Using Paradata to Understand Business Survey Reporting Patterns

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Proceedings of the 2013 Federal Committee on Statistical Methodology (FCSM) Research Conference

Abstract

Paradata are increasingly used as a source of information about respondent behavior and survey outcomes. In this paper, we examine paradata from the 2010 and 2011 Annual Survey of Manufactures (ASM), including cost, follow-up and multi-unit electronic reporting instrument data. Previous research was exploratory in nature, attempting to understand basic questions such as the median length of time from downloading to uploading the survey's software. Current research will be more targeted, whereby we use auxiliary data, including paradata, to model survey response. Additionally, we begin examining ASM costs as they relate to the stages of the survey process.

Keywords: Paradata, Adaptive Design, Annual Survey of Manufactures

1. Introduction

As survey nonresponse has increased over the past two decades (de Leeuw and de Heer, 2002) and survey budgets have declined, it has become imperative to find cost savings wherever possible. One possible intervention to mitigate these trends is the implementation of an effective adaptive survey design program. Adaptive design attempts to utilize already available survey information to make decisions during data collection that balance survey costs and quality. One such source of information comes in the form of the data collected about the survey process, referred to as paradata (Couper, 1998). For instance, Rao, Glickman, and Glynn (2008) proposed data collection stopping rules that depended on comparing estimates derived from early and late responders. It is not the purpose of this paper to review the adaptive survey design approach (see Groves and Heeringa, (2006) for a better exposition on the topic). The first step in using paradata is to identify a set of variables that may provide some utility in understanding the nature of reporting throughout the data collection period.

As such, this paper will be exploratory in nature, developing a profile of respondents based off paradata variables captured in the 2011 Annual Survey of Manufactures (ASM). These data come from two sources: the Business Register (BR) and Surveyor. Surveyor is a downloadable reporting software platform used for multi-unit businesses. The BR is a centralized business database where information for enterprises, establishments, and other administrative data are stored. Additionally, we have cost data that includes costs associated with the initial survey mail-out operation, as well as mail and telephone follow-up.

For this paper, we define an establishment as a single physical location where business is conducted or where services or industrial operations are performed. Further, the terms "establishment" and "unit" are used interchangeably in this paper. Finally, we define an enterprise as a business organization consisting of one or more domestic establishments that were specified under common ownership or control. The enterprise and the establishment are the same for single-unit organizations. Each multi-unit company forms one enterprise.

In this paper, we will discuss the following: Section 2 gives relevant background information on the ASM; Section 3 will describe the methods we used to analyze the data; Section 4 will present results. Finally, Section 5 discusses the results and future research directions.

2. Background

The ASM is a mandatory response survey that provides statistics on employment, payroll, supplemental labor costs, cost of materials consumed, operating expenses, value of shipments, value added by manufacturing, detailed capital expenditures, fuels and electric energy used, and inventories for all manufacturing establishments with one or more paid employees. In this section, we provide information on the major components of the ASM program, including

[1] Any views expressed are those of the authors and not necessarily those of the U.S. Census Bureau.

sample design, data collection, estimation, and non-response follow-up. For information on the ASM including historical data and forms, go to http://www.census.gov/manufacturing/asm/index.html.

2.1 Sample Design

To select the ASM sample, the manufacturing population is partitioned into two groups: establishments eligible to be mailed a questionnaire, a mail stratum, and establishments not eligible to be mailed a questionnaire, a nonmail stratum. The eligible establishments consist of larger single-location, manufacturing companies and all manufacturing establishments of multi-location companies. The ineligible establishments consist of small and medium-sized, single-establishment companies based on the Economic Census. Data for these ineligible establishments are estimated using information obtained from the administrative records of the Internal Revenue Service (IRS) and Social Security Administration, and are included in the published ASM estimates.

The ASM mail sample includes approximately 50,000 establishments of which about 20,000 are selected with certainty, and about 30,000 are selected with probability proportional to a composite measure of establishment size. Although the nonmail stratum contained approximately 180,000 individual establishments in 2011, it accounted for less than 7 percent of the estimate for total value of shipments at the total manufacturing level. A new sample is selected at five-year intervals beginning the second survey year subsequent to the Economic Census. This information is supplemented with data for new companies from the IRS and the Census Bureau's Report of Organization Survey (COS).

2.2 Data Collection

Data are collected annually for the ASM except for years ending in 2 and 7 when the Economic Census is conducted. The survey is establishment-based, although for a multi-establishment business the questionnaires are mailed to the business enterprise unless another reporting arrangement has been made. Respondents can choose to report by mail or electronically using either the Census Surveyor software (for multi-unit organizations) or by the Web (for single-unit organizations). In addition, respondents can fax forms and in some cases give their responses by phone. In 2011, every enterprise in the sample received a paper form[2]. All multi-units that receive a request to complete the ASM also get a request to complete the COS in the same package. Responses are due within 30 days of receiving the form. The COS is an annual mail-out/mail-back survey of selected companies with payroll, excluding companies engaged exclusively in agricultural production. The purpose of the COS is to obtain current organization and operating information on multi-establishment firms in order to maintain the BR.

Follow-up with nonresponding businesses begins approximately two months after the initial mailout and is usually in the form of a mailed letter. After the first reminder, there are three additional reminders sent, once a month, until a case is considered a delinquent nonrespondent. For some very large establishments that are deemed important for estimation purposes, follow-up may occur via telephone. Currently, data collection continues for the ASM until the project runs out of time or money.

