Non-response Bias Study for Value of Construction Put in Place

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1. Introduction

Both private, non-residential construction and multifamily residential projects in the Value of Construction Put in Place (VIP) series suffer from a low response rate. In order to both understand any problems that this may be causing as well as to fulfill Office of Management and Budget requirements, we conducted a nonresponse bias study for these two components of the VIP. We look at response rates and estimates of bias for some key variables, and provide some suggestions for improvements and other future work.

2. Background

2.1 Survey Overview

The VIP is a monthly measure of the dollar amount of construction put in place within the United States. The VIP data are used in the National Income and Product Accounts produced by BEA. The current historical series began in the early 1960's. The analysis presented in this paper covers only privately-owned, nonresidential construction and multifamily residential construction

Published VIP data are compiled from: (a) a series of construction project surveys, (b) estimates from other construction series, and (c) data from secondary sources such as regulatory agencies. This approach is quite different from the establishment or company-based survey methods used by most economic surveys at the Census Bureau. Data collected through the VIP approach represents an all-encompassing economic measure of construction spending. The survey data are collected from the project owner's point of view. All construction related expenditures are included, not just contractor receipts.

The following types of expenditures are included in VIP:

- New buildings and structures
- Additions, alterations, major replacements, etc. to existing buildings and structures
- Installed mechanical and electrical equipment
- Installed industrial equipment, such as boilers and blast furnaces
- Site preparation and outside construction, such as streets, sidewalks, parking lots, utility connections, etc.
- Cost of labor and materials (including owner supplied)
- Cost of construction equipment rental
- Profit and overhead costs
- Cost of architectural and engineering (A&E) work
- Any miscellaneous costs of the project that are on the owner's books

The VIP excludes several types of expenditures, such as the value of maintenance and repairs to existing structures and land acquisition.

Most of the survey methodology is not necessary for understanding nonresponse bias, however as imputation is by nature linked to nonresponse we wish to go over it briefly. Total construction cost (Rev5c) is imputed by multiplying either the project selection value (PSV), an estimate of a construction project's cost available from the sampling frame, for private non-residential cases or the total units for private multifamily cases, by a factor; the factor is calculated annually as a sum of ratios of Rev5c to PSV for responding construction projects. Monthly VIP is imputed by multiplying Rev5c by a factor specific to the month being imputed for; the factor is calculated monthly as a ratio of total monthly VIP for active construction projects to the total Rev5c for active projects, with a possible additional adjustment added if the start date of the project was imputed due to nonresponse.

2.2 Input Data

This nonresponse bias analysis was conducted using production data for May 2017. Different data sources are used for the two components of VIP studied.

For the private, non-residential component we use a file created each month containing all in-scope construction projects for the current and previous 26 months is created. This file, known as the 27-month file, is our starting point. We further restrict the file to privately (i.e. non-public) owned nonresidential construction projects that entered the universe after August 2001 and that are not in abeyance (suspended construction) or a duplicate of another project.

For multifamily projects we use a combination of monthly files for both VIP and SOC. We restrict this merged file to only multifamily units selected after August 2001, with duplicates and out of scope projects already having been eliminated from the input files due to our regular processing.

3. Response Rates

The following section focuses on response rates for Private nonresidential projects. Multifamily response rates are discussed in Section 5.

Unit response rates (URRs) are calculated two ways. The first considers a unit to be a response if it reported VIP for a given month. The second considers a unit to be a response if it reports revised item 5c during an initial selection mailouts. In both cases we exclude units with a missing response flag, as this indicates that the unit is not active at the given time. The unit response rate is calculated as the number of units with a response flag indicating a response, divided by the total number of units with a non-missing response flag.

In detail, to calculate URRs using monthly response status, we classify each project into one of three categories in each month. The first category contains all projects with a VIP response flag value of "R" and a status flag not equal to "7"; status 7 projects are analyst imputed and not truly a response. The second category contains all projects with a VIP response flag of "*" or a status flag equal to "7". The third category contains all remaining projects (VIP response flag not equal to "R" or "*" and status flag not equal to "7") and consists of all projects that are ineligible for tabulation that month. If we denote the number of projects in the first category as n_r and the number of projects in the second category as n_{nr} then the URR is equal to $\frac{n_r}{n_r+n_{nr}}$.

