Small Business Pulse Survey Phases 1 through 4 Nonresponse Bias and Coverage Bias Analysis Report

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Executive Summary

We analyzed data from Phases 1 through 4 of the Small Business Pulse Survey (SBPS) in order to determine the extent to which SBPS estimates suffered from nonresponse bias and coverage bias. Nonresponse bias is defined as systematic differences between the respondents and the nonrespondents for an estimated characteristic. For SBPS, coverage bias is defined as systematic differences between the small businesses that are *eligible* for sample selection (the ones in the SBPS target population that the Census Bureau had email addresses for when the SBPS sample was selected in Phase 1) and the small businesses that are *not eligible* for sample selection (the ones in the SBPS target population that the Census Bureau did not have email addresses for during the initial sample selection) for an estimated characteristic.

The nonresponse bias analyses provided evidence that:

- There are persistent significant differences in unit response rates by sector, state, and employment size class across Phases 1 through 4 of the SBPS.
- Larger establishments (in terms of annual payroll) are more likely to respond to the SBPS than smaller establishments.

The coverage bias analyses provided evidence that:

- Small businesses with four or fewer employees are underrepresented in the SBPS sample whereas small businesses with five or more employees are overrepresented. Recall that the SBPS sample consisted of the small businesses that the Census Bureau had email addresses for, which were generally much larger than the small businesses in the full SBPS universe.
- Neither the SBPS sampling weights nor the nonresponse-adjusted weights adequately compensate for coverage bias.
- Since both the SBPS sample and respondents underrepresented small businesses with four or fewer employees and overrepresented small businesses with five or more employees, using the full SBPS sample to estimate total payroll for all small businesses resulted in payroll estimates that were about 2.75 times larger than those obtained from the full SBPS universe. The difference in payroll estimates between the SBPS respondents and the SBPS universe was even larger.
- The coverage bias likely affected many of the estimates that SBPS publishes, such as the change in the number of paid employees, because there are large differences in these estimates by employment size class.

The main takeaway from this study is that nonresponse bias was an issue for the SBPS, but coverage bias was a much larger issue. Even if the SBPS had a 100% response rate, its estimates would still suffer from significant coverage bias. That said, given that SBPS respondents tend to be the larger sampled establishments, it is likely that the SBPS estimate bias is compounded by nonresponse bias.

1. Background

1.1. Overview of the Small Business Pulse Survey (SBPS)

The Small Business Pulse Survey was an experimental program initiated to measure the effect of changing business conditions for small businesses in the 50 states, District of Columbia, and Puerto Rico during the Coronavirus pandemic. The survey was intended to provide high frequency qualitative measures by sector, state, and the fifty most populous Metropolitan Statistical Areas (MSAs). The survey results have assisted government officials for policy and decision-making, businesses in making economic decisions, and researchers in studying the effects of the pandemic. This analysis covers the first four phases of the SBPS, which were conducted from April 26, 2020, through April 18, 2021. SBPS collected qualitative information. Some of the survey content changed over the course of the program, with items rotating on and off the survey instrument. This analysis focuses on 3 key items asked in all phases of the survey:

- In the last week, did this business have a change in operating revenues/sales/receipts, not including any financial assistance or loans? (yes, decreased; yes, increased; and no change)
- In the last week, did this business have a change in the number of paid employees? (yes, decreased; yes, increased; and no change)
- In the last week, did this business have a change in the total number of hours worked by paid employees? (yes, decreased; yes, increased; and no change)

This analysis examines the SBPS estimates produced from these items, including the percentage of businesses in each response category overall and by sector. This section, along with Section 2, summarize the technical information available from the Small Business Pulse Survey website.

1.2 Target Population

The target population for the Small Business Pulse Survey is all nonfarm, single-location employer businesses with between 1-499 employees and receipts of $1,000 or more in the 50 states, District of Columbia, and Puerto Rico. The initial sampling frame was extracted from the final 2018 Business Register in April 2020 and used 2019 employment from the monthly Business Register to determine the employment cutoffs. The following industries were designated as out of scope for the Small Business Pulse Survey:

- Agriculture production (NAICS in ('110000', '111', '112'))
- Railroads (NAICS = '482')
- U.S. Postal Service (NAICS = '491')
- Monetary Authorities – Central Bank (NAICS = '521')
- Funds, Trusts, and Other Financial Vehicles (NAICS = '525')
- Religious grant operations and religious organizations (NAICS = '813')
- Private households (NAICS = '814')

- Public administration (NAICS = '92')
- Unclassified with legal form of organization as tax-exempt or unknown.

This frame represented approximately 5.7 million single-unit employer businesses.

1.3 Sampling Frame

Due to resource limitations and the sudden onset of the pandemic, the sampling frame was limited to those businesses for which a valid email address was already present on the frame. Consequently, the SBPS sample drawn from this sampling frame was a nonprobability sample. This coverage limitation represents a potential (and important) source of bias in the estimates. Therefore, this analysis examines coverage bias in addition to nonresponse bias.

Email addresses were available from the subset of businesses in the target population that responded to the 2017 Economic Census and were therefore identified as eligible to participate in the Small Business Pulse Survey (SBPS). The 2017 Economic Census (EC) utilized an all-electronic data collection strategy. Eligible respondents to the Economic Census were mailed a letter containing an authentication code and were invited to create an account using the Respondent Portal. The Respondent Portal provides access to electronic survey instruments. To establish their Respondent Portal account, respondents provided a valid email address, their name, phone number, and were required to establish a password.

Approximately 1.7 million single-establishment employer businesses received an invitation to respond to the full 2017 Economic Census. Approximately 390,000 additional single-establishment businesses were mailed an abbreviated form primarily to determine the appropriate industry classification. Administrative data were used for the remaining single-establishment businesses to reduce respondent burden.

All businesses receiving an invitation to respond to the Economic Census were asked to provide an email address.

In April 2020, the Census Bureau extracted from the Business Register single-location businesses with payroll and between 1 and 499 employees for the SBPS frame. The number of active, in-scope businesses with valid email addresses totaled about 941,000 businesses. Most of the email addresses were taken from responses to the 2017 Economic Census. However, approximately 91,000 email addresses were updated through a match to the databases used for processing monthly and annual economic surveys.

1.4 Sample Design

To maximize the use of available email addresses, the Census Bureau used the full set of in-scope businesses with email addresses from the 2017 Economic Census in the Small Business Pulse Survey. The initial weight for each unit with an email address was set to the count of the total number of units (both with and without email addresses) in the same state by 2-digit NAICS sector divided by the number of units in the same grouping with an email address. This

post-stratification procedure is designed to reduce the coverage bias; under complete response, the adjusted non-probability sample SBPS estimates are unbiased if the businesses that have email addresses are approximately a random sample of the population of businesses (with or without email addresses) in the same categories (Corness et al 2020 and Kalton and Flores-Cerventez 2003). For SBPS, the population is the total set of all nonfarm, single-location employer businesses with between 1-499 employees and receipts of $1,000 or more and the categories are state crossed with 2-digit NAICS sector. These initial weights will sometimes be referred to as "sample weights" or "sampling weights" throughout this paper.

The 941,000 eligible businesses were divided into nine panels for the weekly email invitations to respond to the survey. Each panel represents a 1/9 probability sub-sample of the entire survey sample. To establish panels of similar size and industry and geography distributions, the businesses with email addresses were sorted by MSA and 2018 annual payroll within each state by 2-digit NAICS cell and then systematically assigned to one of the nine panels.

In the first week of data collection for Phase 1 of the Small Business Pulse Survey, a decision was made to eliminate email addresses linked to three or more businesses from future collections, in order to eliminate ambiguity in associating survey responses to the correct business. Approximately 885,000 businesses remained in the email sample after this removal. Respondents with email addresses linked to two businesses were instructed to provide a separate report for each of the two businesses.

In subsequent phases, email addresses linked to more than 10 businesses remained ineligible for data collection, but all others were retained in the collection. The business name and last five-digits of a selected business' Employer Identification Number were provided to the respondent in both the survey invitation and upon authenticated entry to the survey instrument in order to clarify the intended respondent to the survey.

Phases 2 through 4 used the same nine panels as Phase 1, with adjustments to distribute multiple businesses associated with one email address among the panels to maintain sample sizes of roughly equal size in each of the nine collection weeks.

1.5 Type of Request

The Small Business Pulse Survey is a voluntary survey.

1.6 Questionnaire Content

The questionnaire for each phase of the Small Business Pulse Survey contained 20 or fewer questions about the effect of the Coronavirus pandemic on the business, including impacts on operating revenues and availability of cash; closures; changes in the number of paid employees or hours; the re-hiring of laid off or furloughed employees; disruption of supply chains; adoption of different business practices; changes in operating capacity; missed loan and other payments; requests/receipt of financial assistance; capital expenditures; vaccine and testing requirements; and overall wellbeing and outlook for recovery. The changes in revenues, employees, and hours were considered key items.

1.7 Mode of Contact

Business respondents were contacted by email to respond to the survey. For each weekly survey panel, emails were delivered on Sunday using staggered times to gauge optimal timing of email delivery on response. For Phase 3 and subsequent phases, initial emails were sent on Mondays. The email directed respondents to the https://census.gov/businesspulse landing page that provided information about the survey, FAQs, links to releases of the data products, and a direct link to respond to the survey. Starting in Phase 2, the emails directed respondents directly to the reporting instrument. Respondents were provided access to the survey using an authentication code provided in the email. In addition, an email address econ.pulse@census.gov was provided for respondents to send questions about the survey. Responses to questions were provided by Census Bureau Headquarters staff.

A follow-up reminder email was sent on Wednesdays (Friday for the first week of Phase 1) to all non-respondents in the weekly panel. Starting in Phase 2 Week 7, an additional follow up reminder email was sent on Fridays.

1.8 Response Criteria

For Phases 1 and 2, the response period for each weekly tabulation closed at 11:59 pm on Saturdays. For Phases 3 and 4, the response period for each weekly tabulation closed at 11:59 pm on Sundays.