2.3 Estimation

Most of the ASM estimates derived for the mail stratum are computed using a difference estimator. The difference estimator takes advantage of the fact that, for manufacturing establishments, there is a strong correlation among some estimates between the current year data values and the previous Economic Census values. Because of this correlation, difference estimates are considered more reliable than comparable estimates developed from the current sample data alone. The ASM difference estimates are computed at the establishment level by adding the weighted difference (between the current data and the Economic Census data) to the Economic Census data. However, some estimates are not generated using the difference estimator because the year-to-year correlations are considerably weaker. A standard linear estimator is used for these variables. Estimates are published from the 2 – 6 digit NAICS level, and for the U.S. and by state.

3. Analysis

3.1 Analysis Variables

In analyzing the 2011 ASM Surveyor paradata, we have included additional 2010 and 2011 ASM data obtained from the BR and cost data provided by the program staff. The ASM Surveyor paradata file included the date respondents downloaded the Surveyor software and the date the respondents uploaded the Surveyor data file. From

[2] For the 2012 Economic Census if 2011 ASM responses were electronic, paper forms will not be sent.

the BR we obtained information about participation in other Census Bureau surveys, check-in dates, and the mode the respondent supplied information to the Census Bureau for the 2011 ASM. Finally, we have also obtained data indicating costs associated with initial mailing, as well as follow-up mailings and telephone costs.

3.2 Analysis Questions

Much of the research we have conducted to this point was exploratory in nature. We spent months obtaining and merging the aforementioned data and many of the initial research questions necessitate only descriptive statistics to answer. Our overarching research question is how to use paradata to plan survey contact and nonresponse follow-up strategies. We further refined our question into several more manageable parts about business-respondent behavior. We develop the following initial questions:

1. What is the time between mailout, downloading Surveyor software, and uploading data?
2. What is the cumulative response rate?
3. What is the cumulative total quantity response rate?
4. How much money are we spending on each stage of data collection relative to the achieved response rate?
5. What changes in reporting trends do we notice since the previous survey cycle?
6. What are the characteristics of early versus late responders?
7. Are there strong predictors for switching from paper to electronic reporting? From electronic to paper?

3.3 Limitations of the Analysis

There are some limitations to our analysis. Because all establishments in sample report using their parent company ID, it is not possible to distinguish between multiple establishments downloading or uploading the Surveyor software under a company, and a single individual establishment downloading or uploading the software multiple times on the paradata file. Thus, our analysis is restricted to only the initial download/upload event.

Additionally, to measure response, we calculated a check-in rate, rather than a traditional response rate, as we currently do not have the flags to indicate if a respondent had supplied sufficient information to be deemed a response. The use of a check-in rate is appropriate when used as a measure of data collection performance. It is not, however, to be interpreted as a quality indicator.

As noted above, with multi-unit businesses reporting via Surveyor and single-unit establishments reporting via Web, the analysis below in Section 4.1 is restricted only to multi-unit organizations, as we did not have access to Web-response paradata.

Finally, there are limitations with respect to the cost data presented in Section 4.2. The costs here only reflect mail form and phone call costs (direct labor, overhead, and outgoing calls). At this point, we are unable to reasonably estimate cost by survey or by survey activity such as form design, sample selection, or data processing. Additionally, it is not always possible to separate ASM and COS costs because they are conducted jointly. However, as ASM is a much more involved survey instrument in that it asks much more than does COS, a reasonable simplifying assumption for this paper is that where we are given costs for both ASM and COS, a vast majority of the resources are being utilized for ASM.

4. Results

Results are given below. Subsection 4.1 gives results on the 2,014 companies that responded using the Surveyor software package. Both subsections 4.2 and 4.3 present results on all mailed ASM establishments in NAICS 31, the manufacturing sector. Subsection 4.2 presents results on survey response and costs, and subsection 4.3 presents results on those establishments that changed their method of responding to the survey.

4.1 Surveyor Results

All 33,718 multi-unit establishments had the option of reporting via Surveyor, and approximately 13,150 actually used the Surveyor package to report their 2011 data. Of the 13,150 Surveyor records, 2,014 companies had both an initial download date and an initial upload date. All analyses in this section are restricted to only those companies.

The range in days from when the ASM forms were mailed to recipients to when recipients initially downloaded the Surveyor software package was from -5 to 281 days[3]. A negative value is reasonable,

[3] For initial mailout and the subsequent follow-up waves of mailings, we have a range of three consecutive days for each event. As such, we arbitrarily chose the second of these three days to represent the event we are analyzing.

because of some proactive establishments that are expecting the survey. There were several peak download times at roughly 45 days, 75 days, and 185 days (see Figure 1). As responses were due 30 days after receipt, and follow-ups began 30 days after the due date, and then approximately once a month for three months afterwards for nonresponsive cases, these peaks roughly correspond to those periods.

Most ASM uploads occurred within the first few days of download (see Figure 2). In fact, 81% of initial uploads occurred on the same day the Surveyor package was downloaded. There is evidence of severe decay in download/upload interval. Referring to Figure 3, this decay is still seen among those respondents taking more than ten days to upload their data, but the pattern is not as extreme.