The calculation of URRs using revised item 5c response status is largely similar, just with response defined differently. The three categories are: respondents, those projects with revised item 5c response flag equal to "R"; nonrespondents, those projects with revised item 5c response flag equal to "*"; and ineligibles, those projects with revised item 5c response flag not equal to "R" or "*". Again we denote the number of projects in the first category as n_r and the number of projects in the second category as n_{nr} and the URR is equal to $\frac{n_r}{n_r+n_{nr}}$.

A unit is considered a certainty if it is taken from a stratum where every unit in the stratum is selected into the sample, i.e. the sampling rate for that stratum is equal to 1. This includes every unit that has a value of $10 million or more based on the sampling frame, and includes smaller units from certain types of construction. Note that it is possible for units from strata without a sampling rate of 1 to have a weight close to or equal to one after adjustments and that these units are not considered certainties in this analysis.

We calculate response rates for a given reference month and lag. For example, since we are calculating the response rates for a reference month of May 2017, so lag 0 refers to the data collected for May 2017 that is available in May 2017; lag 1 refers to the data collected for April 2017 that is available in May 2017, and so on. Since revised item 5c is either reported or not reported, and this doesn't change by month, we only need to calculate one set of response rates using that response status. Since VIP is reported on a monthly basis, we calculate response rates for each of a possible 27 lags available on the monthly VIP file.

Table 3.1: Overall URR

	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
Overall	21.6%	27.0%	29.6%	34.5%	37.1%	39.7%	35.9%	8,714	54.4%

Table 3.2: URR by Certainty Status

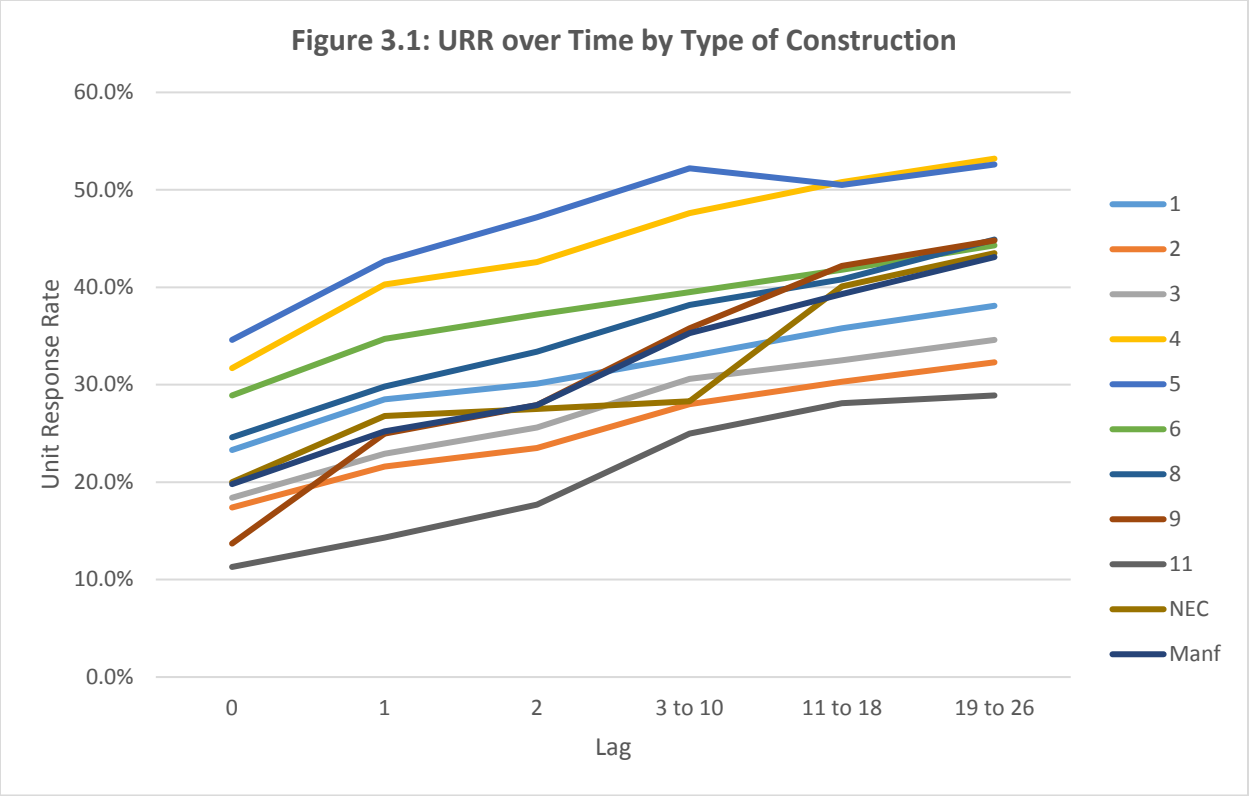
Certainty Status	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
Noncertainty	18.3%	23.0%	25.3%	31.2%	32.2%	35.2%	31.7%	3,835	53.2%
Certainty	24.1%	30.1%	33.0%	37.3%	41.0%	43.3%	39.3%	4,878	55.5%

