

# An Examination of Nonresponse in the Business R&D and Innovation Survey

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## Abstract

Since its inception in 2008, the Business R&D and Innovation Survey's (BRDIS) unweighted unit response rates have varied from 72% to 77%. Most BRDIS estimates are adjusted for unit nonresponse by multiplying each company's sample weight by a nonresponse adjustment factor. Such adjustments may not accurately account for the nonresponse bias in survey estimates if the characteristics of nonrespondents differ meaningfully from those of respondents. This paper applies several nonresponse bias analysis methods to BRDIS. These methods include examining response rates for multiple subgroups of the sample, comparing respondents and non-respondents using a frame variable (payroll), and a response propensity model. We also examine the impact of changes to BRDIS survey methodology in 2012, which resulted in many companies in the sample receiving either a longer or a shorter form than they would have received in prior years. We found little evidence of significant non-response bias in the top level R&D estimate. Our findings also suggest that for BRDIS survey length has a meaningful effect on response rates.

**Key Words:** Company survey, nonresponse bias, measurement error, R&D

## 1. Introduction

The issue of missing data in survey research is one that presents multiple challenges to researchers and data producers. Unit non-response occurs when a sampled unit does not provide any response to the survey. Non-response also occurs when a unit provides information to some but not all questions in the questionnaire (item non-response). Since non-respondents may differ from respondents in terms of the variables collected in the survey, the occurrence of non-response gives rise to concerns about bias in the survey results.

Although businesses that receive the Business R&D and Innovation Survey (BRDIS) are required by law to complete it, unweighted response rates to the survey have not exceeded 77% since its inception in 2008. BRDIS implements a nonresponse weight adjustment to handle unit nonresponse. The adjustment factors are calculated using the measure of size used for sampling as the covariate.<sup>4</sup> These adjustments may not

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<sup>3</sup> This report is released to inform interested parties of research and to encourage discussion. The views expressed on methodological, technical, or operational issues are those of the authors and not necessarily those of the U.S. Census Bureau.

<sup>4</sup> The adjustment factors are not used in the production of BRDIS count estimates.

accurately account for the nonresponse bias in survey estimates if assumptions made about the nonresponse population prove to be incorrect. Much of the literature on analyzing nonresponse bias focuses on demographic surveys (Groves, 2006; Groves et al., 2008; Berg, 2005,) and therefore are not directly applicable to BRDIS, a survey of businesses. Data collected on business surveys tend to have a skewed distribution for key data variables of interest (e.g. sales, inventories, expenses). This implies that the majority of a tabulated cell comes from a small number of large firms. These firms are typically included in the sample as certainty cases (sample weight = 1) for each survey cycle and the remainder of the firms are sampled. The firms that are selected with high sample weights usually contribute very little to the published estimates. This distribution forces survey managers to focus resources on the businesses that have values at the higher end of the scale as they are more significant to the totals than businesses on the low end of the scale.

This paper applies methods suggested by researchers at the U.S. Census Bureau (Lineback and Thompson, 2010) for conducting nonresponse bias studies for business surveys. This paper also investigates the impact on BRDIS response rates of changes to survey methodology in 2012, which resulted in many companies in the sample receiving either a longer or a shorter form than they would have received in prior years. Within the subset of companies selected for the BRDIS sample in both 2012 and 2011 these changes appear to have had a noticeable impact on the likelihood of a company responding to the survey.

### **1.1 Characteristics of the BRDIS**

BRDIS is conducted by the U.S. Census Bureau under a joint partnership agreement with the National Science Foundation (NSF). BRDIS replaced the Survey of Industrial Research and Development (SIRD), which for over 50 years was the official government source of information on the research and development activity of businesses in the United States. BRDIS is an annual survey of approximately 43,000 to 45,000 companies with the primary goal of producing estimates of the amount of research and development (R&D) performed and paid for by a target population of all for-profit businesses that have at least one establishment located in the U.S., have 5 or more paid employees in the U.S., and are classified in selected manufacturing and nonmanufacturing NAICS (North American Industry Classification System) industries. There are approximately 2 million companies in the target population.