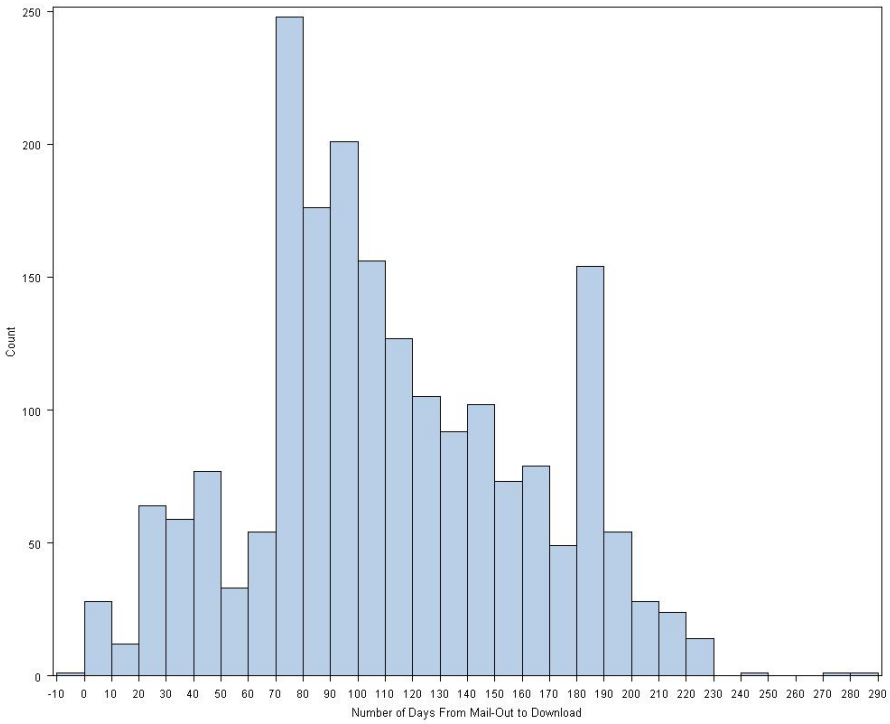

Figure 1. Duration from when the form was mailed to initially downloading the Surveyor package, in 10-day intervals.
Source: 2011 ASM Surveyor Paradata.

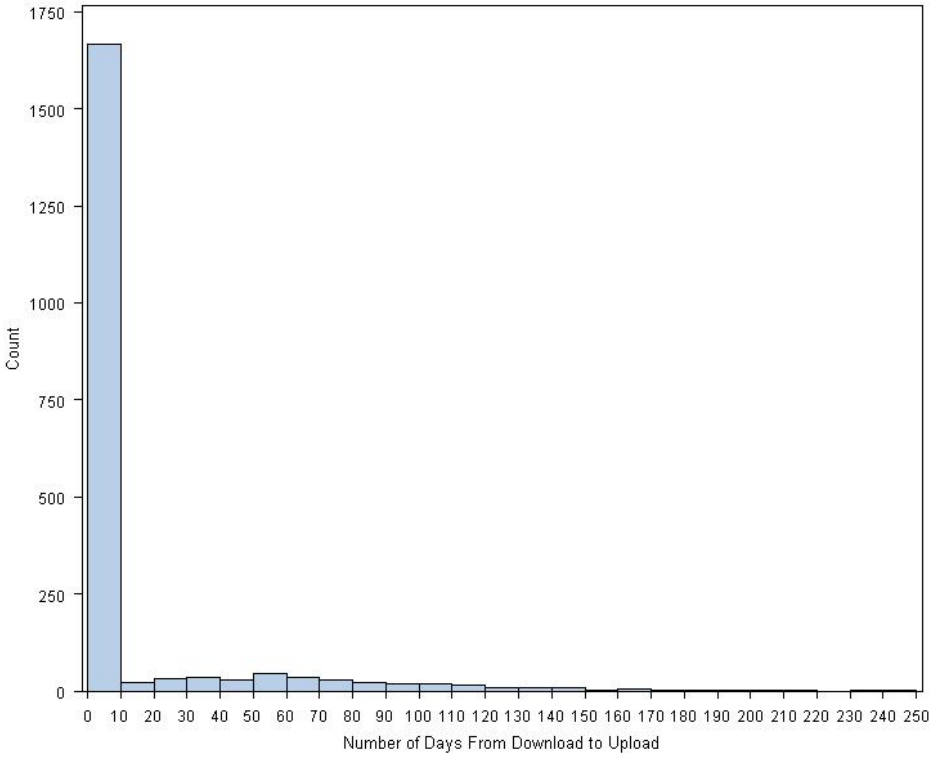

Figure 2. Time elapsed between the initial download to upload of the Surveyor software, in 10-day intervals.
Source: 2011 ASM Surveyor Paradata.