Table 3.3: URR by Type of Construction

Type of Construction	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
Lodging(01)	23.3%	28.5%	30.1%	32.9%	35.8%	38.1%	34.7%	829	50.7%
Office(02)	17.4%	21.6%	23.5%	28.0%	30.3%	32.3%	29.2%	1,555	46.9%
Commercial(03)	18.4%	22.9%	25.6%	30.6%	32.5%	34.6%	31.4%	2,705	51.3%
Health Care(04)	31.7%	40.3%	42.6%	47.6%	50.8%	53.2%	49.2%	982	65.0%
Education(05)	34.6%	42.7%	47.2%	52.2%	50.5%	52.6%	50.6%	678	69.4%
Religious(06)	28.9%	34.7%	37.2%	39.5%	41.8%	44.3%	40.9%	286	64.1%
Amusement & Recreation(08)	24.6%	29.8%	33.4%	38.2%	40.8%	44.9%	40.0%	352	59.2%
Transportation (09)	13.7%	25.0%	27.9%	35.8%	42.2%	44.8%	38.9%	112	55.0%
Power(11)	11.3%	14.3%	17.7%	25.0%	28.1%	28.9%	25.9%	398	40.7%
Not Elsewhere Classified	20.0%	26.8%	27.5%	28.3%	40.1%	43.5%	35.9%	53	57.5%
Manufacturing(20-39)	19.8%	25.2%	27.9%	35.3%	39.3%	43.1%	37.6%	763	59.7%

Table 3.4: URR by Project Selection Value (in Thousands of Dollars)

PSV Category	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
>=10,000	24.3%	30.2%	33.0%	37.1%	40.5%	42.9%	38.9%	4,530	55.0%
>=5,000	22.9%	28.4%	31.7%	37.1%	41.9%	43.5%	39.4%	1,256	58.6%
>=2,000	22.6%	27.6%	30.9%	35.9%	36.8%	41.4%	36.8%	1,026	57.0%
>=750	15.2%	19.7%	21.2%	28.0%	29.2%	29.6%	27.8%	1,028	50.7%
>=250	11.7%	16.1%	18.1%	24.7%	23.0%	28.0%	24.1%	644	49.8%
>=75	11.9%	13.4%	16.0%	23.9%	20.0%	26.5%	22.4%	230	47.2%



Quantity response rates (QRRs) for monthly VIP are calculated in a similar manner to URRs. Instead of simply counting responding and nonresponding units, we sum up weighted monthly VIP for respondents and divide it by the weighted monthly VIP for responding and nonresponding units.

When calculating monthly VIP QRRs using monthly VIP reporting status, place projects into the same three categories as they were placed into when calculating URRs. However, instead of using n_r and n_{nr}, we calculate the weighted sum of monthly VIP for categories one and two. We define $\hat{t}_r$ as the weighted sum of monthly VIP for every project in the first category and $\hat{t}_{nr}$ as the weighted sum of monthly VIP for every project in the second category. Projects in the third category are again unused. The QRR is then calculated as $\frac{\hat{t}_r}{\hat{t}_r+\hat{t}_{nr}}$.

While we could calculate a QRR using response of revised item 5c, it would involve treating imputed values of monthly VIP as reported which would be of limited value. Since projects go into the first category based on the response status to revised item 5c, not monthly VIP, it is entirely possible that we will have projects with imputed monthly VIP in the first category. Similarly, we may have projects in the second category where monthly VIP is reported, not imputed. In both cases we would be misclassifying monthly VIP and the result would not match any standard definition of a response rate. We could calculate a QRR for revised item 5c instead of monthly VIP, however the focus of this study is monthly VIP.

