

Using Paradata and the Nonresponse Follow-up Dashboard Score Function to Prioritize Workload

Terri L. Craig
U.S. Census Bureau

Abstract

Reviewing paradata and monitoring response dashboards are two tools used to help reduce nonresponse. After the 2007 Census of Governments: Finance Component, we developed a dashboard that monitored response in the very early stages of processing. In 2012, we added the use of a score function to the dashboard. As part of our modernization and re-engineering efforts, a new nonresponse follow-up application was also developed. This paper shows how we incorporated the use of paradata into the dashboard score function and subsequently incorporated the new score function into the nonresponse follow-up application to target units with the highest score function in an effort to increase response rates.

Key Words: Paradata, Dashboard, Score Function, Nonresponse Follow-up

1. Introduction

In response to the 21 recommendations issued in 2007 by the Committee on National Statistics in its report, *State and Local Government Statistics at a Crossroads*, the U.S. Census Bureau's Governments Division (GOVS) launched a comprehensive modernization and re-engineering (M&R) effort. As a part of its re-engineering efforts, GOVS implemented the use of dashboards to guide nonresponse follow-up and to help ensure that the Census Bureau Statistical Quality Standards on response rates are achieved (Craig, 2012).

The first dashboard developed was for the Annual Survey of Local Government Finances (ALFIN). It was used during the 2008 ALFIN processing cycle. In 2012, the use of a score function was added in the dashboard when viewing the individual units. For the 2014 survey year, the use of the score function will be incorporated in the Nonresponse Follow-Up (NRFU) application. The score function will incorporate the use of response time paradata.

This paper gives a brief description of the ALFIN dashboard in Section 2 and a description of the NRFU Application (Section 3). Section 4 describes the score function components. Section 5 compares the 2013 NRFU initial listing to both the NRFU listing using the current score function components, and to the NRFU listing adding the final score function component using response time paradata. The final two sections summarize the results and conclusions, and suggest future research, Sections 6 and 7, respectively.

2. Dashboard

a. Annual Survey of Local Government Finance Survey Background

The ALFIN provides data on revenue, expenditures, debt, and assets from state and local governments. There are general purpose and special district

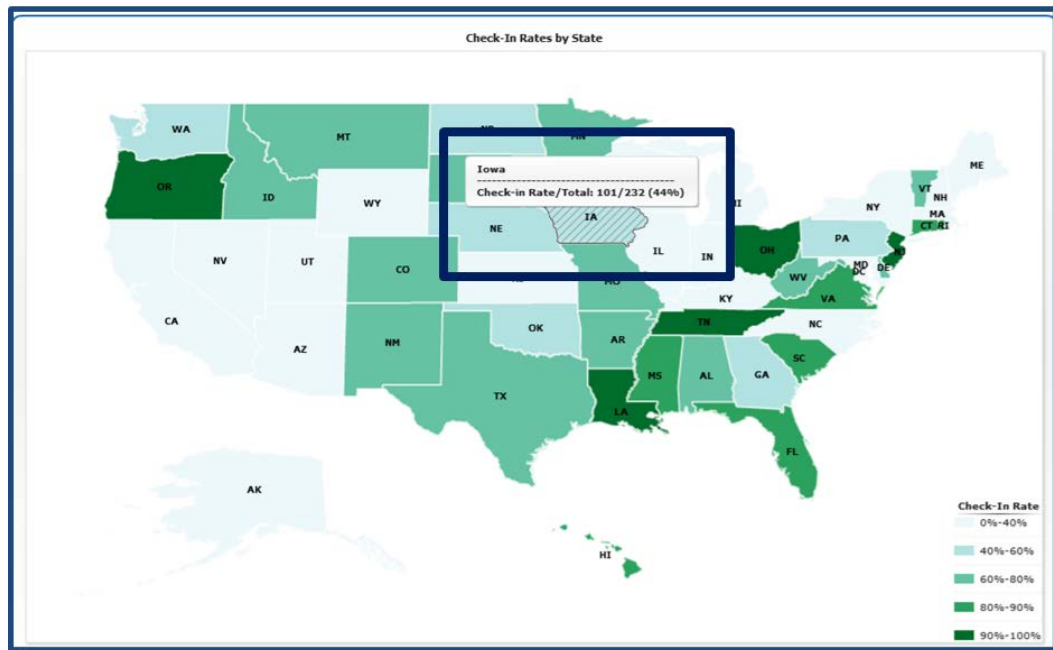
Disclaimer: This report is released to inform interested parties of research and to encourage discussion of work in progress. The views expressed are those of the authors and not necessarily those of the U.S. Census Bureau.