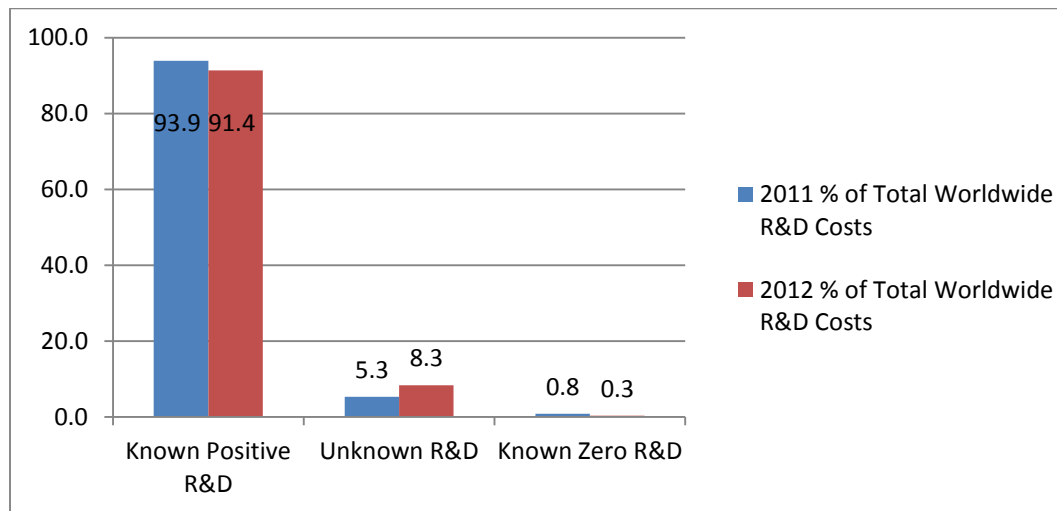
Based on prior results from the BRDIS, we estimate that approximately 3 to 4% of the total population has positive R&D costs and a relatively small number of large firms do the majority of the R&D spending. The top 10% of sampled firms accounted for 89% of the total BRDIS estimate for worldwide R&D costs in 2011 and 90% in 2012. Because R&D is such a rare event within the target population, we use information on R&D activity for prior years from the BRDIS and administrative sources to partition the sample frame. The sample frame is partitioned into three mutually exclusive panels based on information about the companies' R&D activities. The first panel consists of companies with known R&D activity based on data from a previous BRDIS cycle, the Report of Organization (conducted as part of the Census Bureau's Economic Census or the Company Organization Survey, depending on the survey year), IRS Form 6765 (Credit for Increasing Research Activities), online financial databases, and the Bureau of Economic Analysis' Benchmark Survey of U.S. Direct Investment Abroad (USDIA) and Annual Survey of Foreign Direct Investment in the United States (FDIUS). If a company has R&D costs greater than \$3 million, it is in the sample with certainty. Companies with

less than \$3 million are sampled using a probability proportionate to size (PPS) design where R&D cost is the measure of size. The second panel is made up of companies where the known R&D is zero from prior data sources; these companies are sampled using a stratified random sample design. The third panel are companies where no R&D information is available at the time of sampling; this is by far the largest of the three panels (table 1). Companies in the “unknown” stratum are sampled using a PPS design where payroll data from the Census Bureau’s Business Register is used as the measure of size.

**Table 1: BRDIS Frame and Sample Size: 2011 and 2012**

Sampling stratum	2011		2012	
	Sample frame count	Sample size	Sample frame count	Sample Size
Total	1,964,757	43,108	1,971,731	43,655
Known positive R&D	27,049	14,941	29,512	16,188
Unknown R&D	1,863,778	24,782	1,869,215	23,940
Known zero R&D	73,930	3,385	73,004	3,527

One of the challenges in conducting the BRDIS is measuring R&D in the subset of the survey target population for which no prior history of R&D exists (over 1.8 million companies in 2011 and 2012) since R&D is not strongly correlated with other economic variables that are observable such as employment or sales. Identifying companies with R&D within this “unknown” portion of the survey population is truly akin to searching for a needle in a haystack. Although these companies are estimated to account for only a small fraction of the total R&D spending in the U.S. each year (See figure 1), the role of small companies and start-ups in the nation’s R&D and innovation enterprise has grown over the years. It should also be noted that some of the largest companies in terms of R&D spending today did not exist ten years ago.