Table 3.5: Overall QRR of Monthly VIP

Overall	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Overall	31.6%	38.1%	42.5%	45.9%	47.3%	48.9%	46.3%	8,714

Table 3.6: QRR of Monthly VIP by Certainty Status

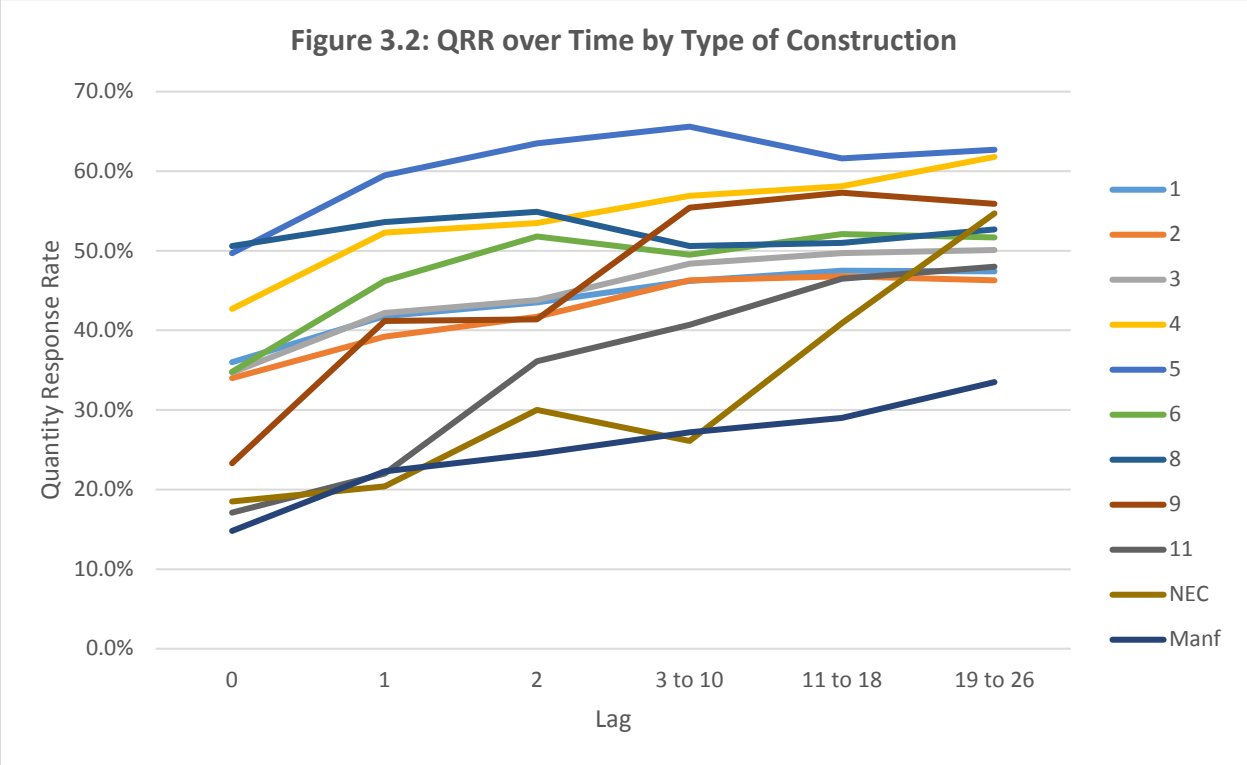
Certainty Status	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Noncertainty	38.7%	46.7%	49.1%	53.1%	52.6%	53.9%	52.3%	3,835
Certainty	29.0%	34.9%	39.8%	42.4%	44.9%	46.5%	43.5%	4,878

Table 3.7: QRR of Monthly VIP by Type of Construction

Type of Construction	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Lodging(01)	36.0%	41.8%	43.5%	46.2%	47.5%	47.4%	46.3%	829
Office(02)	34.0%	39.2%	41.7%	46.3%	46.8%	46.3%	45.6%	1,555
Commercial(03)	34.7%	42.2%	43.8%	48.4%	49.7%	50.1%	48.4%	2,705
Health Care(04)	42.7%	52.3%	53.5%	56.9%	58.1%	61.8%	57.9%	982
Education(05)	49.7%	59.5%	63.5%	65.6%	61.6%	62.7%	62.7%	678
Religious(06)	34.8%	46.2%	51.8%	49.5%	52.1%	51.7%	50.3%	286
Amusement & Recreation(08)	50.6%	53.6%	54.9%	50.6%	51.0%	52.7%	51.6%	352
Transportation(09)	23.3%	41.2%	41.4%	55.4%	57.3%	55.9%	53.9%	112
Power(11)	17.1%	22.0%	36.1%	40.7%	46.5%	48.0%	42.8%	398
Not Elsewhere Classified	18.5%	20.4%	30.0%	26.1%	40.9%	54.7%	38.6%	53
Manufacturing (20-39)	14.8%	22.3%	24.5%	27.2%	29.0%	33.5%	28.9%	763