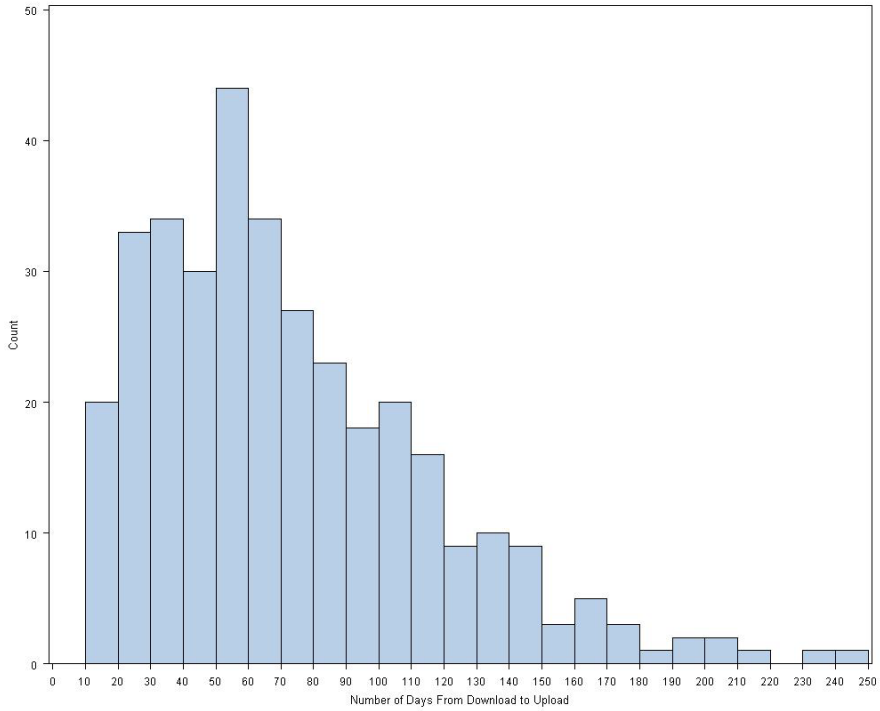

Figure 3. Time elapsed between the initial download to upload of the Surveyor software for those respondents taking longer than 10 days to upload their data, reported in 10-day intervals.
Source: 2011 ASM Surveyor Paradata.

4.2 Response Metrics and Costs

The check-in rate is the percentage of forms returned, either by paper or electronically, to those mailed. The check-in rate covers all mailed multi-unit and single-unit establishments. Again, the check-in rate serves as a measure of data collection performance. The curve in Figure 4 shows a gradual, constant increase in the check-in rate, achieving an overall rate just under 80%. Figure 5 reveals an initial spike in the number of forms checked-in occurred shortly after the due date. Another spike occurred, in the 70-80 day interval, after the first reminder was sent.

Figure 4 also shows the cumulative percentage of the mailing budget from the initial mailing through the fourth follow-up. The first percentage listed is so large because it includes the cost of printing the forms, as well as the cost of postage for the mailing plus the cost of postage on the envelope for return, in addition to early incoming and outgoing phone calls. With the monotonic increase in the check-in rate, it is difficult to assess the utility of spending on follow-up mailings. Some follow-ups have a larger percentage increase in associated costs than others, but do not appear to yield any appreciable increase in the number of check-ins. There is the possibility the follow-ups help maintain the observed monotonic increase in check-ins, but only a carefully planned experiment can help answer that question.

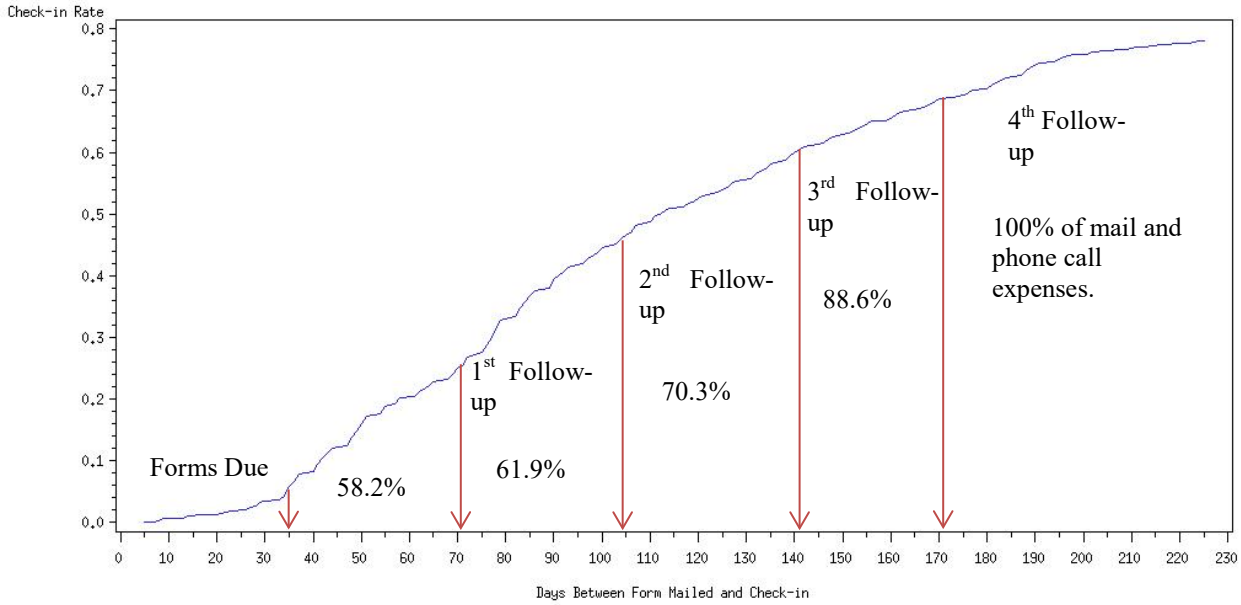

Figure 4. The check-in rate for the 2011 ASM from when forms were initially mailed to respondents. The red arrows represent mail-out dates for follow-up letters at 71, 104, 141, and 174 days for 1st, 2nd, 3rd, and 4th follow-up respectively. The percentages listed show the cumulative percent of the total mailing and telephone expenditures allocated to each stage of data collection up to, but not including, the follow-up subsequently listed.
Source: 2011 ASM.