To be considered a respondent to the SBPS, a business had to respond to at least one of the survey questions. The online instrument was designed to encourage response to each question. If a survey participant attempted to move past a particular question without providing a response, a warning box appeared to prompt the respondent to provide a response. The participant was permitted to move to the next question without responding on the next attempt.

Responses to each question were tabulated independently. All responses, including those from businesses in prior panels, were included in tabulations for the week in which the responses were provided.

1.9 Compilation of Data

1.9.1 Editing

Due to the nature of the survey questions and rapid cycle of data collection and release, the SBPS response data were not subjected to editing.

1.9.2 Survey Schedule

Figure 1 shows the survey schedule for the first four phases spanning April 26, 2020, to April 18, 2021. Colors represent the different phases, and the non-colored dates represent times when data was not being collected.

Figure 1: Small Business Pulse Survey – Collection Dates Phases 1 through 4

		Phase	Week	Sun	Mon	Tue	Wed	Thu	Fri	Sat
2020	May	1	1	26	27	28	29	30	1	2
			2	3	4	5	6	7	8	9
			3	10	11	12	13	14	15	16
			4	17	18	19	20	21	22	23
			5	24	25	26	27	28	29	30
	Jun		6	31	1	2	3	4	5	6
			7	7	8	9	10	11	12	13
			8	14	15	16	17	18	19	20
			9	21	22	23	24	25	26	27
	Jul			28	29	30	1	2	3	4
				5	6	7	8	9	10	11
				12	13	14	15	16	17	18
				19	20	21	22	23	24	25
				26	27	28	29	30	31	1
	Aug			2	3	4	5	6	7	8
		2	1	9	10	11	12	13	14	15
			2	16	17	18	19	20	21	22
			3	23	24	25	26	27	28	29
			4	30	31	1	2	3	4	5
	Sep		5	6	7	8	9	10	11	12
			6	13	14	15	16	17	18	19
			7	20	21	22	23	24	25	26
			8	27	28	29	30	1	2	3
			9	4	5	6	7	8	9	10
	Oct			11	12	13	14	15	16	17
				18	19	20	21	22	23	24
				25	26	27	28	29	30	31
				1	2	3	4	5	6	7
	Nov	3	1	8	9	10	11	12	13	14
			2	15	16	17	18	19	20	21
			3	22	23	24	25	26	27	28
			4	29	30	1	2	3	4	5
			5	6	7	8	9	10	11	12
	Dec		6	13	14	15	16	17	18	19
			7	20	21	22	23	24	25	26
			8	27	28	29	30	31	1	2
			9	3	4	5	6	7	8	9
				10	11	12	13	14	15	16
2021	Jan			17	18	19	20	21	22	23
				24	25	26	27	28	29	30
				31	1	2	3	4	5	6
	Feb			7	8	9	10	11	12	13
		4	1	14	15	16	17	18	19	20
			2	21	22	23	24	25	26	27
			3	28	1	2	3	4	5	6
	Mar		4	7	8	9	10	11	12	13
			5	14	15	16	17	18	19	20
			6	21	22	23	24	25	26	27
			7	28	29	30	31	1	2	3
	Apr		8	4	5	6	7	8	9	10
			9	11	12	13	14	15	16	17
				18	19	20	21	22	23	24

1.9.3 Nonresponse Adjustment

Nonresponse is defined as the inability to obtain requested data from an eligible survey unit. Two types of nonresponse are often distinguished. Unit nonresponse is the inability to obtain any of the substantive measurements about a unit. In most cases of unit nonresponse, the Census Bureau was unable to obtain any information from the survey unit after several attempts to elicit a response. Item nonresponse occurs when a particular question is unanswered. For each of SBPS' three key items, the item response rate among SBPS respondents across Phases 1 through 4 was about 99.98%.

Adjustment factors were applied to SBPS respondent data to account for unit nonresponse. Within each 2-digit NAICS, nonresponse adjustment factors were calculated for businesses by three employment size classes, to account for potential differential response by business size: four or fewer employees; between 5 and 19 employees; and 20 or more employees. To compute the values of the nonresponse adjustment factor, the sum of the sampling weights of all businesses in the weekly panel was divided by the sum of the sampling weights of all responding businesses in the weekly collection period. The resulting factor was used to adjust the sampling weight for all respondents in the given adjustment cell. This nonresponse bias mitigation procedure is evaluated as part of this report by comparing alternative weighting approaches and comparing the resulting estimates for the same items. Differences between the estimates resulting from different weight adjustments can be indicative of nonresponse bias. See Section 3 for analysis results.

1.9.4 Estimation

For each question on the survey, the published percentage estimate for a particular response category is calculated as the sum of the nonresponse-adjusted weights for all responses in that particular response category, divided by the sum of the nonresponse-adjusted weights for each business responding to the question.

In Phases 1 through 3, five indices were calculated from the Small Business Pulse Survey data. These indices summarize the collected data on the following key concepts: overall well-being (Question 1); operations (Questions 2, 4-7); adaptability (Questions 8-9); finances (Questions 10-13); and expected recovery (Question 15). To create the indices, responses for each question were normalized on a [-1, 1] scale. The normalized responses for each business were then averaged over the appropriate set of indexed items. A weighted score for the business was then computed by multiplying the final non-response adjusted weight for the business by the average score. For a given domain (e.g., state, sector, national total), the published index value is the average of the non-response adjusted index values for the responses in the domain. Analysis of nonresponse bias for these derived indices was out of scope for this analysis but will be considered for future work.

In Phase 4, finance content (Questions 10-13) was dropped, leaving four index calculations.

2. Survey Quality Measures

2.1 Sampling Error

The sampling error of an estimate based on a probability sample survey is the difference between the estimate and the result that would be obtained from a complete census conducted under the same survey conditions. With a probability sample, each unit has a known inclusion probability, allowing estimation of the variability due to sampling over repeated samples. Since the SBPS is a nonprobability sample, it is not possible to directly estimate sampling error, aside from variability due to the panel assignment.

A common measure of sampling variability for percentage estimates is the standard error of the estimate. The standard error is the square root of the sampling variance, which is the squared difference, averaged over all possible samples of the same size and design, between the estimator and its average value. The standard errors for the SBPS estimates were calculated using a delete-a-group jackknife procedure, using 10 groups.

It is important to note that the sampling variance and standard error only measure sampling variability. They do not measure any systematic biases in the estimates and do not account for nonsampling errors such as nonresponse unless directly incorporated into the variance estimation procedure.

2.2 Nonsampling Error

Nonsampling error encompasses all factors other than sampling error that contribute to the total error associated with an estimate. This error may also be present in censuses and other nonsurvey programs. Nonsampling error arises from many sources: inability to obtain information on all units in the sample; nonresponse and response errors; differences in the interpretation of the questions; mismatches between sampling units and reporting units, requested data and data available or accessible in respondents' records, or with regard to reference periods; mistakes in coding or keying the data obtained; and other errors of collection, response, coverage, and processing.

For the SBPS, companies with emails are assumed to provide a representative sample of the target population. This is a strong assumption, and potentially a major source of non-sampling error. This analysis will attempt to examine that assumption.

Businesses were assumed to be active and in-scope in the absence of evidence suggesting otherwise. This included unsuccessful delivery of emails to some cases.

2.3 Response Measures

The Unit Response Rate (URR) was calculated weekly as:

Unit response rate = 100*(R+R')/(R+NR)

where

- - R is the number of respondents in the currently weekly panel
- - NR is the number of non-respondents in the currently weekly panel
- - R’ is the number of late respondents included in the estimates from any previous panel within each phase

Note that the late respondents could instead contribute to a revised estimate of the previous panel rather than as an addition to the response of the current panel. However, due to the weekly frequency of the survey, it was impractical to produce revised estimates for previous panels. In addition, it is unclear if late respondents are referencing the week they were initially sampled or referencing the week of actual response, a potential source of measurement error.

The published values of R and URR were rounded for disclosure protection.

In Phase 1, only late respondents from the week immediately preceding the current collection week were tabulated as respondents in the current weekly panel. In subsequent phases, late respondents from all collection weeks were included in tabulations.

In all phases, bounced emails and surveys that had been started but not submitted were counted as nonrespondents in the official response rate computations.

The quantity response rate (QRR) represents the percentage of the estimated total obtained from directly reported data, and the total quantity response rate (TQRR) represents the percentage of the estimated total obtained from directly reported and equivalent quality data. For SBPS, QRR and TQRR are the same. The SBPS QRRs are calculated using all responding firms within a tabulation category.

For this paper, the QRR for SBPS data items will be calculated as follows:

$$QRR = \left[\frac{\sum_{i=1}^{N} samp\_w_i * (r_i) * PAYROLL * t_i}{\sum_{i=1}^{N} tab\_w_i * PAYROLL * t_i}\right] * 100$$

where

- r_i is equal to 1 if the firm is a valid respondent; 0 otherwise
- t_i is the data value (1 for all SBPS checkbox data items)
- *PAYROLL* is the 2019 annual payroll from the Business Register
- *N* is the total number of eligible tabulation units
- $samp\_w_i$ is the initial sampling weight for unit *i*
- tab_w_i is the nonresponse-adjusted weight for unit *i.*

3. Analysis

This analysis was conducted using the SBPS data from Phases 1 through 4. The analysis will attempt to examine two main sources of bias in the estimates: nonresponse bias and coverage bias. A limitation of this analysis is that disentangling the two sources of bias is difficult. To assess the potential for nonresponse bias, we:

- Examine unit response rates across the different weeks of the survey to evaluate if survey fatigue may have led to larger errors in later weeks of the survey than in initial weeks.
- Examine unit response rates by sector to look for systematic differences.
- Examine unit response rates by state to look for systematic differences.
- Examine unit response rates across the three employment size categories used in the nonresponse adjustment (A: four or fewer employees; B: between 5 and 19 employees, inclusive; C: 20 or more employees).
- Compare average payroll for respondents and nonrespondents for each week in the survey at the state by sector (2-digit NAICS) level to evaluate any response differences by size of business.
- Compare alternative nonresponse adjustment approaches and compare the resulting estimates for the same items. Differences between the estimates resulting from differing nonresponse adjustments can be indicative of nonresponse bias.