**Figure 1: Distribution of Total Worldwide R&D Costs by BRDIS Stratum: 2011 and 2012**

## 1.2 Changes to BRDIS Methodology in 2012

Prior to the 2012 cycle BRDIS administered two form types: the complete survey of 44 printed pages (Form BRDI-1) and a shorter form of 32 pages (Form BRDI-1A). Form BRDI-1 was sent to companies in the known positive stratum with reported or imputed U.S. R&D performance of \$7 million or more for at least one of the two prior survey years, and Form BRDI-1A was sent to all other companies. In 2012 Form BRDI-1 grew to 48 pages and Form BRDI-1A was replaced by a much shorter form (Form BRD-1S) which was only 8 printed pages. At the same time, the threshold for receiving the complete survey was reduced to \$1 million. Companies sampled in the unknown and known zero strata received the shorter form in both years. No experiment was designed to explicitly measure the impact of these changes on survey response, but the BRDIS survey methodology does allow some comparisons to be made between 2012 and 2011, and these comparisons are provided in section 3.

## 1.3 Defining response rates

The unit response rate (URR) formula employed by economic surveys at the U.S. Census Bureau is:

$$\text{URR} = [R/(E+U)] * 100$$

where

- R is the (unweighted) number of reporting units selected for the sample that were eligible for data collection and classified as a response.
- E is the (unweighted) number of reporting units selected for the sample that were eligible for data collection, and
- U is the (unweighted) number of reporting units selected for the sample for which eligibility could not be determined (Bates et al., 2008).

An eligible reporting unit is one where an attempt was made to collect data. These are the cases that were included in the initial mail file for each cycle. In order for a reporting unit to be classified as response, it must provide a response to at least one of the following key variables: worldwide sales, domestic sales, worldwide employment, domestic employment, worldwide R&D expense, worldwide R&D funded by others, worldwide R&D employment, or domestic R&D employment. A company may also report that they had ceased operations or were purchased by another company prior to April 1 of the reporting cycle in section 1 of the form to be classified as response.

Due to limitations of the BRDIS frame, we expect it to include companies that are outside the scope of the BRDIS target universe. When a company that was included in the BRDIS sample is determined to be out of scope (such as when a company reports having fewer than 5 paid employees in the U.S.) it is removed from official BRDIS statistics and response rates. However, these cases do meet the criteria to be defined as eligible to report and are thus not excluded from the analysis in this paper. Therefore, response rates based on this paper's definition of unit response are **not** directly comparable to rates published in official BRDIS statistics.

## 2. Analysis of non-response bias in BRDIS

Lineback and Thompson (2010) suggest six different methods for investigating nonresponse bias in business surveys. This paper will use three of the methods to discuss nonresponse bias for the BRDIS. First, we examine response rates for multiple subgroups including certainty status, form type, and sampling stratum. Next, we compare respondents and non-respondents using a frame variable (payroll) and finally, we analyze a response propensity model.

### 2.1 Response Rate Analysis

Lineback and Thompson (2010) noted that response rate analysis by subgroups, using characteristics that may be building blocks in the survey sample design is useful to identify potential nonresponse bias. The first subgroup we analyze is certainty status. BRDIS uses multiple criteria within each of the sample partitions to assign certainty units. In the known positive stratum, all companies with MOS (R&D costs) greater than or equal to \$3 million are selected with certainty. Certainties are also assigned using information about trade association affiliation and data from a link project with the Bureau of Economic Analysis (BEA). In the unknown and known zero strata, certainties are assigned using the Business Register payroll data, trade association affiliation, IRS tax credit data, and establishment industry classification from the Business Register.

Table 2 shows that BRDIS had a higher response rate in the non-certainty group for both the 2011 and 2012 cycles.<sup>5</sup> This result is the opposite observed by Lineback and Thompson (2010) in other economic surveys where the response rate in the non-certainty group was typically significantly lower than the rate for the certainty group. The BRDIS response rates for the certainty cases would likely be much lower were it not for the fact that BRDIS follow-up procedures dedicate significantly more resources to this group. As noted in section 1.2, BRDIS implements a collection strategy that includes two form types. In 2011, all but 10 companies in the non-certainty group received the shorter version (BRDI-1A). In 2012, that number increased to 1,377 companies and the new version of the short form was implemented (BRD-1S) that was significantly shorter.