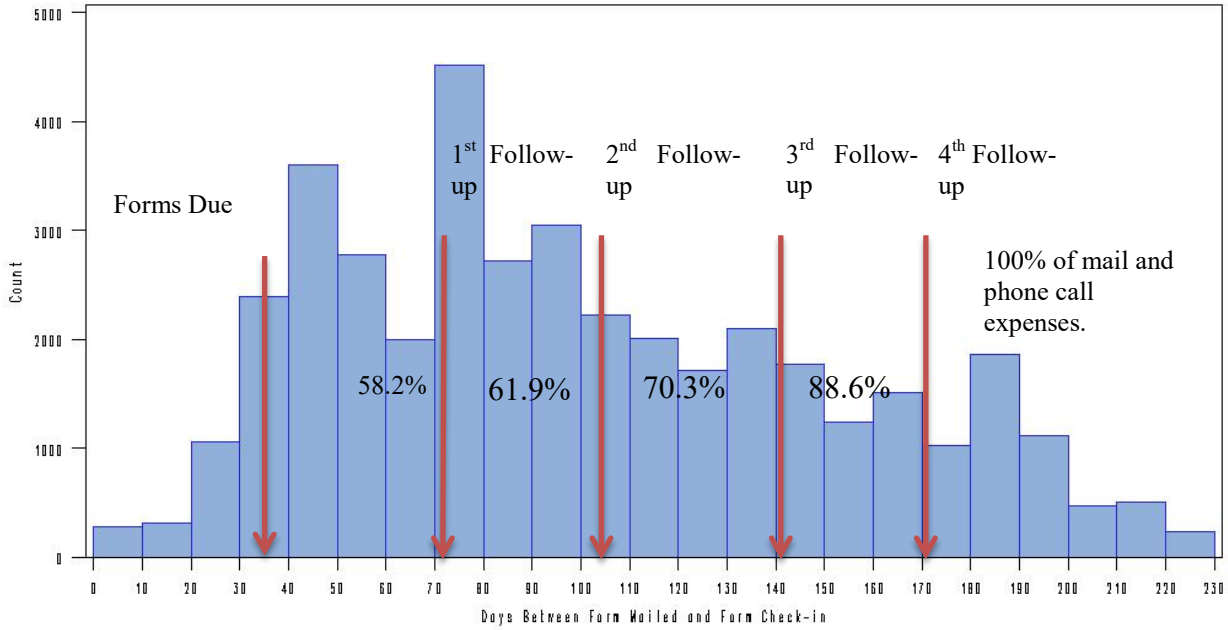

Figure 5. The number of check-ins at 10-day intervals for the 2011 ASM from mail-out to the end of collection. The red arrows represent mail-out dates for follow-up letters at 71, 104, 141, and 174 days for 1st, 2nd, 3rd, and 4th follow-up respectively. The percentages listed show the cumulative percent of the total mailing and telephone expenditures allocated to each stage of data collection up to, but not including, the follow-up subsequently listed.
Source: 2011 ASM.

We also computed a proxy Total Quantity Response Rate (p-TQRR) to allow us to gain insight into the proportion of an estimate that came from both respondent and "equivalent quality" data. Results from the ASM are primarily used to estimate totals. When calculated in real-time, the p-TQRR shows when we are collecting the data that contributes the most to total estimates. This rate was computed similar to the standard, Total Quantity Response Rate (TQRR) used by economic survey programs at the U.S. Census Bureau (U.S. Census Bureau, 2012). The TQRR is computed as follows:

$$TQRR = \left[\frac{\sum_{i=1}^{N_T}(r_{ti} + q_{ti}) * t_i}{\sum_{i=1}^{N_T} f_i t_i}\right] * 100$$

where:

w_i is the design weight of tabulation unit *i*,
r_{ti} is the indicator variable for reported data for tabulation unit *i* and data item *t*,
q_{ti} is the indicator variable of "equivalent quality" data for tabulation unit *i* and data item *t*,
t_i is the design-weighted data value of item *t* for tabulation unit *i*,
f_i is the nonresponse weighting adjustment factor for tabulation unit *i*, and
N_T is the total number of eligible tabulation units.

The TQRR is therefore the proportion of the estimated, weighted total of data item *t* reported by the active tabulation units in the statistical period or from sources determined to be equivalent-quality-to-reported data (expressed as a percentage). While we have flags indicating if a respondent provided a valid response to certain items on the form, we are currently awaiting a finalized list of flags to be developed from a team dealing with response issues in the Economic Directorate. This will ensure consistency across the various surveys. Until that list is complete, we had to rely on a flag indicating simply if a form was returned to the Census Bureau.

To compute the p-TQRR, we assumed a conservative administrative data rate of 8%, a conservative rate consistent with information supplied to us from ASM subject matter specialists at the Census Bureau. We then computed the denominator as:

$$\left[\sum_{i=1}^{N_T} w_i t_i\right] * 1.08$$

Where the variables are defined similarly to the TQRR except:

t_i is the 2011 ASM annual payroll value for tabulation unit i.

The numerator was computed as:

$$q + \sum_{i=1}^{N_T} w_i r_{ti} t_i$$

Where the variables are defined similarly to the TQRR except:

q is the administrative data value calculated from the denominator.

Figure 6 shows the results from this calculation. There is a gradual increase in the rate, with a spike in the rate after the due date. In addition, similar to the check-in rate results, we see increases in reported values on roughly 30-day intervals, corresponding to the initial due dates and subsequent reminders, as Figure 7 indicates. Similar to Figure 4, the red arrows in Figure 6 show the cumulative percentage of the mailing budget from the initial mailing through the fourth follow-up. Again, some follow-ups have a larger percentage increase than others, but do not yield any differential increase in the p-TQRR. Once again, there is the possibility the follow-ups help maintain the observed monotonic increase in check-ins, but only a carefully planned experiment can help answer that question.