To examine coverage bias, we will:

- Use auxiliary data on employment and payroll from the Business Register to look for systematic differences between the full target population and the convenience sample population.

The auxiliary information available from the Business Register includes payroll and employment for all single unit businesses, urban/rural status for some single unit businesses, and operating status. For the coverage bias analyses, we will attempt to examine if there are differences in payroll or employment between the target and sample population.

3.1. Response Rate and Nonresponse Bias Analyses

3.1.1 Response Rates Across Sample Weeks

Response rates are common first-line indicators to gauge the quality of the data. Nonresponse bias would not exist if response rates were 100%. Potential nonresponse bias increases as response rates decrease. Although the examination of the response rates may not give us a complete picture of nonresponse bias, it will give us an idea of how large the nonresponse bias could potentially be.

This report primarily examines unit response rates (URRs), with limited evaluation of QRRs. The URR is the rate required by the OMB statistical standard. Weights are not used to calculate the URR; the sampling and nonresponse-adjusted weights are used to calculate the QRR. In the SBPS, all businesses in the same state and 2-digit NAICS are given the same initial weight, though the nonresponse adjustment factor is computed and applied within 2-digit NAICS and employment size class to account for potential differential nonresponse by business size. Responses to the SBPS are categorical (check-box items); estimates represent the percentage of businesses marking a particular response category; these types of estimates are not subject to the same extreme skewness as estimates of dollar-volume output typical of business surveys. Consequently, the QRRs are not as markedly different from the URRs in the SBPS as is typical of

many surveys measuring outputs. Most of the analysis in this report will focus on URRs. The QRRs in this report are based on the SBPS key item that asks about changes in the number of paid employees. The QRRs for the other two key items were nearly identical to the QRRs for the number of paid employees item, so this report does not show the QRRs for those items.

Figure 2. Unit Response Rate and Quantity Response Rate by Phase and Week

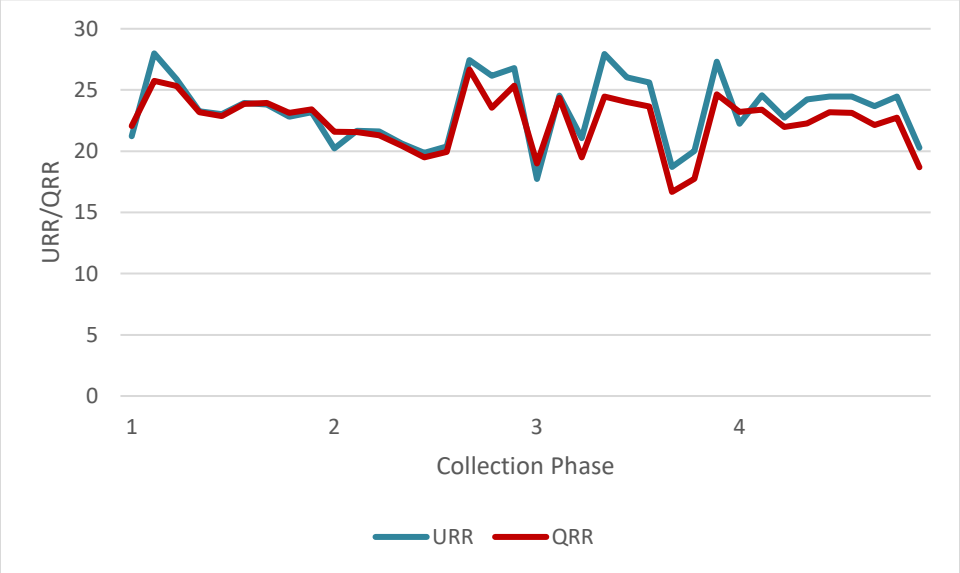


Figure 2 shows the survey-level URR and QRR by phase and week. Figure 3 provides the mean URR and QRR by sector and survey phase. Across all survey phases and weeks, the URR ranged from 17.7 percent to 28.0 percent, with average URRs by phase between 22 and 24 percent. The total QRR ranged from 16.7 percent to 26.7 percent, with average QRRs by phase between 21 and 24 percent. There is a slight declining trend in both URR and QRR over Phase 1 and through Phase 2 Week 6, and more volatility in the remaining weeks and phases. These patterns are informed by the following facts and changes about the survey collection, which impacted the response rates:

1. In Phase 1 Week 1, collection was attempted for all sampled EINs (over 101,000 email addresses) but the respondent was not provided with the EIN for which response was expected.
2. After Phase 1 Week 1, cases for which three or more EINs corresponded to the same email address were dropped from collection, leaving approximately 885,000 EINs in the entire collection group (9 weekly samples) and weekly sample sizes in the remaining weeks of Phase 1 ranging between 90,000 and 94,000. For responses from email addresses associated with two EINs, an attempt was made to match the response with the appropriate EIN. In Phase 1 Week 2, there were 1,100 responses from email addresses associated with two EINs which remained unresolved and were not included in the Week 2 tabulations.

3. Starting with Phase 2 Week 1, the EIN for the intended respondent was provided in the survey invitation. Units linked to email addresses with more than 10 EINs were still dropped from collection. The average weekly sample size was about 98,000 units in Phases 2 and 3 and 97,000 units in Phase 4, after status updates were applied to the sample.
4. Starting with Phase 2 Week 7, a second email reminder was sent on Friday of each collection week.
5. Starting with Phase 3, the collection cycle shifted from Sunday through Saturday to Monday through Sunday.
6. Thanksgiving week coincided with Phase 3 Week 3; the Christmas and New Year holidays were in Phase 3 Weeks 7 and 8, respectively.

There was a slight downward trend in response until the second email reminders were implemented in Phase 2 Week 7. After that point, the response rates were more volatile, but the overall patterns indicate that response did not deteriorate materially over time. Most of the changes were artifacts of the calendar (holidays) or of intentional collection changes. There is no evidence to suggest large-scale survey fatigue through Phase 4 based on the overall response rate patterns.

3.1.2 Response Rates by Sector

Figure 3. Unit and Quantity Response Rates by Sector

	Mean URR (across weeks)				Mean QRR (across weeks)			
SECTOR	P1	P2	P3	P4	P1	P2	P3	P4
Average	23.76	22.33	23.23	23.45	24.66	22.72	22.78	23.35
11	23	15	23	24	34.67	23.65	36.32	32.21
21	23.8	22.6	22.1	22.6	23.58	21.80	21.75	22.25
22	27.4	24.9	25.6	24	27.41	24.86	23.46	22.06
23	21.11	19.18	19.33	19.91	22.37	20.34	18.95	20.14
31-33	31.04	28.96	29.33	30.08	31.43	28.68	27.56	28.69
42	25.44	24.63	25.15	25.51	25.42	24.31	23.70	23.90
44-45	21.35	20.45	21.12	21.37	21.08	19.78	20.14	20.51
48-49	19.99	19.14	20.17	20.29	20.83	19.37	19.54	20.33
51	28.02	26.42	26.93	27.13	28.32	25.70	24.39	25.27
52	21.47	21.06	21.28	22	23.00	21.71	21.43	22.15
53	19.67	19.86	20.35	20.57	21.33	21.17	20.66	21.24
54	27.11	25.55	25.94	26.08	26.54	24.58	23.97	24.76
55	20	19	21	22	23.21	21.47	19.59	26.37

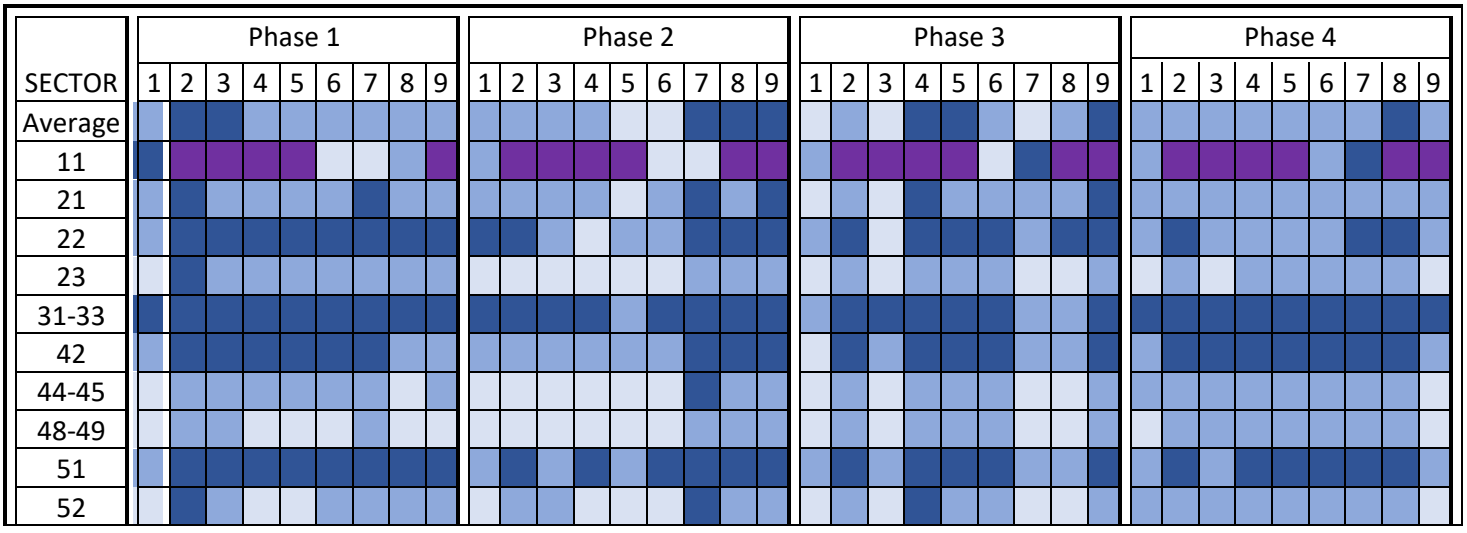
56	21.04	20.25	20.64	21.01	20.77	19.89	19.28	20.26
61	28.87	27.02	27.1	27.32	29.17	27.06	25.63	26.98
62	25.26	22.23	22.33	22.61	24.16	21.52	20.91	21.53
71	25.38	25.8	25.96	25.8	26.43	25.96	25.27	25.11
72	19.61	21.49	22.71	22.19	17.67	19.65	20.44	20.16
81	21.94	20.74	21.3	21.14	21.18	20.18	19.88	19.67