governments. General purpose governments are counties, municipalities, and townships, which cover multiple governmental functions (police, fire, education, administrative, etc.) Special district governments generally cover a single or very limited number of purposes. For example, school districts provide data on the education function. Special districts (airport authorities, regional libraries, housing authorities, drainage ditch districts, etc.) provide data on their single function.

b. Description of Dashboard

The NRFU dashboards were developed to monitor and guide analysts through the data collection process. When analysts open the dashboard and select the appropriate processing year, the analyst has a quick glance of where follow-up is needed on the national check-in rate map (See Figure 1). It displays the United States, color-coded depending on the state's check-in rate. The analyst can hover over a state for more detailed information. The state detail is shown in Figure 1 for the state of Iowa. The check-in rate is 44 percent, with 101 out of 232 units checked-in.

Figure 1: ALFIN National Check-In Rate Map with State Information



Source: U.S. Census Bureau, 2011 Annual Survey of Local Government Finances

The overall check-in rate tab shows the check-in rates by state and by type of government. The state is selected using a drop down menu. On this tab, there is an option to view all ALFIN units. When this tab is selected, a table is displayed with information for each government unit in that state. The information displayed includes the type of government, the government name, the sampling weight, the population, the check-in date, the values for major aggregates (revenue, expenditure, debt and asset), and the SCORE value (see Figure 2). The current unit listing is in government ID order. The analyst has the option to

display it in ascending or descending SCORE value order. Figure 2 shows the ALFIN units by descending SCORE value order for Maine.

Figure 2: Dashboard Partial Unit Listing with the Score Function

<u>Id</u>	<u>Type</u>	<u>Name</u>	<u>Form</u>	<u>Weight</u>	<u>Population</u>	<u>Checkin Date</u>	<u>Score</u>
<u>16100300300000</u>	1	ALLAMAKEE	28	.1863	14610	07/31/2012	-
<u>16100700700000</u>	1	BLACK HAWK	28	1	127446	07/01/2013	111420
<u>16100800800000</u>	1	BOONE	28	1	26391	01/23/2012	85173
<u>16100900900000</u>	1	BREMER	28	.2537	23734	07/01/2013	115176
<u>16101001000000</u>	1	BUCHANAN	28	.5278	20927	07/31/2012	99197
<u>16101101100000</u>	1	BUENA VISTA	28	1	19776	07/31/2012	80885
<u>16101301300000</u>	1	CALHOUN	28	.2828	9987	02/22/2012	-
<u>16101401400000</u>	1	CARROLL	28	1	20923	07/31/2012	37395
<u>16101501500000</u>	1	CASS	28	.7136	13884	01/24/2012	94679
<u>16101701700000</u>	1	CERRO GORDO	28	1	44016	07/31/2012	40320
<u>16102002000000</u>	1	CLARKE	28	1	8995	07/31/2012	41160
<u>16102202200000</u>	1	CLAYTON	28	1	17685	07/31/2012	39221
<u>16102402400000</u>	1	CRAWFORD	28	.547	16579	07/31/2012	136080
<u>16102502500000</u>	1	DALLAS	28	1	57288	02/28/2012	73037
<u>16102602600000</u>	1	DAVIS	28	.6787	8572	01/18/2012	61424