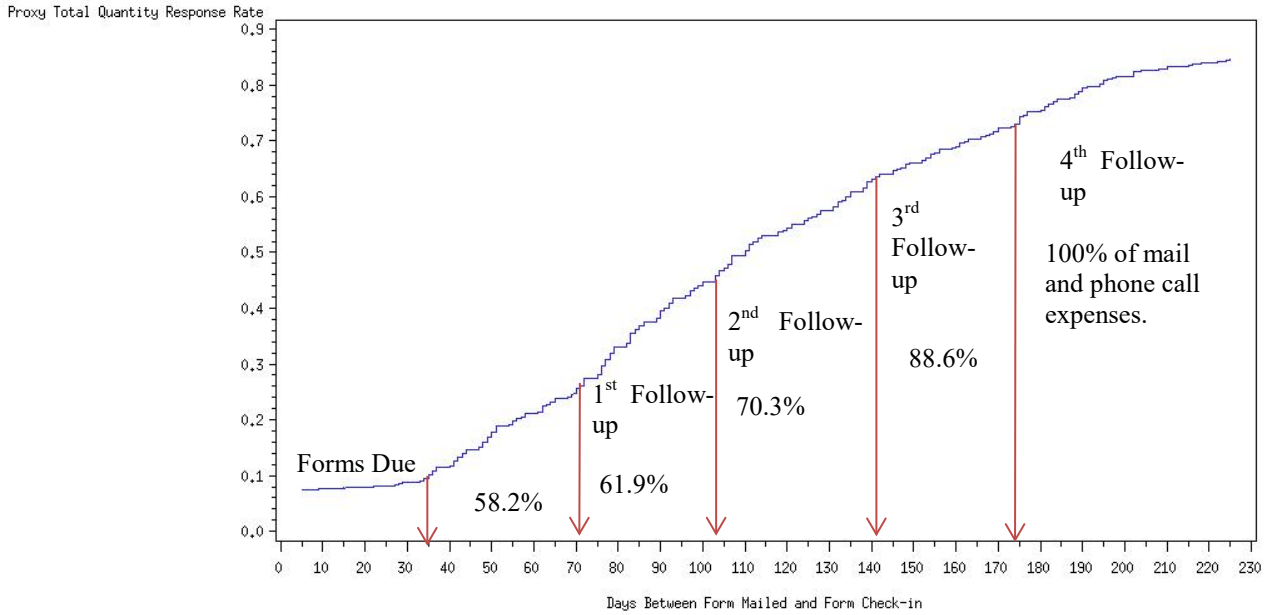

Figure 6. A proxy total quantity response rate for the 2011 ASM from when forms were initially mailed to respondents. The red arrows represent mail-out dates for follow-up letters at 71, 104, 141, and 174 days for 1st, 2nd, 3rd, and 4th follow-up respectively. The percentages listed show the cumulative percent of the total mailing and telephone expenditures allocated to each stage of data collection up to, but not including, the follow-up subsequently listed.
Source: 2011 ASM.

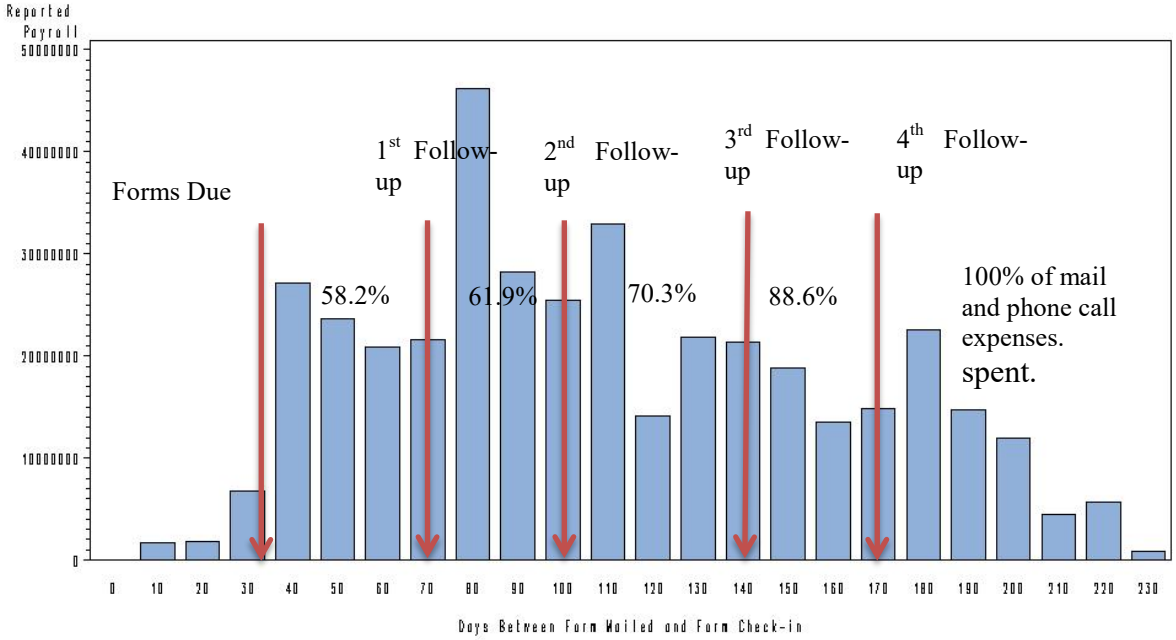

Figure 7. Reported payroll in 10-day intervals for the 2011 ASM from mail-out to the end of collection. The red arrows represent mail-out dates for follow-up letters at 71, 104, 141, and 174 days for 1st, 2nd, 3rd, and 4th follow-up respectively. The percentages listed show the cumulative percent of the total mailing and telephone expenditures allocated to each stage of data collection up to, but not including, the follow-up subsequently listed.
Source: 2011 ASM.

4.3 Mode Change

For ease, we will define "response mode change" as any establishment that changes the mode in which they report data to the Census Bureau from one survey cycle to the next. This change can either be from mailing in a paper form to submitting electronically, or vice versa. We will also define "unit status" as a general term indicating if a unit was a single-unit or multi-unit establishment.