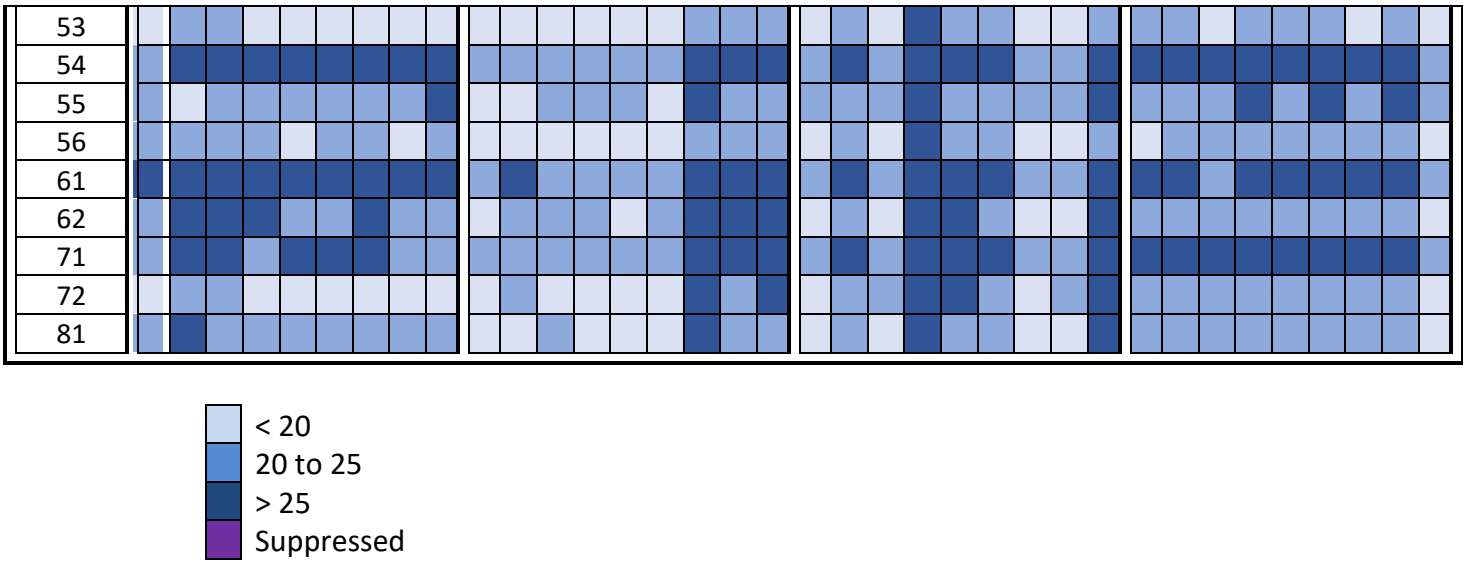
< 20
20 to 25
> 25

Note: "Average" is the average Mean URR/Mean QRR across the 19 sectors in each column. The value in the "Average" row may not match the average sector value in the column because the values in the table were rounded to meet Census Bureau publication rules. The average QRRs are presented here for informational purposes, but no statistical comparisons will be made involving them because methods involved for conducting those tests are very complex and the average URRs and QRRs appear to be similar to each other.

Figure 4 contains cell plots of URR by sector, survey phase, and collection week. We conducted chi-square tests of independence between response and sector within each phase and they were all statistically significant at the 10% level, which means the differences in URR between sectors are systematic and are unlikely to be caused by random variability. The URRs did not decline over the course of the four phases. URRs for sectors 31-33 (Manufacturing), 51 (Information), and 61 (Educational Services) appear to be consistently higher than for other sectors, with URRs above 25% for most weeks. This figure appears to show consistent response rates within sector and phase.

Figure 4. Unit Response Rates by Phase and Sector

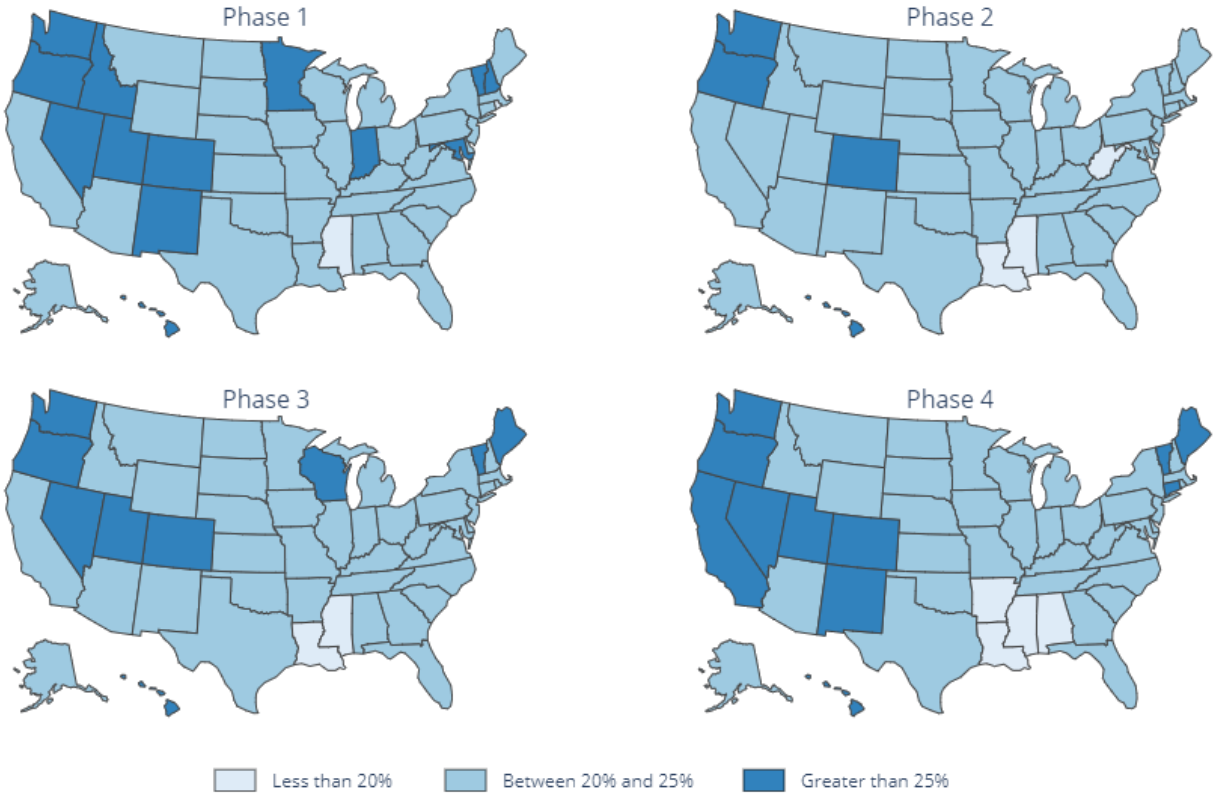




Note: Unit Response Rates based on sample sizes of less than 15 were suppressed. “Average” is the average URR/QRR across the 19 sectors in each column.

Figure 5 shows the average URRs by state for each survey phase, and Figure 6 presents cell plots of the URRs by state, survey phase, and collection week. We conducted chi-square tests of independence between response and state within each phase and they were all statistically significant at the 10% level, which means the differences in URR between states are systematic and are unlikely to be caused by random variability. In both figures, darker shaded states/cells indicate higher URRs. Oregon, Colorado, Washington, and Hawaii were the only states with average URRs above 25% in all four phases (DC also had average URRs above 25% in all four phases) and Mississippi was the only state with an average URR of less than 20% in all four phases. There may be a relationship between average URR and region because many of the states with the highest average URRs are in the West and most of the states with the lowest average URRs are in the South. Similar to the sectors, the URRs by state appear consistently low across the states, so there is high potential for nonresponse bias in the SBPS’ state-level estimates for every state. Additionally, the response rates were so low that small changes in the number of respondents across phases within the same state could give the impression that there were large changes in the URR for that state. There are also some states in Figure 5 that had average URRs very close to the borderline of two different average URR range categories, so small changes in the average URR caused the average URR range category to be different by phase even though the average URR did not change much.

Figure 5. Average URR by State for Each Survey Phase



Note: Puerto Rico is not shown in Figure 5, but the average URR in Puerto Rico was less than 20% in Phase 1, greater than 25% in Phase 2, and between 20% and 25% in both Phase 3 and Phase 4.