Table 3.8: QRR of Monthly VIP by Project Selection Value (in Thousands of Dollars)

PSV Category	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
>=10,000	28.9%	34.8%	39.7%	42.2%	44.5%	46.1%	43.2%	4,530
>=5,000	39.0%	46.8%	49.3%	53.1%	54.7%	57.7%	54.0%	1,256
>=2,000	35.1%	44.6%	48.5%	51.0%	52.6%	56.2%	52.1%	1,026
>=750	40.3%	45.9%	47.2%	52.8%	54.1%	50.8%	51.7%	1,028
>=250	34.6%	47.5%	50.4%	54.9%	51.2%	50.5%	51.3%	644
>=75	56.0%	55.9%	53.4%	57.9%	49.7%	56.5%	54.7%	230



We see a few patterns in URR and QRR for private nonresidential monthly VIP. URR and QRR both increase with lag, with the bulk of the increase occurring during the first few months. URR is higher for certainties than non-certainties, while QRR is higher for non-certainties than certainties. QRR is lowest for the highest value group but it is only 8-10% less than the other value groups. Manufacturing construction has the lowest QRR but Power has the lowest URR. Overall when looking at response across value groups, we see a slight trend towards higher URR for higher value groups but there is no discernable trend when looking at QRR by value group.

4. Relative Bias

The following section focuses on relative bias for Private Nonresidential projects. This analysis was not possible for multifamily projects due to lack of an available frame variable like Project Selection Value (PSV).

We look at the relative bias of Project Selection Value (PSV) calculated for various groups and two ways of determining response status. PSV is used for bias calculations as it is available for both respondents and non-respondents and is reasonably well correlated with both revised item 5c and the total sum of monthly Value of Construction Put in Place (VIP) for a project; correlations are all at least 0.75 between the three variables. We look at Type of Construction (TC), certainty status, and PSV for our categorization variables. For response status, we look at either the actual response status of VIP for a month or whether or not the revised item 5c is reported; this second definition is considered as revised item 5c is used for imputation of monthly VIP.

We calculate relative bias for a given reference month and lag. For example, if we are calculating the relative bias for a reference month of May 2017, then lag 0 would refer to the data collected for May 2017 that is available in May 2017; lag 1 would refer to the data collected for April 2017 that is available in May 2017, and so on. Since revised item 5c is either reported or not reported, and this doesn't change by month, we only need to calculate one relative bias using that response status. Since VIP is reported on a monthly basis, we calculate a relative bias for each of a possible 27 lags available on the monthly VIP file.

Relative bias is presented for response based on monthly VIP response status for lags 0, 1, and 2 corresponding to preliminary, first, and second revision releases. We average the relative biases for lags 3 to 10, 11 to 18, and 16 to 26 in order to keep the presented data manageable while still giving a picture of the full life of the relative bias.

For a given reference month and lag, we set projects as either a response or non-response. We also classify it into it's appropriate category based on TC, certainty status, or PSV depending on what we are looking at. The average PSV is calculated for the response and non-response groups for each level of the classification variable. The bias is then calculated as $\frac{n-n_r}{n}(\overline{PSV_r} - \overline{PSV_{nr}})$, where n is the number of sampled projects for the given level of the classification variable; n_r is the number of responding sampled projects for the given level of the classification variable; $\overline{PSV_r}$ is the estimation weighted average of PSV for responding sampled projects for the given level of the classification variable; and $\overline{PSV_{nr}}$ is the estimation weighted average of PSV for non-responding sampled projects for the given level of the classification variable. Thus the relative bias depends on both the response rate and the difference in average PSV between respondents and non-respondents. A positive bias means that respondents tend to be larger than non-respondents and that basing our estimates on only respondents will result in an overestimation. Relative bias is calculated by taking the bias and dividing by the average PSV for all sampled units for a given level of the classification variable.

We do not see a strong trend that relative bias decreases as lag time increases, either overall or by different categorization variables. We also see (not yet shown) an increase in response rate as lag time increases. This means that despite collecting data from more units over time, we do not see a decrease

in difference between respondents and non-respondents. This suggests that we may be able to find improvements to current nonresponse followup (NRFU) procedures. Any final conclusions would require an analysis of bias with respect to current imputation procedures, as imputation is the model that links project selection value to monthly VIP.