Previous research suggested multi-unit establishments reported 2011 ASM data electronically at higher rates than single-unit establishments (Fink et al., 2013). From 2010 to 2011, 18.96% of establishments changed the mode in which they reported to the ASM. Among those establishments who changed how they reported the ASM from 2010 to 2011, 69.57% changed from paper submission to electronic, while 30.43% changed from electronic to paper. We are interested in the characteristics of the businesses that switched from one mode to another.

Given the above results, among those establishments switching response mode we modeled the characteristics of establishments switching from paper to an electronic means of submission. In particular, we included American Community Survey (ACS) data in the model to understand how community-level (i.e., ZIP code) characteristics may help predict mode change. For instance, younger individuals may be more internet savvy and thus more likely to respond electronically. Similarly, those who share a house with extended families may be in contact with various forms of social media (and therefore more likely to be exposed to computers) and thus more likely to respond electronically.

In order to model this change, ACS data were merged to survey data at the ZIP code level. A logistic regression model was constructed for those establishments in the NAICS 31 (manufacturing) subsector that changed response modes, taking into account survey weights and strata. The binary dependent outcome of interest was coded as a 0 if the establishment switched from electronic to paper, and 1 if the establishment changed from paper to electronic.

The parameters in the final model include a count of the number of days between form mail out and form return, and a count of the number of establishments. Also included are ACS variables that were merged at the ZIP code level to where each establishment is physically located. These variables include the average percent of personal income imputed for ACS respondents and the average minutes to work for residents. Other variables were also considered in other versions of the modeling process, but were not included as they were not statistically significant. These other variables include the difference in the count of employees from 2010 to 2011 for each establishment, the difference in total annual payroll from 2010 to 2011 for each establishment, and the difference in the total amount of receipts from 2010 to 2011 for each establishment, and the difference in the total count of establishments under a company from 2010 to 2011. Finally, other ACS variables were also considered, including the household income, poverty index indicators, and income-to-living costs indicators.

The results can be seen in Table 1. The results demonstrate that the most powerful predictor is the duration between form mail-out and form return. Those establishments responding earlier were more likely to switch from electronic to paper, while those responding later were more likely to switch from paper to electronic. Also of interest is a negative association between the dependent variable and the size of establishment, indicating smaller establishments were more likely to switch from paper to electronic, holding other predictors constant. Also of note is that two of the ACS variables were significant – average percentage of personal income imputed and average minutes to work. At this time, we are unable to explain why either of these variables would be associated with mode change, but it is something we are examining the literature to explain.

Parameter	***df***	**Estimate**	**Standard Error**	**Wald Chi-Square**	***p*-value**
Days between mail out and form return	1	0.00223	0.000553	16.29	< 0.0001
Number of establishments	1	– 0.00024	0.000122	3.98	0.0461
Average percent of personal income imputed	1	– 0.0384	0.0102	14.11	0.0002
Average minutes to work	1	0.0212	0.00972	4.76	0.0291

Table 1. Results of logistic regression modeling the propensity to switch from paper to electronic. There is a 52.4% concordance rate in the model.
Source: 2011 ASM, 2010 ACS 5-year estimates.

Further analysis on business size was conducted. Weighted confidence intervals were constructed for the average number of establishments based on a company-level ID number. The results indicated those who changed from paper to electronic (45.37, 53.79) had, on average, fewer establishments mailed forms than those who changed from electronic to paper (58.14, 79.49). Further analysis shows an association among unit status and response mode change (χ^2= 35.25, df = 1, $p < 0.0001$). In fact, the odds indicate multi-unit establishments were $^4/_5$ as likely as single-unit establishments to switch from electronic to paper reporting (see Table 2 for the weighted frequencies) when examining the weighted 95% confidence interval (CI) of the odds (0.77, 0.87). This result may seem self-evident to those who study survey response among establishments, however, as many larger establishments tend to send paper forms to different areas of their business to fulfill information requests it is not clear that this would necessarily indicate they would prefer to ultimately report in either mode (Anderson et al. 2005). This result, when also recounting the above model results whereby smaller establishments were more likely to switch from paper to electronic demonstrates that mode switch by establishment type is not very clear-cut. There may be other reasons for mode switch. Table 3 presents results from calculated confidence intervals for the number of establishments that switched modes. The results demonstrate that across 9 out of 23 subsectors, those establishments deciding to switch modes did so preferring an electronic mode of submission versus paper.

Type of Establishment	Switch from electronic to paper	Switch from paper to electronic
Multi-unit	2154.15	5083.66
Single unit	3177.16	6137.47

Table 2. Weighted frequencies of establishments that switched response mode from 2010 to 2011 in the ASM.
Source: 2010, 2011 ASM.

3-Digit NAICS	Lower Bound for Paper	Upper Bound for Paper	Lower Bound for Electronic	Upper Bound for Electronic
310	0.00	4.07	0.00	8.31
311	220.70	472.86	479.93	864.01
312	0.00	61.75	88.26	221.20
313	20.38	80.92	30.78	110.88
314	15.51	239.17	80.98	397.56
315	10.88	135.10	99.91	371.55
316	0.00	25.63	4.93	33.25
321	148.79	383.83	391.64	706.18
322	34.38	115.18	98.74	239.06
323	278.54	694.70	719.78	1308.00
324	22.69	152.39	38.06	104.26
325	101.01	286.51	420.26	733.64
326	107.43	237.27	543.55	895.77
327	245.87	557.87	543.40	968.82
330	0.00	6.34	N/A	N/A
331	55.91	196.61	143.01	268.43
332	837.88	1417.00	1985.00	2798.00
333	253.50	534.38	894.23	1339.00
334	79.05	312.27	305.30	564.84
335	38.71	111.53	126.67	261.35
336	91.77	247.99	219.04	400.16
337	159.01	451.27	322.13	712.57
339	339.90	854.92	502.06	1013.00

Table 3. Based on those establishment that switched response mode, those subsectors highlighted in red have more establishments reporting electronically instead of submitting a paper form. The confidence intervals generated are 99.78% intervals, correcting for 23 pairwise comparisons.
Source: 2010, 2011 ASM.

