attempts in the record of contact section. All cases without a defined interview are grouped in the last row for each form. These cases have anywhere between one and six attempts. Cases with no attempts documented have been removed from analysis. Cases where attempts were made and no defined interview was recorded are listed as “No Interview” (see Section 4.3).

Approximately one percent of all NRFU cases did not have a defined interview by the final contact attempt. The final cumulative percentage of completed cases was within 0.1 percent for all contact strategies (four-, five-, and six- contacts). Of note is the similarity of distributions between the treatments. For instance, the fourth contact attempt had the same cumulative completion rate (91.1 percent) for both the six- and five-contact strategies. The cumulative total of interviews after the third contact attempt were also relatively similar across the three treatments, within 1.5 percentage points of each other (although the cumulative rate is significantly higher for the four-contact form at  $\alpha=0.10$ ). As predicted, additional effort made by the enumerators to complete cases on the final attempt occurs regardless of how many previous attempts have been made.

On average, cases assigned a production six-contact enumerator questionnaire and cases assigned an experimental five-contact questionnaire took 2.2 contact attempts to complete. Cases assigned an experimental four-contact questionnaire took only 2.1 contact attempts on average to complete.

**Table 2. Cumulative Total and Percentage Point Increase for Defined Interviews by Form Type**

	Contact Attempts	Interviews Completed at Each Contact	Cumulative Total	Cumulative Percent	Percentage Point Increase
Six Attempt Treatment	1	18,605,185	18,605,185	41.1	
	2	11,259,665	29,864,850	66.0	24.9
	3	7,353,238	37,218,088	82.3	16.3
	4	3,964,490	41,182,578	91.1	8.8
	5	1,629,254	42,811,832	94.7	3.6
	6	2,045,470	44,857,302	99.2	4.5
	No Interview	363,394	45,220,696		0.8
Five Attempt Treatment	1	197,363	197,363	39.0 (0.07)	
	2	130,347	327,710	64.8 (0.07)	25.8 (0.07)
	3	86,401	414,111	81.8 (0.05)	17.1 (0.06)
	4	46,685	460,796	91.1 (0.04)	9.2 (0.05)
	5	40,934	501,730	99.1 (0.01)	8.1 (0.04)
	No Interview	4,348	506,078		0.9
Four Attempt Treatment	1	199,216	199,216	39.8 (0.07)	
	2	133,501	332,717	66.4 (0.07)	26.7 (0.07)
	3	83,428	416,145	83.1 (0.05)	16.7 (0.06)
	4	80,524	496,669	99.2 (0.01)	16.1 (0.05)
	No Interview	4,147	500,816		0.8

Source: 2010 Decennial Response File and Auxiliary files

Note: Standard errors are provided in parentheses for experimental treatments. The six-contact treatment is the standard census form and has no variance.

Table 3 shows the distribution of all contact outcomes, by contact attempt number, for each experimental treatment. Unlike Table 2, which shows the cumulative total of defined interviews by the total number of contact attempts, this table shows all possible outcomes at each attempt number for defined attempts. Potential outcomes from the record of contact section were conducted interview (CI), left notice of visit (NV), refusal (RE), no contact (NC), and other (OT). The undetermined category contains all other letter combinations and missing contained cases where no outcome was recorded in the presence of other information. Note that in some cases an enumerator may have recorded a contact as a “CI” but, for unknown reasons, there were subsequent contact attempts for that housing unit (0.87 percent overall). This table also includes cases without an outcome of a defined interview, that is, those that remained unresolved by the end of the NRFU operation.