We see certainties have a lower relative bias than noncertainties, which suggests putting greater effort into NRFU on non-certainties. The degree to which the effort should be increased is proportional to the percentage of the estimated totals that non-certainties account for. It's also worth noting that the opposite is true for some types of construction; one such example is TC 09 where certainties have a 68.8% relative bias and noncertainties have a -28.7% relative bias at lag 0 (the initial release of an estimate for a given month.)

Looking at relative bias for Type of Construction level estimates and excluding Not Elsewhere Classified, we see that TC 01 tends to have the lowest relative bias. After TC 01 come TC 08 and 09. TCs 02 and 11 tend to have the largest relative bias values, suggesting that they may benefit the most from additional NRFU resources.

Looking at relative bias by project selection value gives consistently low results. This is to be expected since the categories limit how much the nonrespondents can differ from the respondents. No strong patterns appear in the relative bias statistics to suggest a particular area to focus NRFU. The occasional large value of relative bias for the largest category (those units with project selection values over $10,000,000) can be partially understood by the potential for arbitrarily large differences between project selection values for units in that group; in smaller groups the difference is bounded by the minimum and maximum values that define the group.

While the relative bias values for project selection value can be quite high, they do not immediately indicate a problem. We know project selection value for all units in the sampling frame, so in practice we know what the true total is. Our real estimation target is the total value of construction, which has a reasonably strong relationship with project selection value. By making use of the project selection value of nonrespondents, we should be able to produce imputation-based estimates of total value of construction with small relative bias.

Table 4.1: Overall Relative Bias of Project Selection Value

Overall	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
Overall	47.7%	41.1%	52.0%	32.5%	40.8%	24.9%	34.3%	8,714	7.3%

Table 4.2: Relative Bias of Project Selection Value by Certainty Status

Certainty Status	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
Noncertainty	39.5%	38.0%	37.2%	23.5%	31.6%	24.1%	27.7%	3,835	9.1%
Certainty	-2.5%	-6.9%	1.8%	0.3%	-1.9%	-7.5%	-3.0%	4,878	-3.0%

Table 4.3: Relative Bias of Project Selection Value by Type of Construction

Type of Construction	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
Lodging(01)	9.9%	17.1%	15.5%	18.4%	20.3%	9.2%	15.8%	829	6.29%
Office(02)	75.4%	66.5%	60.3%	31.9%	49.7%	53.7%	47.6%	1,555	2.10%
Commercial(03)	71.0%	82.3%	73.6%	46.9%	48.8%	23.8%	43.8%	2,705	8.65%
Health Care(04)	74.2%	65.4%	68.3%	37.7%	39.1%	34.6%	40.7%	982	15.82%
Education(05)	34.0%	24.8%	26.5%	22.4%	31.1%	16.4%	23.9%	678	4.06%
Religious(06)	25.0%	33.1%	56.6%	47.0%	45.8%	40.6%	43.8%	286	15.71%
Amusement & Recreation(08)	23.8%	18.2%	25.5%	26.9%	17.4%	3.2%	16.6%	352	18.25%
Transportation (09)	17.4%	19.5%	27.5%	29.9%	40.6%	38.2%	34.6%	112	-6.07%
Power(11)	68.9%	47.4%	81.9%	49.6%	63.3%	42.9%	53.5%	398	16.50%
Not Elsewhere Classified	3.5%	-14.2%	-23.6%	10.1%	-11.8%	-13.3%	-5.7%	53	-19.10%
Manufacturing (20-39)	-14.0%	-24.3%	-16.7%	-39.8%	-39.4%	-34.5%	-35.7%	763	-3.84%

Table 4.4: Relative Bias of Project Selection Value by Project Selection Value (in Thousands of Dollars)

PSV Category	Lag, Monthly Response Status							Average Monthly Sample	Rev5c Resp Flag
	0	1	2	3 to 10	11 to 18	19 to 26	Average		
>=10,000	-3.1%	-7.3%	1.7%	0.6%	-0.9%	-6.7%	-2.4%	4,530	-2.2%
>=5,000	2.1%	2.5%	2.4%	1.6%	0.6%	0.3%	1.0%	1,256	0.3%
>=2,000	0.2%	-1.1%	-0.8%	-0.7%	1.7%	1.8%	0.8%	1,026	0.1%
>=750	4.8%	5.3%	6.2%	3.8%	2.4%	2.1%	3.0%	1,028	0.9%
>=250	2.7%	1.1%	4.0%	0.9%	1.2%	-2.8%	0.1%	644	-0.1%
>=75	-12.0%	-9.2%	-11.1%	-2.0%	1.2%	-0.4%	-1.5%	230	-0.5%