**Table 2:** Un-weighted Unit Response Rates by BRDIS Certainty Status

Certainty status	2011	2012
Certainty cases	71.1	71.3
Non-certainty cases	76.1	80.4
Total	73.9	76.4

We see from table 3 that, for both 2011 and 2012, the unit response rates are higher for companies receiving the complete form. These cases receive significantly more attention during non-response follow-up but also have higher burden estimates than the companies receiving the shorter form. The short form companies have a burden estimate range of 0.5 hours to 12.5 hours depending on the R&D activities and receive much less attention during non-response follow-up.

<sup>5</sup> The unit response rates are calculated without using design weights to avoid over-representation of smaller companies that have large design weights but contribute very little to total R&D estimates.

**Table 3:** Un-weighted Unit Response Rates by BRDIS Form Type

Form type	2011	2012
Short form (BRDI-1A in 2011, BRD-1S in 2012)	73.7	76.0
Complete form	77.1	77.9
Total	73.9	76.4

Examining unit response rates by sampling stratum reveals that the known zero stratum has the highest response rate for both the 2011 and 2012 cycles (table 4). All companies in this group received the shorter form in both cycles and they receive little to no nonresponse follow-up. The estimated burden for companies with zero R&D is 0.5 hours. They are only asked to report sales and employment data.

**Table 4:** Un-weighted Unit Response Rates by BRDIS Sampling Stratum

Sampling stratum	2011	2012
Known positive R&D	74.3	75.0
Unknown R&D	72.9	76.5
Known zero R&D	79.0	82.5
Total	73.9	76.4

In this section we analyzed the unit response rate across subgroups based on three characteristics that are the building blocks for the sample design. In two of the three cases we see higher response rates in the group where there are significantly less non-response follow-up resources utilized but the burden estimate is significantly lower and the majority of the cases were mailed the shorter version of the form. We also observe increases in the response rate from 2011 to 2012 for these groups across all three characteristics. For all three characteristics, the range of the unit response rate between the groups is less than 10 percentage points for each cycle.

## 2.2 Comparison of Respondents to Non-respondents Using Frame Variables

In this section, we use payroll data from the Census Bureau's Business Register to analyze differences between respondents and non-respondents. We performed two-tailed, two-sample t-tests of equivalence of the means of the payroll data for respondents to the corresponding value for non-respondents. The t statistic was computed within each cell as

$$t_j^* = (\hat{y}_{R,j} - \hat{y}_{NR,j}) / \sqrt{VAR(\hat{y}_{R,j}) + VAR(\hat{y}_{NR,j}) - 2COV(\hat{y}_{R,j}, \hat{y}_{NR,j})}$$

where:

$\hat{y}_{R,j}$  is the estimate of the subgroup j mean for response cases

$\hat{y}_{NR,j}$  is the estimate of the subgroup j mean for nonresponse cases

$VAR(\hat{y}_{R,j})$  is the variance estimate for subgroup j response cases

$VAR(\hat{y}_{NR,j})$  is the variance estimate for subgroup j nonresponse cases

$COV(\hat{y}_{R,j}, \hat{y}_{NR,j})$  is the covariance estimate for subgroup j

We used the following variables to subset the data: sample stratum, form type, legal form of organization, total employment size and an indicator of whether a reporting unit had a

single U.S. business establishment (single-unit) or more than one such business establishment (multi-unit). Table 5 summarizes the results of the tests.

**Table 5:** Average Payroll (\$millions) of BRDIS Respondents and Non-respondents: 2011 and 2012

Form type	2011		2012	
	Respondents	Non-respondents	Respondents	Non-respondents
Short form <sup>1/</sup>	1.7*	1.3*	1.6	1.5
Complete form (BRDI-1)	398.5*	160.9*	174.2*	77.1*
Complete form excluding Account manager cases	148.6*	110.9*	66.0*	50.1*
Sampling stratum				
Known positive R&D	63.7*	37.9*	59.5*	46.0*
Unknown R&D	0.8*	0.6*	0.8*	0.6*
Known zero R&D	17.4	18.3	15.4	22.0
Known positive excluding Account manager cases	33.5*	31.8*	31.9*	36.2*
C-Corporations	6.1*	3.8*	5.0	6.2
Employment size				
<500 domestic employees	0.9*	0.7*	0.9*	0.8*
>=500 domestic employees	186.5*	123.9*	166.9	166.8
Number of establishments				
Single-unit companies	0.8*	0.6*	0.8*	0.6*
Multi-unit companies	22.0	19.7	21.2	27.3
Total	2.3*	1.6*	2.2	1.9

<sup>1/</sup> Form BRDI-1A in 2011, Form BRD-1S in 2012.