**Table 3. Distribution of Outcomes at Each Contact by Form Type**

	Contact Number	Number of Contact Attempts	Contact Outcome in Percents						
			Conducted Interview	Left Notice of Visit	Refusal	No Contact	Other	Undetermined	Missing
Six Attempt Treatment	1	45,220,696	39.8	47.1	1.3	4.9	6.5	0.2	0.2
	2	26,543,824	41.8	34.3	1.6	15.4	6.3	0.2	0.5
	3	15,244,351	47.4	26.4	2.0	17.1	6.3	0.1	0.5
	4	7,804,378	49.8	22.7	2.0	17.3	7.2	0.2	0.9
	5	3,792,340	41.6	26.1	2.5	21.2	7.6	0.2	0.8
	6	2,134,725	83.3	4.2	1.8	6.3	3.3	0.2	0.9
Five Attempt Treatment	1	506,078	37.7 (0.07)	48.5 (0.07)	1.4 (0.02)	5.0 (0.03)	6.9 (0.04)	0.2 (0.01)	0.2 (0.01)
	2	308,049	41.6 (0.09)	34.4 (0.09)	1.8 (0.02)	14.8 (0.06)	6.8 (0.05)	0.2 (0.01)	0.5 (0.01)
	3	177,215	48.0 (0.12)	25.7 (0.10)	2.4 (0.04)	16.6 (0.09)	6.7 (0.06)	0.1 (0.01)	0.5 (0.02)
	4	89,672	50.9 (0.17)	21.5 (0.14)	2.4 (0.05)	16.6 (0.12)	7.5 (0.09)	0.2 (0.01)	1.0 (0.03)
	5	42,366	83.4 (0.18)	4.5 (0.10)	1.8 (0.06)	5.7 (0.11)	3.5 (0.09)	0.2 (0.02)	0.9 (0.05)
Four Attempt Treatment	1	500,816	38.6 (0.07)	48.4 (0.07)	1.3 (0.02)	4.8 (0.03)	6.5 (0.03)	0.2 (0.01)	0.2 (0.01)
	2	301,056	43.7 (0.09)	33.0 (0.09)	1.7 (0.02)	14.6 (0.06)	6.3 (0.04)	0.2 (0.01)	0.4 (0.01)
	3	167,111	48.9 (0.12)	25.8 (0.11)	2.2 (0.04)	16.0 (0.09)	6.4 (0.06)	0.2 (0.01)	0.5 (0.02)
	4	82,697	86.3 (0.12)	4.0 (0.07)	1.5 (0.04)	4.4 (0.07)	2.9 (0.06)	0.2 (0.02)	0.7 (0.03)

Source: 2010 Decennial Response File and Auxiliary files

Note: Standard errors are provided in parentheses for experimental treatments. The six-contact treatment is the standard census form and has no variance.

If enumerators had resolved cases in a consistent way, there would not have been any major differences in the distribution of contact outcomes at each contact number between the three different contact strategies. In fact, the distributions of outcomes at initial contact were similar among all strategies. For instance, 47.1 percent of the initial visits for the standard six-contact form had an outcome of “left notice of visit,” compared to 48.5 percent and 48.4 percent in the five- and four- attempt treatments. Distributions for the final attempt (fourth, fifth, or sixth respectively) were also similar. Although intermediate distributions varied depending upon strategy, they were still generally similar to each other in outcome (for instance, 15 to 17 percent of the second and third contacts for each strategy resulted in no contact with the housing unit).

The reduction by two attempts does not appear to cause any damage to successful case completion. Results of outcome by attempt showed that, regardless of the contact



strategy, the majority of final attempts results in a conducted interview (83.3 percent for the six-contact form, 83.4 percent for the five-contact form, and 86.3 percent for the four-contact form). This suggests that some enumerators may have altered their strategy or increased effort to complete the cases by the final attempt.

Next, we examined the rate of proxy and household member interviews between the three NRFU contact strategies. Table 4 shows the distribution of contacts by respondent type for each of the treatment groups for cases with a defined interview. There was not a large difference in the average number of proxy<sup>4</sup> respondents for the treatments (51.8 percent for the six-contact strategy, 49.7 percent for the five-contact strategy, and 50.2 percent for the four-contact strategy). The percentage of cases that have a missing or undetermined respondent was comparable.

The percentage of household member respondents was significantly higher on both the reduced contact treatments (47.5 percent of six-contact attempts, 49.5 percent of five-contact attempts, and 49.1 percent of four-contact attempts). This is a positive finding for the two experimental treatments because one of the concerns was that fewer contact attempts would lead to enumerators seeking a proxy sooner. The concern stems from evidence that the use of proxy respondents leads to higher item nonresponse (Chesnut 2005).

Lower proxy rates from the experimental questionnaires could be related to the form data selection process in which only the final NRFU form for each household was used for analysis purposes. It is possible proxy cases were more likely to be reworked (needed additional attempts to enumerate). Cases that were reworked or corrected for any reason would have been completed on a six-contact form though the case initially was assigned an experimental form. If this was the case, it may have altered the overall household proxy rates by “moving” some of the experimental proxy cases to the control group.

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<sup>4</sup> For the purposes of this analysis, “proxy” respondents include household in-movers after Census Day (April 1) and neighbors or landlords, for example.