Figure 4.1:
Relative Bias of PSV over Time by Type of Construction, All

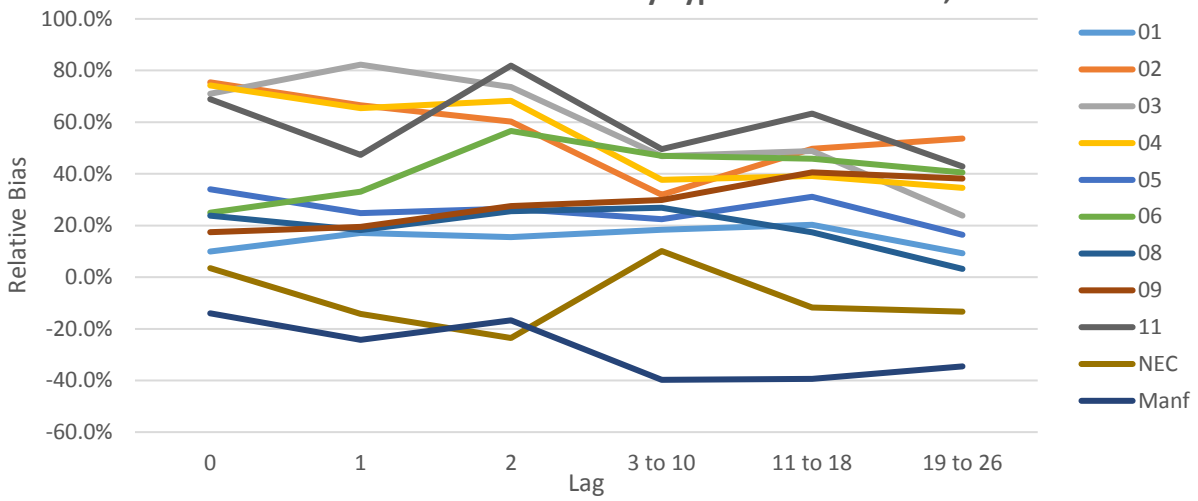


Figure 4.2: Relative Bias of PSV over Time by TC, Noncertainties

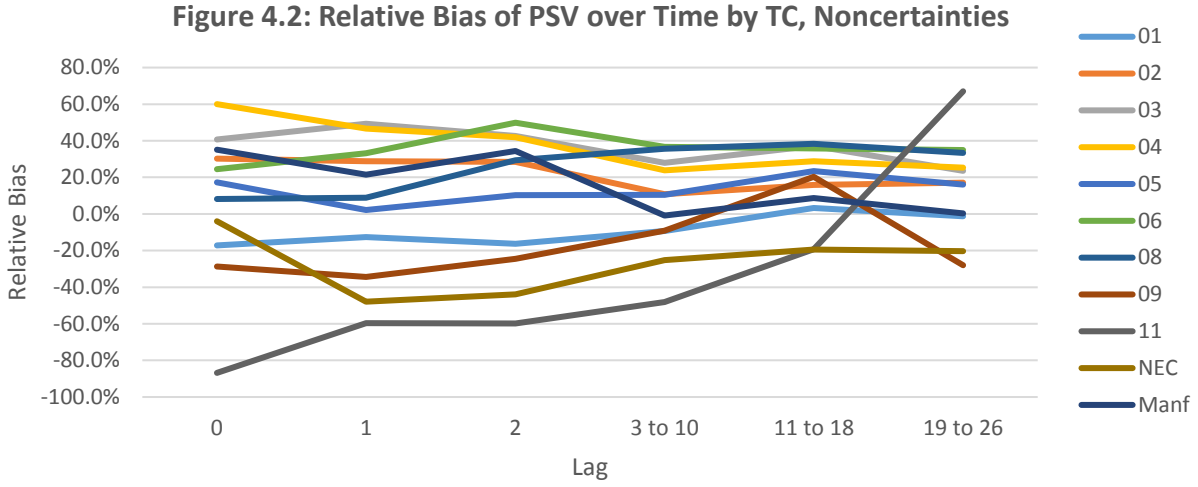
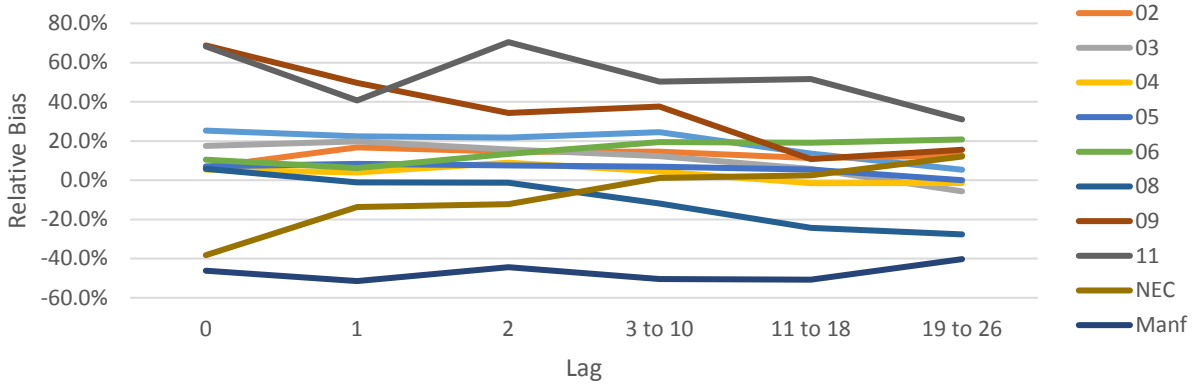