\* Difference between respondents and non-respondents significant at the 10% level.

For 2011, we see that the differences are significant in 11 of the 13 groups analyzed. In each group where the differences were significant, the average payroll for respondents was larger than that of non-respondents. For 2012, we have 7 of the 13 groups with significant differences and in 6 of those groups the average payroll for respondents was greater than the non-respondents. These results are expected given that the larger R&D performing companies receive significantly more attention during non-response follow-up. Non-response follow-up listings are generated by sorting the nonresponse companies by size using the sampling measure of size. Since the measure of size is different for each sample stratum, the listings are generated within each stratum. Companies within the known positive stratum receive the highest priority. Figure 1 shows that the known positive stratum accounts for more than 90% of total worldwide R&D costs for both 2011 and 2012. The distribution within the known stratum is also highly skewed with the largest R&D performing companies accounting for the majority of the total estimate. Because of this distribution, these cases receive an isolated follow-up treatment where an account manager is assigned from the Census Bureau's headquarters' staff. There are

about 600 companies assigned account managers each cycle and they have had an unweighted unit response rate between 87 – 93% each cycle. Because of this isolated treatment, we separated the account manager companies for two of the variables. We see that in each case, the difference between the means is significantly less and, in 2012, the difference changed to negative.

We see from Table 5 that the differences between respondents and non-respondents at the total level are significant in 2011 and not significant in 2012. Table 5 also shows that the differences between average payroll for both 2011 and 2012 were not significant in the known zero stratum. These companies are only required to report sales and employment data on the shorter version of the form. We estimate their burden to be 0.5 hour, compared to 25 hours for a company that is required to complete all of the sections in the full version of the form. This stratum receives little to no attention during non-response follow-up and accounts for a very small portion of the total estimate (see figure 1).

We see from tables 3 and 4 above that the unit response rate for the subgroups associated with form type and sampling stratum all increased from 2011 to 2012. We also observed, from table 5, that the differences between the mean payroll for the respondents and non-respondents were significant in three of the subgroups and for each of the three subgroups, the difference between the means decreased or remained the same from 2011 to 2012. This would imply that the bias measured in terms of payroll as:

$$\text{Bias}(\bar{y}_r) = (M/N)(\bar{Y}_r - \bar{Y}_{nr})$$

where

$\text{Bias}(\bar{y}_r)$  = the nonresponse bias of the unadjusted respondent mean;

$\bar{Y}_r$  = Mean payroll of the respondents;

$\bar{Y}_{nr}$  = Mean payroll of the non-respondents;

$M$  = the number of non-respondents; and

$N$  = total population

for these subgroups, decreased from 2011 to 2012 since  $(M/N)$  decreased for all three subgroups and  $(\bar{Y}_r - \bar{Y}_{nr})$  decreased for two subgroups and remained equal for the third.

### 2.3 BRDIS Response Propensity Model

In this section, we examine a response propensity model with the measure of size (MOS) as the independent variable. To account for unit nonresponse, BRDIS implements a non-response weight adjustment where the adjustment factor is the ratio of the sum of the MOS for all companies in the adjustment cell to the sum of the weighted MOS for all companies with reported or imputed data. With ratio adjustments, the covariate is used to predict the response variable and when the covariate is related both to the response propensity and the prediction model, both estimation bias and total variance are minimized (Vartivarian and Little, 2002).

As noted earlier, BRDIS implements a sample design where information about the companies' R&D is used to subset the frame into three mutually exclusive partitions. To examine the propensity model assumptions we fit logistic regression models within the known positive R&D and unknown R&D strata. Table 6 presents the results of the logistic regression models. For each model except one the coefficient on  $\log(\text{MOS})$  was determined to be statistically significant and positive. Although significant and positive



for most specifications, the estimated impact of an incremental increase in MOS on the probability of response was small.