Source: U.S. Census Bureau, 2011 Annual Survey of Government Finances

The TQRR tab displays the Total Quantity Response Rate (TQRR) for revenue, expenditure, debt, or assets (the four major aggregates) for the state selected. The TQRR yields a rate that reflects the portion of the estimate that is from the respondents. For each variable, an estimate of the current year's total forms the denominator. This estimate is the sum of each government's weighted current year response or prior year response if the current year is not yet available. The weighted values for the current year respondents form the numerator. The TQRR variable selected will also be shown by type of government. The TQRR formula is shown below. On the dashboard screen, there is also the option to view all ALFIN units.

$$\text{TQRR} = \frac{\sum w_i(\text{Variable Estimate})_{R_i}}{\sum w_i(\text{Variable Estimate})_{R_i} + \sum w_i(\text{Variable Estimate})_{NR_i}}$$

Where w_i is the weight of the unit, R_i is a respondent unit and NR_i is a nonrespondent unit. These four aggregates for which TQRRs are calculated are used in the SCORE function.

c. Use of The Score Function

In the paper, 'Use of a Score Function to Prioritize and Limit Recontacts in Editing Business Surveys', it was shown that recontacting a limited number of units can achieve about the same level of data quality as full recontact (Latouche and Berthelot, 1992). The limited number of units to recontact was determined by

calculating a score value for each survey unit and setting a critical value score. The units with a score value above the critical value are recontacted.

After the development of the ALFIN dashboard, the score function was developed and used to help identify chronic non-respondents for follow-up. When the NRFU application was complete, it was determined that the score function could be used to prioritize the NRFU listing, as in the Latouche and Berthelot paper. By using the score function to prioritize the NRFU listing, there is more of an effort to get a response from the chronic non-respondents that could have an impact on the final estimates. The analyst will begin at the top of the list and follow-up the units listed, as time permits.

3. Nonresponse Follow-up (NRFU) Application

a. Description

In preparation for the 2012 Census of Governments (CoG), the Governments Division initialized a large Modernization and Reengineering project to update and improve the processes and systems that the programs in the division currently use to collect, process, and release data. A NRFU application was developed for the surveys of the Governments Division. The M&R team that developed and tested the system requirements and functionality of the NRFU application was the Post Collection Team.

The NRFU application's primary use is to identify government units (GU) to contact who have not responded to one or more of the Governments Division surveys. In addition, the NRFU application is used to assist staff in answering questions, documenting incoming calls from government units, updating contact information, and re-mailing survey forms. The NRFU application is used by staff at both the National Processing Center (NPC) and headquarters (HQ). Currently, four surveys have been incorporated in the NRFU application. The application has reduced the duplication of effort for obtaining responses and allowed for improved information sharing between NPC and HQ regarding the respondent contact of government units from the initial mailout to non-respondent follow-up after the second mailout.

b. Prioritization of Workload

Following the second mail out and survey due date of the surveys, nonresponse follow-up is conducted by NPC to contact current non-respondents and increase the response rate. For the 2012 CoG, a Work Priority List was used within the NRFU application to generate a list of units to contact based on certain criteria. Currently, the Work Priority List is programmed to display records for the selected survey and cycle (year) based on the government units null check-in status, and NRFU actions taken. While the manner in which the Work Priority List is generated is the same for each user, the Work Priority List displayed for the individual users will differ based on the states assigned to the analyst for nonresponse follow-up. The current method of displaying the Work Priority List only allows for respondents to be prioritized based on the last NRFU action taken (i.e., Called-Left Message). This listing is generated based on information obtained from the unit in the current survey cycle. Table 1 shows the NRFU actions that can be taken on a unit.