**Table 4. Distribution of Respondent Type for Defined Interviews by Form Type**

	Contact Number	Household Respondent (Percent)	Proxy Respondent (Percent)	Missing (Percent)
Six Attempt Treatment	1	52.1	46.8	1.1
	2	49.4	50.1	0.5
	3	44.9	54.5	0.5
	4	35.1	64.5	0.4
	5	40.1	59.4	0.5
	6	34.2	65.2	0.6
	<b>Total</b>	<b>47.5</b>	<b>51.8</b>	<b>0.7</b>
Five Attempt Treatment	1	54.8 (0.11)	44.0 (0.11)	1.2 (0.02)
	2	51.2 (0.14)	48.2 (0.14)	0.6 (0.02)
	3	46.7 (0.17)	52.7 (0.17)	0.6 (0.03)
	4	37.9 (0.22)	61.6 (0.23)	0.5 (0.03)
	5	38.0 (0.24)	61.3 (0.24)	0.7 (0.04)
	<b>Total</b>	<b>49.5 (0.07)</b>	<b>49.7 (0.07)</b>	<b>0.8 (0.01)</b>
Four Attempt Treatment	1	54.7 (0.11)	44.4 (0.11)	1.0 (0.02)
	2	50.2 (0.14)	49.3 (0.14)	0.5 (0.02)
	3	45.7 (0.17)	53.8 (0.17)	0.5 (0.02)
	4	36.9 (0.17)	62.6 (0.17)	0.4 (0.02)
	<b>Total</b>	<b>49.1 (0.07)</b>	<b>50.2 (0.07)</b>	<b>0.7 (0.01)</b>

Source: 2010 Decennial Response File and Auxiliary files

Note: Standard errors are provided in parentheses for experimental treatments. The six-contact treatment is the standard census form and has no variance.

## 5.2. Item Nonresponse and Completeness

Though case completion was of great concern for NRFU, the quantity and detail of the data being collected were also very important. Data quality can mean many different things, however this study looked at very specific measures to analyze the quality of the data obtained for each of the three strategies. These included overall form completeness and item nonresponse.

Table 5 shows the average form completeness based on respondent type for each of the treatments. Average form completeness for household members and proxies is comparable across all treatments. In general, form completeness was higher for household-member interviews (97.1 percent for six-contact questionnaires) than for proxy cases (72.5 percent for six-contact questionnaires), and almost identical across the three contact strategies (significant at  $\alpha=0.10$ ). Proxy respondents are often correlated with poorer data quality than that of household members (Chesnut 2005) since they do not typically have full knowledge of or familiarity with all residents compared to an actual household member.

**Table 5. Average Form Completeness by Respondent Type for Defined Interviews by Form Type**

	Contact Number	Household Member	Proxy Respondent	Undetermined	Overall
Six Attempt Treatment	1	97.7	82.4	87.2	96.1
	2	97.4	77.0	86.5	94.2
	3	96.6	69.9	79.9	88.0
	4	95.8	68.5	77.6	82.2
	5	95.4	69.1	77.3	83.1
	6	94.0	67.9	71.1	79.2
<b>Total</b>		<b>97.1</b>	<b>72.5</b>	<b>83.4</b>	<b>91.3</b>
Five Attempt Treatment	1	97.9 (0.04)	85.3 (0.37)	90.0 (1.32)	96.9 (0.05)
	2	97.4 (0.06)	77.9 (0.42)	83.5 (2.16)	94.8 (0.08)
	3	96.6 (0.09)	69.7 (0.35)	79.7 (2.65)	88.5 (0.13)
	4	95.7 (0.15)	68.8 (0.38)	80.5 (3.45)	83.3 (0.21)
	5	94.2 (0.19)	68.5 (0.37)	70.7 (3.62)	81.0 (0.22)
<b>Total</b>		<b>97.2 (0.03)</b>	<b>72.6 (0.17)</b>	<b>83.5 (1.02)</b>	<b>91.8 (0.05)</b>
Four Attempt Treatment	1	97.8 (0.04)	85.1 (0.36)	90.1 (1.52)	96.7 (0.05)
	2	97.3 (0.06)	77.2 (0.40)	84.9 (2.31)	94.3 (0.08)
	3	96.5 (0.10)	70.1 (0.35)	75.4 (3.27)	88.3 (0.14)
	4	95.0 (0.13)	68.6 (0.27)	72.9 (3.09)	81.8 (0.16)
<b>Total</b>		<b>97.1 (0.03)</b>	<b>72.8 (0.17)</b>	<b>82.8 (1.19)</b>	<b>91.8 (0.05)</b>

Source: 2010 Decennial Response File and Auxiliary files

Note: Standard errors are provided in parentheses for experimental treatments. The six-contact treatment is the standard census form and has no variance. Only occupied units with completed interviews were included.