**Table 6: Logistic Regression Results: 2011 and 2012 BRDIS**

	2011				2012			
	Estimate	Standard Error	Chi-square	Prob > Chi-square	Estimate	Standard Error	Chi-square	Prob > Chi-square
<b>Known Positive R&amp;D Stratum</b>								
Intercept	-1.196	0.089	179.96	<.0001*	-1.883	0.088	460.22	<.0001*
Log(MOS)	0.002	0.012	0.04	0.833	0.098	0.011	76.00	<.0001*
<b>Known Positive R&amp;D Stratum excluding Account Manager Companies</b>								
Intercept	-1.536	0.105	542.63	<.0001*	-2.448	0.105	542.63	<.0001*
Log(MOS)	0.053	0.014	14.84	0.0001*	0.18	0.014	169.90	<.0001*
<b>Unknown R&amp;D Stratum</b>								
Intercept	-1.400	0.062	503.27	<.0001*	-1.539	0.065	556.39	<.0001*
Log(MOS)	0.058	0.009	45.84	<.0001*	0.051	0.009	32.71	<.0001*

### 3. Impact of Changes to the BRDIS Survey Methodology in 2012

As noted earlier, for the vast majority of companies in the BRDIS frame (almost 1.9 million in both 2012 and 2011) there is no available information indicating the presence or absence of R&D. Companies sampled from this unknown stratum were administered the 32-page form BRDI-1A in 2011 and the 8-page form BRD-1S in 2012. Other than the different form types administered in the two years, another difference in the two years was that the Economic Census was administered in 2012, which placed additional survey-related burden on companies. As shown in Table 7 the weighted unit response rate for the unknown stratum was 4.4 points higher in 2012 than in 2011. Note that, for a given row in the table, the sum of the sample weights gives an estimate of the number of companies in the population.

Many companies are selected in the BRDIS sample in consecutive years. These companies include those sampled with certainty in both years based on evidence of R&D or based on their size relative to other companies in the same industry or geographic location. Other companies are selected in two consecutive years based on their selection probabilities.<sup>6</sup> In 2012 over a third of the BRDIS sample (16,686 companies) were also

<sup>6</sup> The use of PPS sampling in the BRDIS known positive and unknown strata means that larger companies (in terms of R&D or payroll) are more likely to be sampled repeatedly than smaller companies.

sampled in 2011. In 2011 14,771 companies were sampled that were also sampled in 2010.

**Table 7:** Response Statistics for BRDIS Unknown Stratum

	Survey Year: 2011		2012	
	n	$\Sigma(\text{weights})$	n	$\Sigma(\text{weights})$
Sampled cases	24,519	1,861,069	23,923	1,869,486
Response cases <sup>1/</sup>	17,882	1,411,396	18,292	1,498,899
Weighted unit response rate <sup>2/</sup>	72.9%	75.8%	76.5%	80.2%

<sup>1/</sup> Includes cases determined to be out-of-scope for published BRDIS estimates.

<sup>2/</sup> Standard error of weighted unit response rate is 0.460 in 2011 and 0.427 in 2012. Difference in rates is significant at the 1% level.

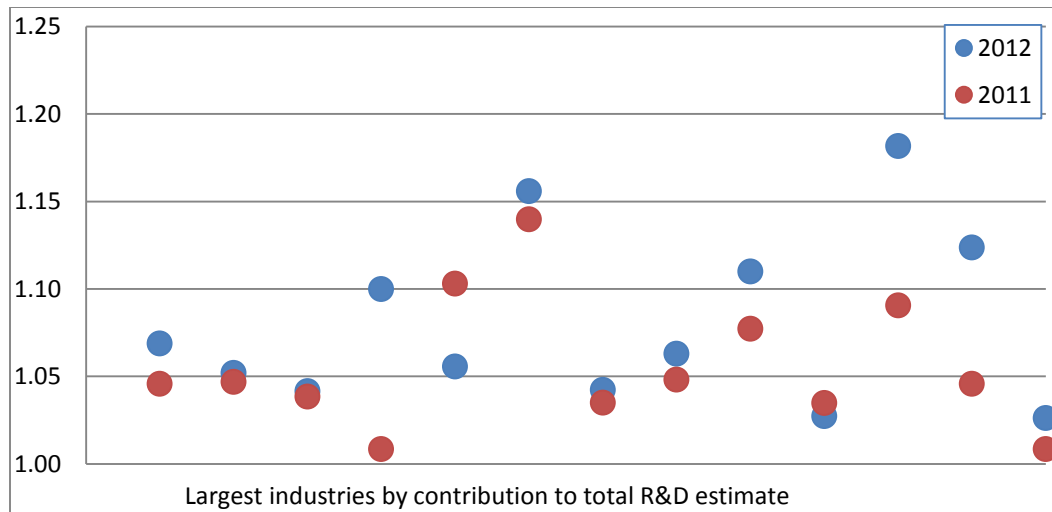
Prior to 2012 the majority of companies sampled in consecutive years by BRDIS were administered the same form type in both years. For example, 95% of the companies sampled in both 2011 and 2010 were administered the same form type in both years. Due to the changes in BRDIS survey methodology in 2012 explained in Section 1.2 above only 15% of the companies sampled in both 2012 and 2011 were administered the same form type in both years (Table 8). Of the companies sampled in both 2012 and 2011, the 9,991 that received the much shorter BRD-1S form in 2012 had an (unweighted) unit response rate almost 8 points higher in 2012 than in 2011. By contrast, those that went from receiving Form BRDI-1A in 2011 to the longer Form BRDI-1 in 2012 had an (unweighted) unit response rate nearly 11 points lower in 2012.