5. Discussion

5.1 Paradata research and Economic Survey Programs

This research stems largely from the need for business survey programs to better understand data collection processes and to improve the efficiency of data collection operations by taking advantage of paradata. With shrinking federal budgets, federal agencies may not be able to afford current data collection models. However, any changes to existing processes need to be made wisely, keeping in mind tradeoffs that exist between survey costs and

data quality. Therefore, before delving into a general discussion about the results and direction for future research, we will first address the topic of conducting paradata research for economic survey programs.

Paradata offers the potential to make smart decisions during data collection, but some proof of concept-type work needs to be conducted first. Many program areas in the Economic Directorate at the Census Bureau are only beginning to use paradata to their full potential. A major goal of this initial research was to find out what paradata exists, compile these data for a given survey program, and find out how to use it for research. The research questions changed considerably from the start of this project until the first draft of this paper because the data differed from what we expected. This is a major point because we now know what we would like to have for future paradata/adaptive design research. For instance, we will need a good handle on survey expenses, additional paradata (such as the number and type of error messages, survey break-off information, etc.), and auxiliary data from other business surveys to make this project a success. In a perfect setting, this information is housed in a central location or easily accessible to every survey program. Additionally, there is a need to develop quality measures that update daily. (Such quality measures stem nicely from programs set up for flow processing.) In short, programs can expect up-front costs before we can expect long-term gains.

5.2 Discussion of results

Based on these preliminary results, there are no obvious actionable items to recommend for the ASM. On the surface, the nonresponse follow-ups seem effective. There is a relatively monotonic increase in check-in rates and well as proxy quantity rates. After about 35 days post mail out, the number of forms checked-in begins an appreciable increase, before leveling off at roughly 200 days after mailing. Also of interest is the fact that most Surveyor software packages are initially uploaded the same day they are initially downloaded. This result initially suggested to us that most establishments have the information readily accessible to enter into the software. However, most establishments do not respond until 70 – 190 days after receiving their paper form. This suggests that establishments take the time to record requested information on a paper form, downloaded Surveyor, entered the necessary information, and then uploaded the software. This hypothesis is lent further support when comparing Figures 2 and 3. The bulk of companies who do not initially download and upload Surveyor on the same day take at least 60 days to submit data once the software package is downloaded.

Upon examining the check-in and p-TQRR figures, it does not appear that differential investment in each phase of follow-up is yielding any discernible increase in the rates. It may be that each wave of follow-up is preserving the continued monotonic increase in the rates, or we may be able to discard one wave of follow-up. Only a carefully designed experiment would allow for such conclusions.

There is clearly still a place in the ASM data collection for paper forms. Table 3 shows that, for establishments that switched response mode, there are many subsectors where the difference between the frequency of establishments reporting by paper and the frequency of establishments reporting electronically is not statistically significant. Additionally, multi-unit establishments were $^{4}/_{5}$ as likely as single-unit establishments to switch from electronic to paper reporting, indicating that mode needs are different by establishment type. On the surface, it seems that this may have something to do with the amount of information being reported. From qualitative research conducted at the Census Bureau, large businesses that have information compartmentalized in disparate areas throughout the organizational structure may find it easier to use paper, rather than electronic, means of reporting information (Anderson et al., 2005). It is possible that businesses experiment with both paper and electronic means of reporting, and after several survey cycles (or even within a single cycle) decide one particular mode that best meets their needs (Hak et al., 2003). As many surveys consider switching to electronic-only response, the above analysis stresses the importance of proceeding down this path only with careful testing about what electronic options might be able to meet the needs of paper respondents.

The outstanding question becomes, given cost and quality indicators, could we be just as effective for less cost? Further investigation is warranted. Figures 2 and 3 indicate that the time from download to upload might best be modeled using a discrete hazard model, something we will undertake as our analysis continues.

5.3 Future research

This research is only scratching the surface of using paradata to examine business-reporting patterns. We are continuing to incorporate the cost information into our analysis, most notably we hope to be able to show how

resources are being allocated throughout the survey life cycle in hopes that we can find ways to improve efficiency. We will also be expanding the above logistic regression model into a multinomial model to understand business characteristics of those establishments not changing response mode. As mentioned above, even if no interventions seem obvious, we may be able to research ways via experimental design to shorten the data collection period, increase conversion of paper respondents to electronic respondents, or test the effects of altering follow-up procedures. Thus, no matter where the research takes us, paradata will prove to be an indispensable tool to create effective models, allowing us to save costs while maintaining high quality in the survey estimates. As we continue to add cost and quality indicators, we will get a better idea how to approach the ASM in an adaptive design context.

Acknowledgements: We wish to thank Eric Merriman for supplying us with Business Register data. We thank Robert Struble for his review of this paper and help in answering questions on the ASM. We thank Michelle Vile Karlsson and Michael Zabelsky for help in supplying us with cost data. Finally, we thank Xijian Liu and Stephen Kaputa for reviewing this paper.

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