Similar to what we found with the overall form completeness analysis (see Table 6), item nonresponse rates for household respondents did not differ much between the three contact strategies. There was some variability in item nonresponse between strategies for proxy respondent cases. For example, nonresponse to the tenure question was 33.9 percent on the six-contact form, 36.1 percent on the five-contact form, and 35.2 percent on the four-contact form (statistically significant at  $\alpha=0.10$ ). Also, nonresponse to the age question was 54.9 percent for the six-contact form and 54.8 percent for the five- and four-contact questionnaires (not statistically significant at  $\alpha=0.10$ ). However, on the whole, no one form type performed better across all items.

Individual measures such as population count, Hispanic origin, race, and the overcount question had reduced nonresponse for experimental strategies, while tenure, name and age saw an increase in nonresponse. We do not believe any of these small, but significant, differences were attributable to the questionnaire type; they were likely caused by random error.

### 5.3 Cost-Benefit Analysis

As shown in Section 5.1, the cumulative percentage of NRFU interviews completed was approximately the same regardless of the maximum number of contacts made or mode in which the case was completed. The final count of unique housing units enumerated in the 2010 Census NRFU operation was 47,197,405 at an average field operation cost of \$28.00 per case, after enumerator training was excluded (Jackson et. al. 2011). This study had a case average of 2.23 attempts to obtain an interview (based on defined interviews). The average cost per case divided by the average number of attempts per case came out to about \$12.56 per contact attempt.

Without precise data, average cost was calculated for any attempt regardless of mode of contact. This, then, is a *high end estimate* as it assumes an equal distribution of cost across attempts. It is likely that there is a base cost per case as well as high variability in cost across attempts (i.e., initial attempts may cost more than subsequent attempts, final attempts may cost more than earlier attempts, etc.). In lieu of more comprehensive data on NRFU costs per contact attempt, we provide a rough order of magnitude benchmark for potential cost savings in this section.

In order to analyze cost-benefits for a reduced contact strategy, we extrapolated the NRFU workload that would have been completed on each attempt, had a uniform strategy been employed. Percentages were calculated to include all cases, including those in which contact attempts were recorded but lacked a defined interview, which would have added to cost in NRFU and are not the same as those in previous analyses. Cases with a defined interview but no defined contact attempt data were excluded from analysis.

**Table 6. Estimated Total NRFU Costs for Each Contact Strategy**

	<u>Six-Contact Strategy</u>			<u>Five-Contact Strategy</u>			<u>Four-Contact Strategy</u>		
	Percent Cases	Estimated Cases (in millions)	Estimated Cost (in millions)	Percent Sample Cases	Estimated Cases (in millions)	Estimated Cost (in millions)	Percent Sample Cases	Estimated Cases (in millions)	Estimated Cost (in millions)
1	41.3	19.49	\$244.84	39.1	18.47	\$231.96	39.9	18.83	\$236.45
2	25.0	11.79	\$296.25	25.9	12.20	\$306.51	26.7	12.62	\$317.09
3	16.5	7.77	\$292.59	17.3	8.16	\$307.63	16.9	7.96	\$299.75
4	8.9	4.19	\$210.38	9.3	4.41	\$221.65	16.5	7.79	\$391.54
5	3.7	1.73	\$108.65	8.4	3.95	\$248.13			
6	4.7	2.23	\$167.91						
	Total	<b>47.20</b>	<b>\$1,320.67</b>	Total	<b>47.20</b>	<b>\$1,315.88</b>	Total	<b>47.20</b>	<b>\$1,244.84</b>
	Census Adjusted Cost		\$1,322.49	Savings		\$4.73	Savings		\$75.77

Source: 2010 Decennial Response File and Auxiliary files and 2010 Decennial Cost Data

Note: Calculations are based on rounded numbers. Census Adjusted Cost consists of total NRFU field work costs which include production hours, production and training units and miscellaneous expenses for enumerators, crew leaders, and field operation supervisors.

The method used to calculate cost savings involved calculation of the cost for each case based on the number of maximum contact attempts. The total number of cases was multiplied by the percentage of sample cases completed at each attempt to calculate an estimated number of cases that would be completed in each number of attempts. The average cost per attempt (approximately \$12.56) was then multiplied by the number of cases and the number of attempts those cases would require. For example, using the four-contact strategy, an estimated 12,623,112 housing units would need two attempts to complete the case. The estimated total NRFU cost for these housing units is \$317,092,573 ( $2 \times 12.56 \times 12,623,112$ ). These total estimated costs were summed to gain an overall cost for the NRFU operation assuming the given strategy had used one treatment exclusively. Rounded numbers were used for all calculations. The full results are shown in Table 6.

Because the vast majority of the enumeration used a six-contact form, it was not surprising that the six-contact strategy was within 0.01 percent of the actual NRFU field operation costs. To control for calculation error, strategies were only compared against each other. For example, estimated cost savings using a four-contact strategy is the estimate for a four contact strategy subtracted from the estimate for a six-contact strategy. All cost savings were calculated by comparison to the six-contact control.