Table 1: List of NRFU Actions Taken and Return to Workload timeframes

ID	ACTION TAKEN	Return to Workload	ID	ACTION TAKEN	Return to Workload
1	No Action Taken	0 days	16	Respondent Request Remail	21 days
2	First Refusal (Soft)	14 days	17	Edit Referral	---
3	Second Refusal (Hard)	---	18	Edit Referral Resolved	---
4	Received Data - Keyed	---	19	Comp Complete	---
5	Received Data - To be keyed by analyst	---	20	Comp to HQ	---
6	Called - Respondent will respond	21 days	21	Comp Pending	---
7	Called - Left Message	2 days	22	Comp Received	---
8	Called - No Message, Busy, or No Answer	1 day	23	Classification Ruling Pending	---
9	Emailed Respondent	2 days	24	Classification Ruling Complete	1 day
10	Faxed Respondent	2 days	25	Classification Ruling Closed	---
11	Washington Referral	---	26	Classification Ruling Out-of-Scope	---
12	Updated Unit Info	0 days	27	Extension – 2 week	14 days
13	Needs Research	---	28	Extension – 4 week	28 days
14	Research Attempted/Failed	---	29	Extension – 6 week	42 days
15	Set Up Appointment	21 days	30	Extension – 8 week	56 days

Source: NRFU Application Requirements Document

4. Score Function

a. Description

A score function assigns a value to each survey unit using various elements for the unit. The higher the unit's score the more critical it is to follow-up on the unit if it is a nonrespondent. For initial ALFIN, the score function had four multiplicative components, the check-in rate for the state in which the unit resides, the data flag during the last processing cycle for the unit, the unit's maximum data value of revenue, expenditure, debt or asset for the most recent prior year data available, and the unit's nonresponse rate.

b. Enhancements

In an effort to link dashboard information and response time paradata into the NRFU listing, two score function components were enhanced. The first enhancement comes from the dashboard. The national check-in rate map is used for the state's check-in rate, the first component of the score function. Using the national check-in rate from the dashboard changed the number of response categories from three to five as well as the response categories themselves, see Table 2. The second enhancement comes from the NRFU application. It uses the amount of time it took a unit to respond from the time of the initial mail out. The response time category is used as the final component of the score function. The first three components of the score function will be referred to as the paradata score function. The score function with the fourth component added will be referred to as the response time paradata score function.

This paper uses 2011 processing cycle information to determine the score function values.

Table 2: Original *rrscore* Compared to New *rrscore*

<i>Rrscore</i>	Old category	New category
1	>70%	90% - 100%
2	60% - 70%	80% - <90%
3	<60%	60% - <80%
4		40% - <60%
5		<40%

Source: 2012 ALFIN Dashboard Specifications and ALFIN Dashboard

5. Comparing Prioritization with and without using the Score Function and Paradata

a. NRFU Listing - Original Order

The NRFU Listing used in this research consists of five states, Kentucky, Maine, Minnesota, Tennessee, and Virginia, 392 government units. The listing contains both parent governments and child governments. A child government is an entity lacking sufficient independence and administrative autonomy from another government to be considered independent. Therefore, a government entity includes the parent government and its associated child or children (dependent units). This research used parent level data; as this is the way imputation processing is currently done. Parent level processing decreased the number of units to 290. The listing was received in government ID order. The government ID is a 14 digit number. The first two numbers indicate the unit's state. The third digit indicates the unit's type of government (county, municipality, township, special district). In the NRFU listing, original order, all units needing NRFU in Kentucky are listed first then Maine, Minnesota, Tennessee and Virginia.

b. Paradata Score Function Components

There are three paradata score function components, the state check-in rate, the unit data flag during the last processing cycle, and the unit financial information.

As mentioned earlier, the response rate component is taken from the ALFIN dashboard national check-in rate map information. Table 3 shows for each state on the NRFU listing, their check-in rate as of March 5, 2014 and the response rate component value. This component is called *rrscore*. Kentucky and Maine have response rates less than 40 percent, they are assigned an *rrscore*=5. States with a low check-in rate will most likely have a lower response rate. These states should be at the top of the list to ensure they are contacted during nonresponse follow-up. The other three states, Minnesota, Tennessee, and Virginia have a response rate between 41 percent and 60 percent, they are assigned an *rrscore*=4.