Figure 6. Response Rates by Phase, Collection Week, and State

	Phase 1									Phase 2									Phase 3									Phase 4								
STATE	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
AK																																				
AL																																				
AR																																				
AZ																																				
CA																																				
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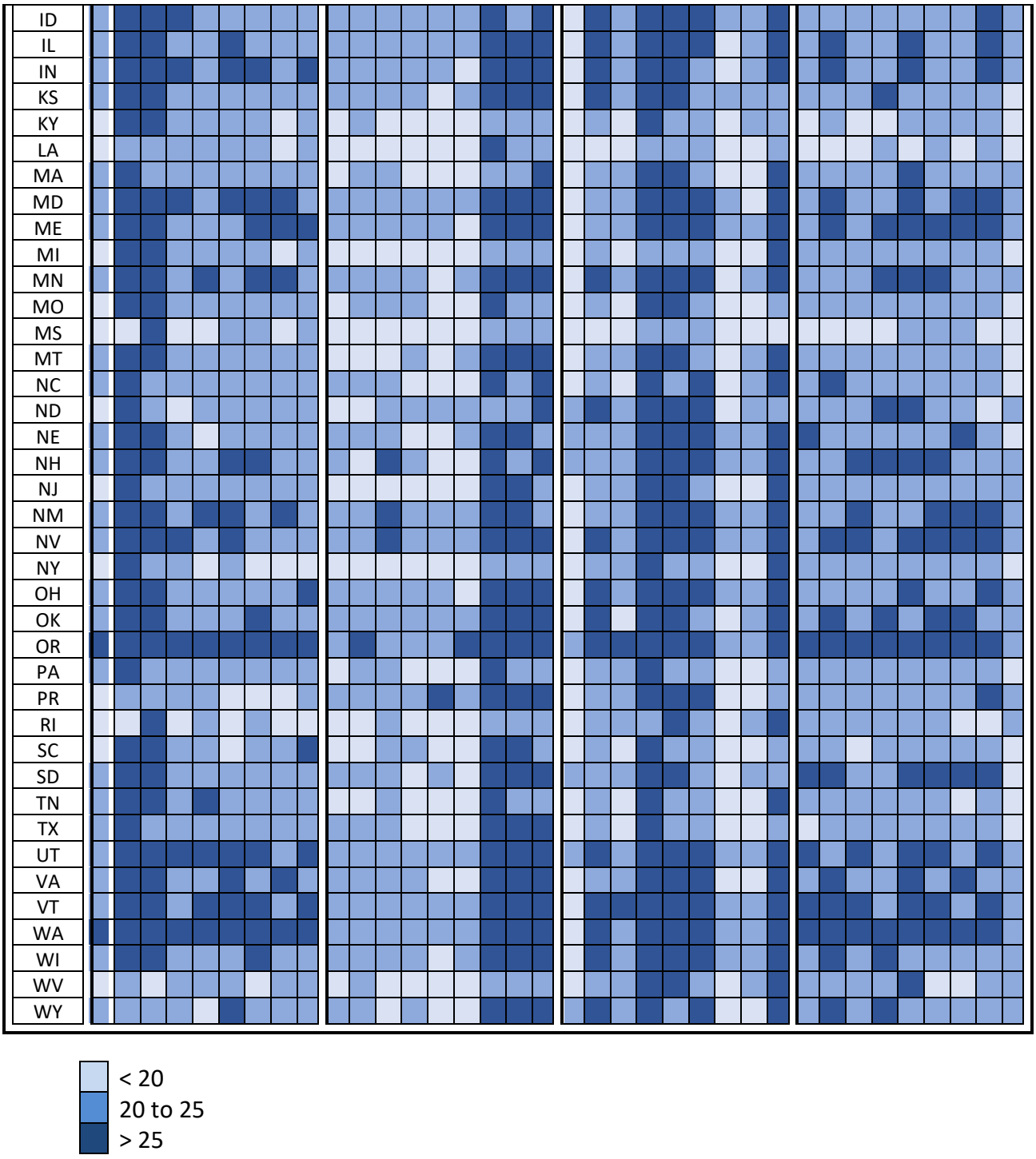


Figures 7 and 8 show the URRs and QRRs, respectively, by the three employment size categories used in the nonresponse adjustment (A: four or fewer employees; B: between 5 and 19 employees, inclusive; C: 20 or more employees). We conducted chi-square tests of independence between response and employment size class within each phase and they were all statistically significant at the 10% level, which means the differences in URR between employment size classes are systematic and unlikely to be caused by random variability. Figure 7 demonstrates patterns consistent with the overall URRs among all three employment size groups; businesses in the smallest employment group experienced the lowest URRs and businesses in the largest employment group had the highest URRs.

Figure 7. Unit Response Rates by Employment Size

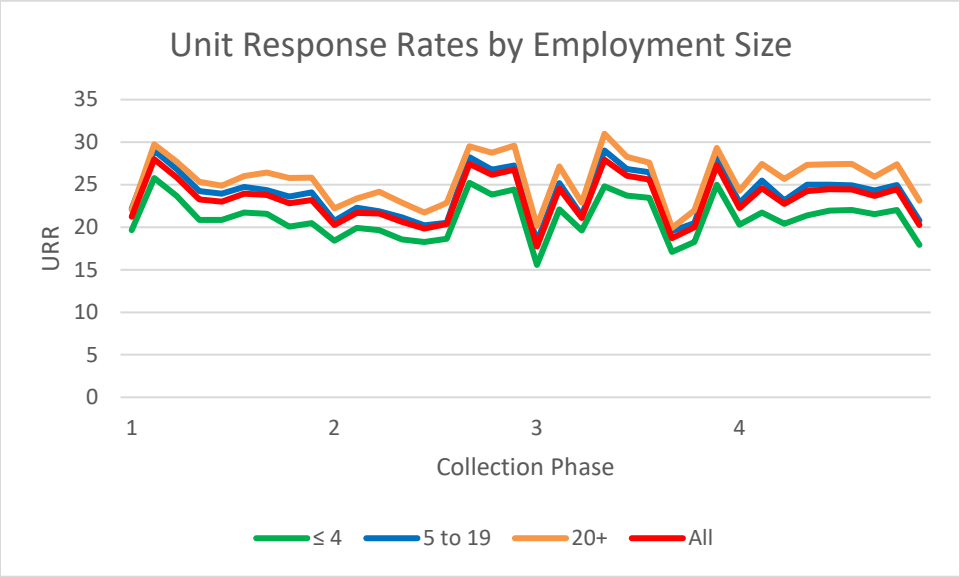
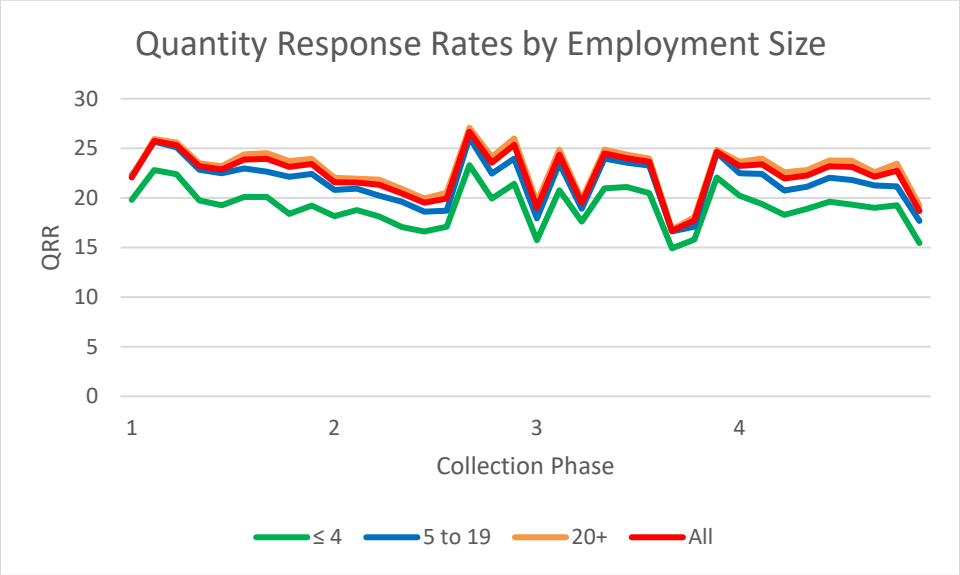


Figure 8. Quantity Response Rates by Employment Size for Change in Number of Paid Employees



Note: The QRRs by employment size are presented here for informational purposes, but no statistical comparisons will be made involving them because methods involved for conducting those tests are very complex and the URR and QRR patterns appear to be similar to each other.

3.1.2 Characteristics of Respondents and Nonrespondents

To further evaluate the potential for nonresponse bias, we compared the average payroll for respondents and nonrespondents for each week in the survey at the state by sector (2-digit NAICS) level. For both this analysis and the one in Section 3.1.3, late respondents were treated as nonrespondents for the week in which they were sampled and were not treated as

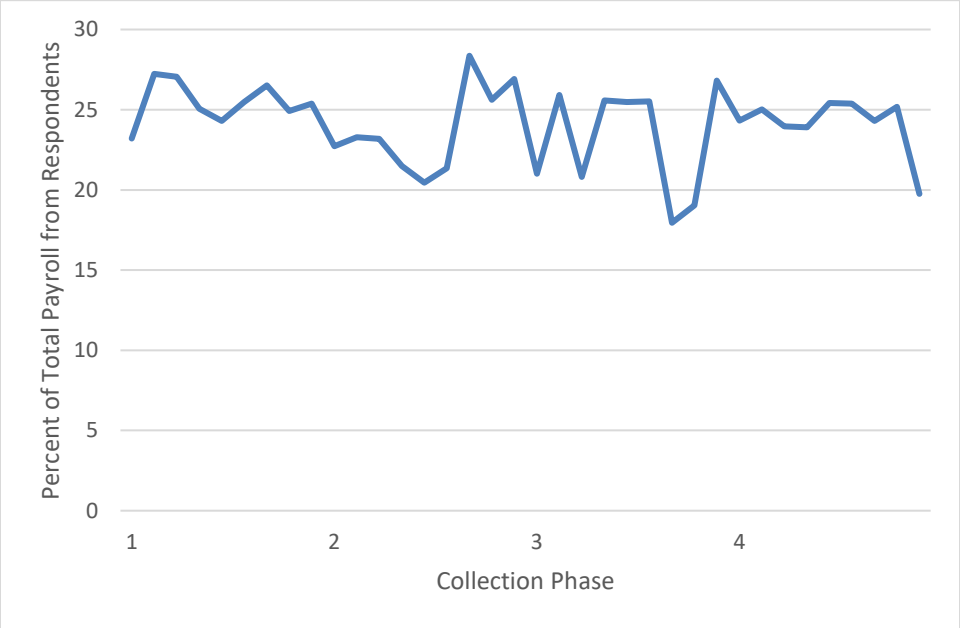
respondents for the week in which they responded. Payroll is available from the Census Bureau's Business Register for all units in the target population and is used as a proxy for size of the business. We conducted two-sample t-tests at the 10-percent significance level comparing average payroll for respondents and nonrespondents for each state, sector, and survey week. We used the TTEST procedure in SAS to conduct the t-tests. The results of these tests assume that the sample units are independent and identically distributed within each state, sector, and survey week.