- Savings associated with the use of a five-contact strategy instead of the six-contact strategy were approximately 0.4 percent of the six-contact estimated cost (4.7 million dollars).
- Savings associated with using a four-contact strategy instead of a six-contact strategy were approximately 5.74 percent of the six-contact estimated cost (75.8 million dollars).

The larger reduction in attempts could elicit increased effort very early in enumeration, which is supported by Table 2. A slightly larger number of cases were completed within the first three attempts with a four-contact strategy (83.1 percent) when compared to the five- or six-contact strategies (81.8 percent and 82.3 percent respectively). It is possible that the reduction to a four-contact strategy could encourage enumerators to complete

cases more quickly and result in more cases being enumerated in two or three attempts. Summed across the entire NRFU workload of over 47 million cases, a one or two percentage point difference adds up to large cost savings.

Alternatively, the larger increase in estimated cost savings from five- to four- contact attempts could result from the lack of cost distribution data by contact attempt. As mentioned in the limitations (Section 4), it is likely that the average cost per case includes a base price per case. So a reduction in one attempt, though calculated as saving 12 dollars might only reduce cost 10 dollars or 5 dollars. Among other reasons, first attempts require time to find the unit and must be made in person. Also travel cost to a neighborhood, which would initially be spread amongst numerous cases, would be the same if only a single case remained in the neighborhood. This would drive up the cost per case of later attempts.

## **6. Conclusions and Recommendations**

### **6.1 Conclusions**

Census 2000 research indicated that 70 percent or more of NRFU housing units were enumerated in three contacts or fewer (Tancreto and Bentley 2004). In the 2010 Census, over 80 percent of housing units were enumerated in three or fewer attempts. Overall, data show that experimentally reducing the maximum number of contact attempts neither reduces the number of successfully completed cases, nor inflates the use of proxy respondents.

The expected “final push” to complete cases occurred on the last attempt regardless of the maximum number of contact attempts on the questionnaire. Whether this is due to extra effort made on the last contact or merely exaggerates the existing tendency for enumerators to make additional, unrecorded attempts is unknown given the methodology employed. Enumerator debriefing results suggest both explanations. Regardless, there is no increase in proxy respondents.

There was no reduction in form completeness or item nonresponse rates as might have been expected when reducing the maximum number of contact attempts an enumerator had to make before seeking a proxy respondent. Form completeness and item nonresponse were both fairly consistent between all strategies. This supports reducing the maximum number of contact attempts in order to realize savings in enumeration cost.

Cost savings estimates ranged from 5 million to over 75 million dollars assuming the standard six-contact attempts procedure were reduced to a five- or four-contact procedure, respectively. This most likely over estimates actual cost-savings, since debriefing results suggest more than half of enumerators still made more contacts than indicated in the record of contact data. Because of this, we must be cautious when interpreting results from this research. However, the cost analysis does give an idea of the magnitude of cost savings and that cost savings are a real possibility.

Though enumerators made more contact attempts than were recorded, there is evidence that a number of enumerators reduced the number of contacts and sought a proxy sooner. This could result in cost saving with high estimates near a 5 percent reduction in the total NRFU budget. More importantly, we found no evidence that reducing the maximum number of attempts would increase item nonresponse or reduce overall form

completeness. In conclusion, a reduction in the number of contact attempts has the potential to maintain the same level of data quality and save costs in the NRFU operation, provided these experimental results hold when implemented at the area level, as opposed to the case level.

## 6.2 Recommendations

**We recommend an area-level study be conducted before full-scale implementation of a reduction in the maximum number of NRFU contact attempts.**

We see no reduction in data completeness when a reduced contact strategy is employed and no increase in proxy respondents. Implementation of a reduction in the number of contact attempts for all enumeration procedures should not have any detrimental effects on case completion or data quality, based on the results of this experiment. There should also be some cost savings realized if a reduced contact strategy were employed.

However, this study was unable to control for a number of factors that could have a significant impact on overall cost savings. Though we found no reduction in data quality, an area-level design in a mid-decade test would eliminate concerns over poor data quality clustering of census data. Area-level implementation would also allow for homogeneity of organizational, training, and caseload management, to ensure consistency between enumerators and across field operations.

It is important that site selection be made based on comparability in all features. Not only would this allow direct comparison of case completion and data quality for the NRFU operation performed under each strategy, but accurate cost savings comparisons could be made. This would also provide data on other factors not taken into consideration in this study.

## 7. References

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