**Table 8:** Response Statistics for Companies Sampled in the 2011 and 2012 BRDIS

	n	Unit response rate in 2011	Unit response rate in 2012	Difference
All companies sampled in both years	16,686	68.6%	69.7%	1.1%
Sent shorter form in 2012 than 2011	9,991	60.1%	67.9%	7.7%
Sent same length form both years	2,443	78.6%	72.7%	-5.8%
Sent longer form in 2012 than 2011	4,252	82.7%	72.1%	-10.7%

Because only companies with estimated R&D from prior periods were eligible to receive the longer BRDI-1 form, only cases from the known positive sampling stratum are represented in the two groups from Table 8 with decreases in response rates. As noted earlier, the known positive sampling stratum accounts for over 90% of BRDIS R&D estimates so nonresponse within this group of companies may have an outside impact on the quality of BRDIS estimates. Fortunately, many of the largest R&D companies are publicly traded and administrative data are available for direct substitution in case of survey nonresponse. Remaining nonresponse cases are accounted for by a nonresponse weight adjustment factor. Figure 2 shows the nonresponse weight adjustment factors for certainty cases in the largest industries (by R&D) in the known positive sampling stratum. In 11 of the 13 largest industries the nonresponse weight adjustment factor increased in 2012, but the increases were small in most of these cases. It is these factors,

not measures of unit nonresponse that directly impact the quality measures estimated by the Census Bureau for BRDIS.



**Figure 2:** Nonresponse Weight Adjustment Factors for Certainty cases in the BRDIS Known Positive Sampling Stratum by Selected Industries: 2011 and 2012

#### 4. Conclusions

This paper applies several methods to assess possible nonresponse bias in BRDIS using the key data variables to define the response criteria. An analysis of response rates across subgroups of the BRDIS sample showed that, unlike in other business surveys, cases sampled without certainty by BRDIS had higher unit response rates than certainty cases. Subsequent analysis confirmed that statistically significant differences in average annual payroll (a frame variable) did exist between BRDIS response and nonresponse cases, but the differences were not large from an analytical perspective. Logistic regression models showed a positive relationship between the log of a unit's measure of size (estimated R&D for known positive cases and annual payroll for unknown cases) and probability of response. Per Vartivarian and Little (2002), this result along with strong correlation between survey estimates of R&D and MOS in the known positive stratum affirms the use of the MOS for non-response weight adjustment. The MOS in the unknown stratum does not have a strong correlation with survey estimates of R&D, but this stratum contributes relatively little to overall survey estimates of R&D (figure 1) and response rates within this group have increased since the adoption of the shorter BRD-1S form. Our analysis of the impact of implementing the BRD-1S form in 2012 showed that a longer form did decrease the response rate for companies who received a shorter form in 2011. These results are consistent with Goyder (1985) and Heberlein and Baumgartner (1978) where they showed that an increase in burden measured by the number of pages in a self-administered questionnaire produced decreased unit response rates.

Our analysis focused on some of the methods for investigating nonresponse bias in business surveys that were given in Lineback and Thompson (2010), as well as the impact of recent changes to the BRDIS survey methodology. Future nonresponse bias research will focus on an analysis of response rates that incorporate weighted data for key

items collected in the BRDIS and are calculated by chosen subdomains of interest. These response rates measure the combined effect of imputation and weight adjustment, which are the methods used for the BRDIS to account for nonresponse bias in weighted totals produced from the survey.

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