Of 29,945 hypothesis tests, 4,185 (or 14.0 percent of the tests) failed, indicating significant differences in mean payroll. Review of the tests did not reveal remarkable differences in the number of failures by state, sector, or survey week. However, in 95.2 percent of the cells with statistically significant differences, the mean payroll for respondents was larger than the mean payroll for nonrespondents. This suggests that the mean payroll was consistently larger for respondents than for nonrespondents, but that the two-sample t-tests were unable to detect most of the differences because most of the state by sector combinations had very few respondents. This provides preliminary evidence that the nonresponse bias is across all states, sectors, and weeks. This could also be caused by a high proportion of the smallest businesses being temporarily closed or no longer active.

3.1.3 Percent of Total Payroll from Respondents by Phase and Week

Figure 9 shows the percent of total payroll among sample cases that came from respondents by phase and week.

Figure 9. Percent of Total Payroll from Respondents by Phase and Week



Within each phase, the percent of total payroll from respondents could vary each week by up to about nine percentage points.

3.1.4 Alternative Nonresponse Adjustments

We tried using alternative nonresponse adjustments in the weighting and then computed the national-level and sector-level estimates for each week from Phases 1 through 4 of the SBPS to see how much the estimates would change. Large changes in the estimates when alternative nonresponse adjustments are used could indicate that the current SBPS nonresponse adjustment is not adequately accounting for nonresponse bias. It could also indicate that the alternative nonresponse adjustment does not adequately account for nonresponse bias and that the current nonresponse adjustment is performing fine.

The two alternative nonresponse adjustments we tried included 1) a weighting class adjustment with cells defined by sector and state, and 2) a weighting class adjustment with cells defined by sector and payroll size. Payroll size had six categories based on annual payroll (in thousands of dollars): less than or equal to $24, between $25 and $74, between $75 and $149, between $150 and $399, between $400 and $999, and $1,000 or greater.

Table 1 shows the distributions of the percentage point changes in national-level estimates for changes in the number of paid employees, changes in the total number of hours worked by paid employees, and changes in operating revenues/sales/receipts when the nonresponse adjustment uses adjustment cells defined by sector and state instead of sector and employment size.

Table 2 is similar to Table 1, but compares estimates formed using a nonresponse adjustment with adjustment cells defined by sector and payroll size versus sector and employment size. Tables 3 and 4 are similar to Tables 1 and 2, respectively, but show changes in sector-level estimates instead of national-level estimates.

Let $\hat{\theta}_k^m =$ national-level estimate for item *k* using weighting adjustment method *m* (*m = 0* corresponds to the current SBPS weighting adjustment method*, m = 1* or *2* are defined above). The percentage point change for a given industry *k* due to alternative weighting is given by $\hat{\theta}_k^{m-0} = \hat{\theta}_k^m - \hat{\theta}_k^0$; *m = 1* in Table 1 and *m = 2* in Table 2*.* The percentiles reported in Tables 1 and 2 use the 36 national estimates (3 items x 3 responses/item x 4 phases). Analogously, Table 3 and Table 4 compute percentage point differences for each sector estimate.

Table 1. Distributions of National-Level Estimate Changes when Nonresponse Adjustment Cells are Defined by Sector x State Instead of Sector x Employment Size

		Percentile									
Question	**Response**	**0th**	**1st**	**5th**	**25th**	**50th**	**75th**	**95th**	**99th**	**100th**	**N**
Change in the number of paid employees?	Yes, increased	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	36
Change in the number of paid employees?	Yes, decreased	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.4	0.4	36
Change in the number of paid employees?	No	-0.9	-0.9	-0.7	-0.5	-0.4	-0.4	-0.2	-0.1	-0.1	36
Change in the total number of hours worked by paid employees?	Yes, increased	-0.1	-0.1	0.0	0.1	0.2	0.2	0.4	0.4	0.4	36
Change in the total number of hours worked by paid employees?	Yes, decreased	-0.3	-0.3	-0.3	-0.2	-0.1	0.0	0.3	0.4	0.4	36
Change in the total number of hours worked by paid employees?	No	-0.4	-0.4	-0.2	-0.2	-0.1	0.0	0.2	0.2	0.2	36
Change in operating revenues/sales/receipts?	Yes, increased	-0.1	-0.1	-0.1	0.0	0.1	0.1	0.2	0.2	0.2	36
Change in operating revenues/sales/receipts?	Yes, decreased	-0.3	-0.3	-0.3	-0.1	0.0	0.2	0.4	0.4	0.4	36
Change in operating revenues/sales/receipts?	No	-0.3	-0.3	-0.3	-0.2	-0.1	0.0	0.2	0.3	0.3	36

Table 2. Distributions of National-Level Estimate Changes when Nonresponse Adjustment Cells are Defined by Sector x Payroll Size Instead of Sector x Employment Size

		Percentile									
Question	**Response**	**0th**	**1st**	**5th**	**25th**	**50th**	**75th**	**95th**	**99th**	**100th**	**N**
Change in the number of paid employees?	Yes, increased	-0.1	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	0.1	36
Change in the number of paid employees?	Yes, decreased	-0.1	-0.1	0.0	0.0	0.0	0.1	0.2	0.2	0.2	36
Change in the number of paid employees?	No	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.1	0.2	0.2	36
Change in the total number of hours worked by paid employees?	Yes, increased	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.1	0.1	36
Change in the total number of hours worked by paid employees?	Yes, decreased	-0.1	-0.1	-0.1	0.1	0.1	0.1	0.2	0.2	0.2	36
Change in the total number of hours worked by paid employees?	No	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	0.0	0.1	0.1	36
Change in operating revenues/sales/receipts?	Yes, increased	-0.1	-0.1	-0.1	0.0	0.0	0.0	0.1	0.1	0.1	36
Change in operating revenues/sales/receipts?	Yes, decreased	-0.1	-0.1	0.0	0.0	0.1	0.1	0.2	0.3	0.3	36
Change in operating revenues/sales/receipts?	No	-0.2	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.1	0.1	36

Table 3. Distributions of Sector-Level Estimate Changes when Nonresponse Adjustment Cells are Defined by Sector x State Instead of Sector x Employment Size

		Percentile									
Question	**Response**	**0th**	**1st**	**5th**	**25th**	**50th**	**75th**	**95th**	**99th**	**100th**	**N**
Change in the number of paid employees?	Yes, increased	-4.2	-1.0	-0.3	0.0	0.2	0.4	0.8	1.7	2.6	588
Change in the number of paid employees?	Yes, decreased	-14.0	-2.3	-0.4	0.0	0.2	0.4	1.0	2.2	9.5	593
Change in the number of paid employees?	No	-17.8	-3.9	-1.7	-0.7	-0.3	0.0	1.2	5.6	52.1	663
Change in the total number of hours worked by paid employees?	Yes, increased	-3.3	-1.0	-0.3	0.0	0.1	0.3	0.7	1.6	3.4	588
Change in the total number of hours worked by paid employees?	Yes, decreased	-15.4	-3.1	-0.9	-0.3	-0.1	0.2	1.1	6.6	34.1	612
Change in the total number of hours worked by paid employees?	No	-20.0	-7.3	-1.6	-0.4	-0.1	0.2	1.1	5.0	15.4	660
Change in operating revenues/sales/receipts?	Yes, increased	-2.6	-1.3	-0.6	-0.1	0.1	0.2	0.6	1.3	18.0	594
Change in operating revenues/sales/receipts?	Yes, decreased	-14.0	-3.0	-1.0	-0.3	0.0	0.4	1.7	7.1	34.1	634
Change in operating revenues/sales/receipts?	No	-32.2	-11.8	-2.1	-0.4	-0.1	0.2	1.6	6.0	12.6	659

Table 4. Distributions of Sector-Level Estimate Changes when Nonresponse Adjustment Cells are Defined by Sector x Payroll Size Instead of Sector x Employment Size

		Percentile									
Question	**Response**	**0th**	**1st**	**5th**	**25th**	**50th**	**75th**	**95th**	**99th**	**100th**	**N**
Change in the number of paid employees?	Yes, increased	-1.6	-0.8	-0.3	-0.1	0.0	0.0	0.2	0.7	6.4	588
Change in the number of paid employees?	Yes, decreased	-3.0	-0.9	-0.2	0.0	0.0	0.1	0.4	1.1	4.5	593
Change in the number of paid employees?	No	-9.2	-4.5	-0.7	-0.2	0.0	0.1	0.7	3.0	34.5	663
Change in the total number of hours worked by paid employees?	Yes, increased	-8.2	-0.6	-0.3	-0.1	0.0	0.1	0.2	0.6	1.9	588
Change in the total number of hours worked by paid employees?	Yes, decreased	-10.3	-3.5	-0.5	0.0	0.1	0.2	0.6	1.3	58.5	612
Change in the total number of hours worked by paid employees?	No	-9.2	-2.1	-0.8	-0.2	-0.1	0.0	1.0	4.7	13.6	660
Change in operating revenues/sales/receipts?	Yes, increased	-4.3	-1.2	-0.3	-0.1	0.0	0.1	0.2	0.8	12.6	594
Change in operating revenues/sales/receipts?	Yes, decreased	-19.2	-4.3	-0.9	-0.1	0.1	0.2	0.7	4.7	58.5	634
Change in operating revenues/sales/receipts?	No	-13.7	-5.2	-1.1	-0.2	-0.1	0.1	1.6	5.9	20.6	659