Table 3: Check-in Rate Information as of 3/5/2014

State	Check-in Rate	<i>rrscore</i> Value
Kentucky	17%	5
Maine	25%	5
Minnesota	42%	4
Tennessee	51%	4
Virginia	59%	4

Source: 2013 ALFIN Dashboard

The data flag is assigned by unit and item code. The data flag component uses the most frequent data flag assigned to the unit. The data flag consists of a four digit year and a letter. The four digit year represents the year the unit last responded. The letter indicates how the data were obtained. If the unit was imputed the letter is G, P, or Q. A 'G' means growth rate imputation (prior year reported data times a growth rate) was used on the unit in the last processing cycle. If there is no reported data at any point in the past for a unit, it is a birth. It is imputed using a donor unit and assigned a P flag. For the Q flag, the year indicates when it was a birth and initially imputed. The Q means a growth rate has been applied to the prior year donor imputation. For the unit's score function we define a unit flag which is the most frequently used data flag for the unit. If the unit was reported, the score function component is equal to 1. If the unit was imputed with a G flag, the four-digit year determines the value of the component. The longer it has been since receiving a response the higher the unit should be on the NRFU listing. Units with a Q or P get the highest values for this component, respectively. Table 4 below shows the years and the score function value assigned to it. This component is called *flgscore*.

Table 4: Data Flag Score Function Component

Year of Last Reported Data	<i>flgscore</i> Value
2011	1
2010	2
2009	3
2008	4
2007	5
2006	6
2002	7
Any year with a Q flag	8
2011P	9

Source: 2011 Finance Data File

A government's financial information is used to help measure the size of the government. Most governments have total revenue and total expenditures. The maximum of these two values is taken as the unit's size. This variable is called *dscore1*. Some governments incur a lot of debt when coming into existence. Therefore, the maximum of total revenue, total expenditures, total debt and total assets is also taken as the unit's size. This variable is called *dscore2*. In the final score, the maximum of *dscore1* and *dscore2* is used in the score function calculation. All values are multiplied by the unit's weight. This component is called *dscore*.

Governments that exist but have no activity, or have all reported or imputed zeroes, are assigned a *d*score of 1.

The paradata score function (*pscore*) is equal to the product of the three components ($rrscore * flgscore * dscore$). Table 5 shows the top 12 order changes of the 290 units from the NRFU original order listing to the NRFU paradata order listing using the *pscore* value. The table columns are the government ID, *pscore*, original order number, paradata order number, and the absolute change in position.

The first unit in the original order number NRFU listing is now down to position 276. There are five births in the listing. These units should automatically go to the top of the original order number NRFU listing. They are shown in red in all of the tables throughout this paper. There was one unit that was imputed with all zeroes in the listing (shown in blue). Its score is low and its position went from 8 to 290. There were three units that were on the bottom of the list that moved up to the top of the list. The original order units that were in positions 1-42 moved to positions 243 or higher.

Table 5 – NRFU Listing using the first three components of the Score Function

Government ID	<i>pscore</i>	Original Order Number	Paradata Order Number	Absolute Difference
18405630100000	10	8	290	282
18404270400000	10,360	1	276	275
18401880200000	6,147.54	11	281	270
47212700100000	5,431,152	269	5	264
47210100100000	2,722,972	273	9	264
18403780300000	11,740	13	274	261
18403820100000	10,640	14	275	261
18408080100000	48,825	6	265	259
18403291300000	50	27	285	258
18411191300000	50	28	286	258
47105405400000	5,716,888	255	3	252
18404570100000	100,622.71	2	243	241
20400140200000	4,630	42	283	241

Source: 2011 Finance Data File and 2013 NRFU Listing

c. Paradata Component

During the summer of 2013, Professor Frauke Kreuter was consulted on the use of paradata in determining the NRFU listing. The score function in the nonresponse follow-up dashboard was discussed. The suggestion was made to consider the way the government units respond and the amount of time it takes them to respond. It was determined the best way to do this was to look at how long it took a unit to respond in the previous processing cycle and incorporate it into the score function.