The results presented in Tables 1-2 provide preliminary evidence that at the national level, it makes little difference whether employment size or payroll size is used in the nonresponse adjustment, but that using state instead of employment size does systematically change the estimates for some characteristics. At the national level, the changes in the estimates are

sometimes non-negligible when sector and state are used instead of sector and employment size to define the nonresponse adjustment cells, which provides evidence of nonresponse bias. For the change in the number of paid employees characteristics, the top 25% largest estimate changes in magnitude ranged from 0.3 percentage points to 0.5 percentage points for the "Yes, increased" response, 0.3 percentage points to 0.4 percentage points for the "Yes, decreased" response, and 0.5 percentage points to 0.9 percentage points for the "No" response. At least 75% of the estimates for the "No" response had changes of at least 0.4 percentage points in magnitude. Also, all of the changes for the number of paid employees statistics are in one direction within each response (or equal to 0.0%). For the change in the total number of hours worked by paid employees characteristics and the change in revenue characteristics, the estimate changes are generally smaller than for the change in the number of paid employees characteristics, but they were still up to 0.4 percentage points in magnitude. When sector and payroll size replace sector and employment size in the nonresponse adjustment, the changes in national-level estimates are generally smaller (0.3 percentage points or less) than when sector and state replace sector and employment size in the nonresponse adjustment.

Tables 3-4 suggest that at the sector level, the changes in the estimates when using either of the two alternative nonresponse adjustments are generally larger than at the national level, but the median changes are similar to those for the national-level estimates and the changes are less systematic than at the national level, suggesting that some of the larger changes are noise since the sector-level estimates are based on smaller sample sizes than the national-level estimates. For all nine characteristics, when sector and state replace sector and employment size in the nonresponse adjustment, at least 50% of the estimates had changes of less than 1 percentage point in magnitude and at least 90% of the estimates had changes of less than 2.5 percentage points in magnitude. Also, for the change in number of paid employees characteristics, the value at the 25^{th} percentile for each response is either negative or 0.0% and the value at the 75^{th} percentile is either positive or 0.0%, suggesting that the changes in the sector-level estimates for these characteristics are less systematic than the changes for the national-level estimates. When sector and payroll size replace sector and employment size in the nonresponse adjustment, the changes in the sector-level estimates are even smaller than when sector and state replace sector and employment size, suggesting that replacing sector and employment size with sector and payroll size in the nonresponse adjustment would have little impact on sector-level estimates.

3.2. Coverage Bias Analysis

3.2.1 Comparing Payroll Totals of the SBPS Respondents, Sample, and Universe

As mentioned in Section 1.3, the SBPS was limited to small businesses for which the Census Bureau had email addresses, making the sample a nonprobability sample. Therefore, in order to determine if excluding small businesses without email addresses caused SBPS estimates to suffer from coverage bias, we compared the 2019 annual payroll total on the SBPS universe file to the estimated 2019 annual payroll totals for each phase that are obtained 1) using the SBPS respondents weighted with the nonresponse-adjusted weights, and 2) using the full SBPS sample with the sampling weights. The SBPS universe file used for this analysis includes all the records in the SBPS target population from the 2018 Business Register, including those with email addresses and without email addresses.

Table 5 shows the mean payroll totals from the full SBPS universe file, the SBPS sample weighted with the sampling weights, and the SBPS respondents weighted using the nonresponse-adjusted weights (we tried three different nonresponse adjustments). Table 6 shows the percent differences in the mean payroll totals between the respondents, sample, and universe. The mean payroll total for each phase is equal to the mean payroll total among the nine weeks within each phase.

Table 5. Mean Payroll Totals from Sample and Respondents to Universe by Phase

	Mean Payroll Total				
Phase	Sector x EMPSIZE	Sector x State	Sector x Payroll Size	Sample	Universe
1	5,667,000,000	6,085,000,000	5,561,000,000	5,531,000,000	2,001,000,000
3	5,665,000,000	6,066,000,000	5,566,000,000	5,501,000,000	2,001,000,000
4	5,790,000,000	6,267,000,000	5,692,000,000	5,600,000,000	2,001,000,000

Table 6. Percent Differences between Mean Payroll Totals of Respondents, Sample, and Universe by Phase

	Percent Difference in Mean Payroll Total						
Phase	Sample → Sector x EMPSIZE	Sample → Sector x State	Sample → Sector x Payroll Size	Universe → Sector x EMPSIZE	Universe → Sector x State	Universe → Sector x Payroll Size	Universe → Sample
1	2.46%	10.02%	0.54%	183.2%	204.1%	177.9%	176.4%
3	2.98%	10.27%	1.18%	183.1%	203.1%	178.2%	174.9%
4	3.39%	11.91%	1.64%	189.4%	213.2%	184.5%	179.9%

Note: Phase 2 was excluded from Tables 5 and 6 because there was a processing issue in Phase 2 that caused the sampling weight values for each sample case to be much smaller than they should be, so the totals would not make sense.

The mean payroll total for each phase is equal to the mean payroll total among the nine weeks within each phase.

"Sector x EMPSIZE" refers to the mean payroll total from respondents using the nonresponse-adjusted weights with a nonresponse adjustment that uses sector x employment size (EMPSIZE) adjustment cells (the production methodology).

"Sector x State" refers to the mean payroll total from respondents using the nonresponse-adjusted weights with a nonresponse adjustment that uses sector x state adjustment cells.

"Sector x Payroll Size" refers to the mean payroll total from respondents using the nonresponse-adjusted weights with a nonresponse adjustment that uses sector x payroll size adjustment cells.

"Sample" refers to the mean payroll total from the entire sample using the sampling weights.

"Universe" refers to the 2019 payroll total from the universe file, which includes all of the small businesses in the SBPS target population that were on the 2018 Business Register.

A → B = 100*(B-A)/A, where A and B are the totals in the A column and B column taken from Table 5.

Overall, it appears that coverage bias is a much larger issue than nonresponse bias for payroll estimates based on SBPS respondents. When comparing the weighted respondent totals to the weighted sample totals, the percent difference between the respondent total and the sample total ranged from 2.46% in Phase 1 to 3.39% in Phase 4 when using the sector x employment size nonresponse adjustment, it ranged from 10.02% in Phase 1 to 11.91% in Phase 4 when using the sector x state nonresponse adjustment, and it ranged from 0.54% in Phase 1 to 1.64% in Phase 4 when using the sector x payroll size nonresponse adjustment. This suggests that

sector x payroll size and sector x employment size are better nonresponse adjustment cells than sector x state, but this could also be due to the high correlation between payroll and employment size and between payroll and payroll size (payroll size is a categorical version of payroll), so this analysis unfairly favors using payroll size or employment size instead of state in the nonresponse adjustment. However, when comparing all three of the weighted respondent payroll totals to the universe payroll total, all three methods show a large difference between the sample estimated totals and actual universe totals. For example, the percent difference between the respondent total and the universe total in Phase 1 was 183.2% when using the sector x employment size nonresponse adjustment, 204.1% when using the sector x state nonresponse adjustment, and 177.9% when using the sector x payroll size nonresponse adjustment. Even if SBPS had a 100% response rate in Phase 1, it would not estimate total payroll well since the percent difference between the sample total and the universe total in Phase 1 was 176.4%.

3.2.2 Comparing Employment Size Distributions of the SBPS Respondents, Sample, and Universe

Given the large amount of coverage bias in SBPS's estimated payroll totals, we wanted to see if there were differences in the employment size (EMPSIZE) distributions of the weighted respondents, the weighted sample, and the universe. The sampling weights were computed so that when the sampling weights were applied to the full sample, the total number of businesses within each state x sector stratum would match the totals from the universe, but since the sample was not selected at random within each state x sector stratum, the EMPSIZE distribution of the sample may be different from the EMPSIZE distribution of the universe.

Table 7 shows the EMPSIZE distribution for the respondents, the sample, and the universe for Phase 1. The EMPSIZE distributions in Phases 2-4 are similar to the ones in Phase 1.

Table 7. EMPSIZE Distributions for Respondents, Sample, and Universe for Phase 1

	Percent				
1. Number of Employees (EMPSIZE)	2. Respondents (Unweighted)	3. Respondents (Weighted)	4. Sample (Unweighted)	5. Sample (Weighted)	6. Universe
4 or fewer	33.28	35.35	36.80	35.36	63.86
Between 5 and 19	41.26	39.32	39.79	39.32	27.28
20 or more	25.46	25.32	23.41	25.32	8.86

The EMPSIZE distribution for the unweighted respondents (Column 2 of Table 7) is only slightly different from the EMPSIZE distribution for the weighted (by the sampling weight) sample (Column 5 of Table 7). Also, the EMPSIZE distribution for the weighted (by the nonresponse-adjusted weight created in production) respondents (Column 3 of Table 7) is almost identical to the weighted sample (this is expected since the nonresponse adjustment is defined by sector x EMPSIZE). However, these distributions all look quite different from the EMPSIZE distribution for the universe (Column 6 of Table 7). We conducted chi-square goodness-of-fit tests to compare the EMPSIZE distributions for the weighted and unweighted respondents and sample (Columns 2-5 of Table 7) to the EMPSIZE distribution of the universe and found that they were all significantly different from the universe distribution at the 10% level. The smaller businesses (4 or fewer employees) are very underrepresented in the SBPS sample, while the relatively larger businesses (between 5 and 19 and 20 or more employees) are overrepresented. For

example, about 9% of businesses in the universe have 20 or more employees, but about 25% of the weighted sample and respondents have 20 or more employees. Also, about 64% of businesses in the universe have 4 or fewer employees, but only about 35% of the weighted sample and respondents have 4 or fewer employees.

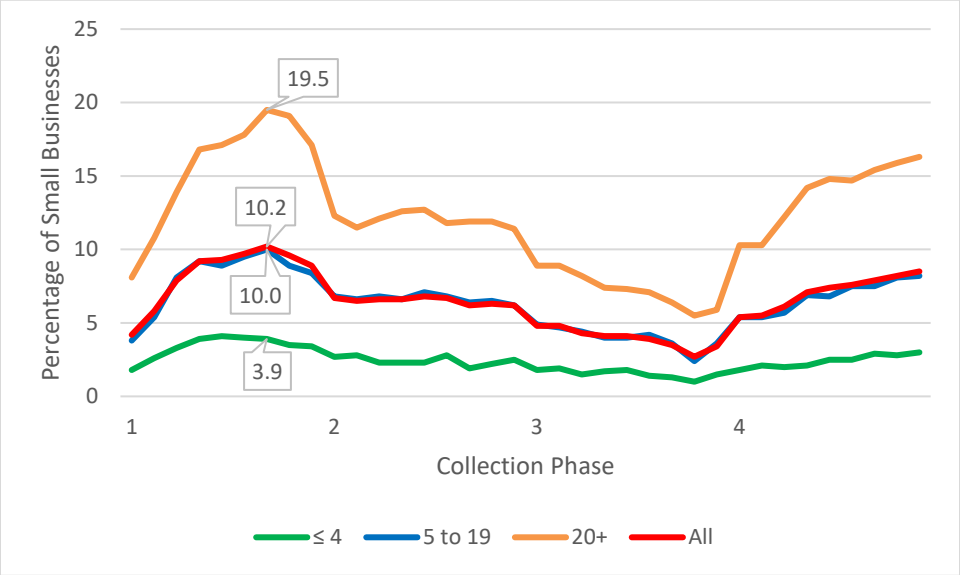
The large differences between the EMPSIZE distributions in the universe and in the sample happened because 1) the SBPS used a convenience sample instead of a probability sample and firms for which the Census Bureau had valid email addresses when the SBPS sample was initially selected tend to be larger than those for which the Census Bureau did not have valid email addresses in most state x sector strata, and 2) the sampling weight computation did not factor in EMPSIZE since the strata are defined by state and sector, so the weighting does not fix the large difference between the EMPSIZE distribution of the sample versus the universe. The reason the firms for which the Census Bureau had valid email addresses tended to be larger than those for which the Census Bureau did not have valid email addresses is because the email addresses came from the respondents of the 2017 Economic Census. Despite being called a census, the 2017 Economic Census only took a sample of smaller firms (in terms of payroll), while all larger firms were included (U.S. Census Bureau, 2021). This means that the sample for the 2017 Economic Census was skewed towards larger businesses, causing the SBPS sample to also be skewed towards larger businesses.

3.2.3 Comparing Change in Employment Estimates by EMPSIZE

Although the large differences in the EMPSIZE distribution between the sample and the universe caused a large amount of bias in payroll estimates, that does not necessarily mean that these differences caused large amounts of bias in the estimates that SBPS produces. If the estimates for the key items SBPS measures are similar to each other across EMPSIZE, it would suggest that the differences in the EMPSIZE distribution between the sample and the universe are not a major concern. However, if the EMPSIZE-level estimates of the key items are different from each other, it would suggest that the differences in the EMPSIZE distribution between the sample and the universe added bias to SBPS estimates.

Figures 10 – 12 show the EMPSIZE-level estimates by phase and week for the three response choices for the following SBPS question: “In the last week, did this business have a change in the number of paid employees?” Figure 10 shows the estimates for “Yes, increased,” Figure 11 shows the estimates for “Yes, decreased,” and Figure 12 shows the estimates for “No” or “No Change” (the wording for this response choice changed from Phase 1 to Phase 2). The national averages are also included in each figure (these are labeled “All”).

Figure 10. Percentage of Small Businesses that had an Increase in the Number of Paid Employees in the Last Week by EMPSIZE, Phase, and Week



Note: The data labels in Figure 10 point to the values for Week 7 of the SBPS because they are referenced later in this paper.

Figure 11. Percentage of Small Businesses that had a Decrease in the Number of Paid Employees in the Last Week by EMPSIZE, Phase, and Week

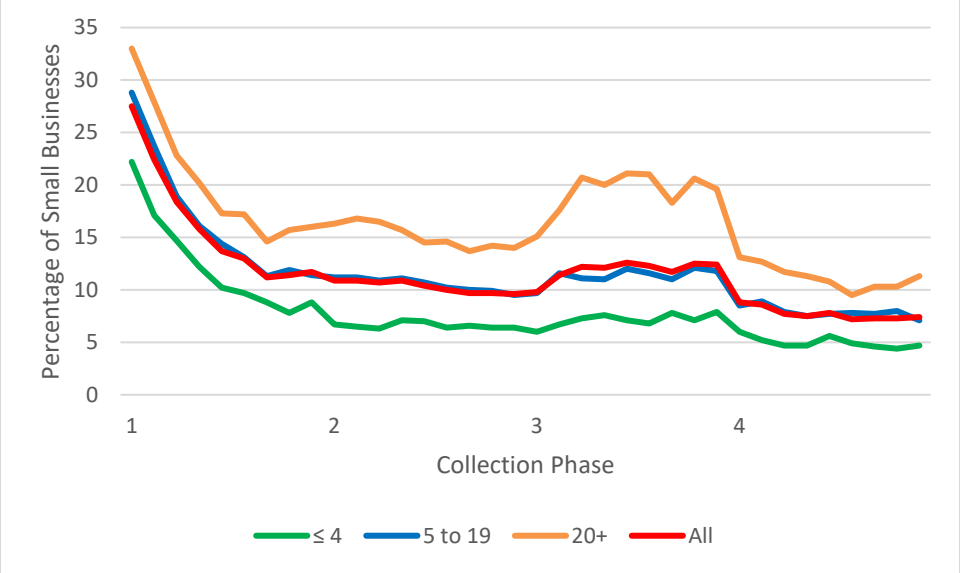
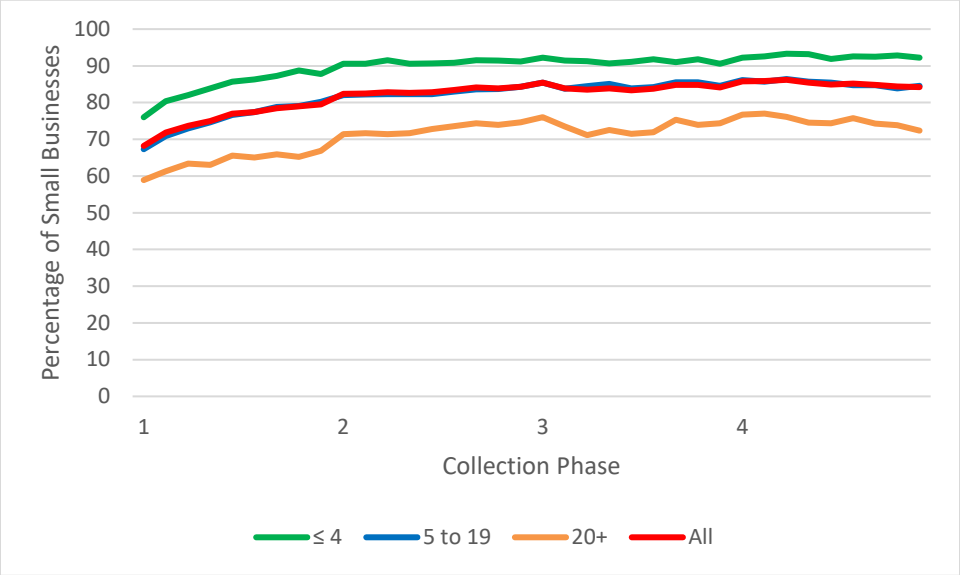


Figure 12. Percentage of Small Businesses that had No Change in the Number of Paid Employees in the Last Week by EMPSIZE, Phase, and Week



Figures 10 – 12 show that there were large differences in the estimates for all three response choices by EMPSIZE, suggesting that the national averages for each response choice may have a lot of bias because SBPS overrepresented businesses with 5 – 19 employees, overrepresented businesses with 20 or more employees, and underrepresented businesses with 4 or fewer employees. For example, in Week 7, Figure 10 shows that 19.5% of businesses with 20 or more employees had an increase in the number of paid employees in the last week, but this was true for only 3.9% of businesses with 4 or fewer employees and 10.0% of businesses with 5 – 19 employees. This suggests that the estimate for this characteristic's Week 7 national average (10.2%) is higher than it would have been if the SBPS coverage and response were representative of the target population employment size distribution.

4. Conclusions and Future Work

This paper presents the results of an investigation of potential nonresponse bias and coverage bias for Phases 1 through 4 of the Small Business Pulse Survey. This weekly survey is characterized by fairly consistent but low unit response rates overall across the first four survey phases, with some variation by sector, state, and employment size class. Response patterns were consistently different among all three employment size classes; businesses in the smallest employment size class experienced the lowest unit response rates and businesses in the largest employment size class experienced the highest unit response rates. This represents a potentially significant source of nonresponse bias as measures of the change in the number of paid employees key item also differed by employment size.

Additionally, these analyses show that the estimates are subject to coverage bias, and the effects of the coverage bias on the estimates may dwarf the nonresponse bias effects. This is mainly because the SBPS was not a probability sample, and the weighting methodology did not include a coverage adjustment to account for the large differences in employment size between the sample and the universe. Adding a post-stratification coverage adjustment to the SBPS

weighting methodology that makes the sector x employment size distribution of the weighted respondents match the universe distribution may reduce the amount of coverage bias in SBPS estimates.

We plan to do analyses similar to the ones in this paper with SBPS Phases 5 through 8 data in the future.

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