Table 6 shows the response time and the value assigned in the score function. The longer it took during the previous processing cycle to receive a response from the government, the higher the response time score function component. Units that were never checked in and births are assigned the highest value, respectively. This component is called *rtscore*.

Table 6: Response Time Score Function Component

Response Time	<i>rtscore</i> Value
0 to 60 days from mail out	1
61 to 90 days from mail out	2
91 to 120 days from mail out	3
121 days or more from mail out	4
Unit never checked in	5
Unit is a birth	6

Source: 2011 Finance Data File

The final score for a unit is the $pscore * rtscore$. Using response time paradata, the units that had the greatest position change went from position 30-90 to position 140-200. For the units that moved up on the NRFU listing the largest change was 42 positions from 230 to 188. The use of response time paradata did not affect 14 units. Those fourteen units include the five births and the unit that was imputed all zeroes. Table 7 below shows the top 12 units with the largest position change.

Table 7 – NRFU Listing using the all components of the Score Function

Government ID	Score	Original Score Order	Paradata Score Order	Response Time Paradata Score Order	Absolute Difference
4310550550000	862,971.53	163	45	163	118
4710420420000	863,286.02	248	44	161	117
4310880880000	891,553.13	164	41	155	114
4721105010000	814,340.00	260	53	167	114
2440132010000	605,980.92	151	76	190	114
4710850850000	779,509.57	256	57	170	113
4740449010000	646,808.00	286	72	185	113
4320015010000	983,275.00	192	35	147	112
4721240010000	537,548.00	268	89	200	111
4320530010000	1,018,345.00	195	33	142	109
4710980980000	1,027,650.69	241	32	140	108
2420860030000	379,580.00	278	113	217	104

Source: 2013 NRFU Listing and 2011 Finance data File

6. Summary of Results

The use of the score function will affect the order of contact if the listing is used the way it is intended. Using response time paradata in the score function also appears to be beneficial. Table 8 shows the number of units that moved up, moved down and stayed the same in the NRFU listing. The second column is the change from the original NRFU listing and the paradata NRFU listing. The third

column is the change from the paradata NRFU listing and the response time paradata NRFU listing.

Table 8: Summary of Changes in the NRFU Listings

Direction of Change	Original NRFU Listing to Paradata NRFU Listing	Paradata NRFU Listing to Response Time Paradata Listing
Up	140	201
Down	149	75
Same	1	14

Source: 2011 Finance Data File

The recommendation is to use the score function to determine and prioritize the NRFU listing. Plans are already being implemented to incorporate the score function into the NRFU application as well as data editing. It is also recommended to conduct a thorough review of units that were imputed all zeroes.

7. Future Research

For this research, only one year of response time information was used for the *rt*score. We would like to research the response time for a unit over a number of years, take the average response time, and use this to determine the *rt*score.

The development of the score function for other surveys is being incorporated into the NRFU applications. We will consider adding more paradata components to the score function.

We would like to also take into consideration the mode of collection in conjunction with the response time since this could add information about data quality. Currently there are three modes of collection, mail canvass, internet collection, or central collection agreement. For the Annual Survey of Local Government Finances, there are about 26 states that have central collection agreements. This is an agreement with a state government to collect local government finance data from one central source. The agreement varies from state to state in both the way the data are collected and the type of data collected. Because in central collection states there is an agreement, we can be sure to receive data for those units included in the agreement. The agreement also includes when that data will be received. Therefore, the paradata response time component should give more weight to the web and paper units, then the central collection units.

8. References

National Research Council, Committee on National Statistics, State and Local Government Statistics at a Crossroads, September 2007.

Craig, T. and Hogue, C. (2012), The Implementation of Dashboards in Governments Division Surveys.

Latouche, M. and Berthelot, J.M. (1992). Use of a Score Function to Prioritize and Limit Recontacts in Editing Business Surveys. *Journal of Official Statistics*, 8, pp. 389-400

9. Acknowledgements

The author thanks Robyn Harris for co-authoring the paper. Thanks also goes to Carma Hogue, Carol Caldwell, and Jeffrey Barnett for their valuable input.