Figure 4.3: Relative Bias of PSV over Time by TC, Certainties



5. Private Multifamily Structures

Unit and Quantity Response Rates were calculated for private multifamily (MF) structures. For these structures, response status is defined only by whether or not a unit reported VIP for a given month. As with private non-residential structures, URR is calculated as the number of units with a response flag indicating a response, divided by the total number of units with a non-missing response flag. Quantity response rates for monthly VIP are calculated in a similar manner to URRs. Instead of simply counting responding and nonresponding units, we sum up weighted monthly VIP for respondents and divide it by the weighted monthly VIP for responding and nonresponding units. Project Selection Value is not available for multifamily structures, so we define size categories based on the number of units associated with that structure on the frame; number of units is also collected as a survey variable, but for measure of size purposes we use the frame value. Additionally, since multifamily structures all share the same Type of Construction (residential), we do not provide a breakdown by that variable.

We see similar patterns in URR and QRR for both private, non-residential and private, multifamily structures. URR and QRR both increase with lag, with the bulk of the increase occurring during the first few months. URR is higher for certainties than non-certainties for both groups, which flips with QRR being higher for non-certainties than certainties; the difference for URR is much closer in the case of multifamily structures. When looking at size of units, we see a slight trend towards higher URR for larger units for both multifamily and private, non-residential structures. There is no strong trend when looking at QRR by size, although we see some evidence that for multifamily structures the smallest structures have a lower QRR than the rest of the population.

Table 5.1: Overall URR

Overall	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Overall	26.9%	31.4%	33.2%	34.9%	38.0%	40.3%	36.9%	3,957

Table 5.2: URR by Certainty Status

Certainty Status	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Noncertainty	26.4%	32.0%	33.7%	35.1%	37.0%	39.4%	36.5%	727
Certainty	27.1%	31.3%	33.1%	34.8%	38.2%	40.5%	37.0%	3,227

Table 5.3: URR by Number of Units

Number of Units	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
>= 300	35.7%	41.6%	43.6%	44.6%	48.1%	51.3%	47.1%	548
>= 200	32.4%	36.2%	40.6%	43.8%	47.5%	49.3%	45.7%	474
>= 100	30.9%	36.7%	37.3%	41.3%	47.2%	49.2%	44.7%	573
>= 50	35.2%	40.2%	41.9%	41.2%	45.6%	49.5%	44.7%	541
>= 25	25.9%	30.0%	31.6%	33.0%	36.2%	39.0%	35.3%	571
>= 5	16.8%	20.2%	21.4%	22.5%	23.7%	25.9%	23.5%	1,118
>= 0	9.52%	13.4%	16.8%	18.3%	19.5%	18.6%	18.2%	130

Table 5.4: Overall QRR

Overall	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Overall	52.6%	59.2%	62.3%	63.9%	67.1%	69.8%	65.94%	3,957

Table 5.5: QRR by Certainty Status

Certainty Status	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
Noncertainty	56.8%	62.6%	62.9%	64.1%	70.0%	74.7%	68.6%	727
Certainty	50.2%	57.1%	62.0%	63.6%	65.0%	66.2%	64.0%	3,227

Table 5.6: QRR by Number of Units

Number of Units	Lag, Monthly Response Status							Average Monthly Sample
	0	1	2	3 to 10	11 to 18	19 to 26	Average	
300+	49.9%	59.4%	64.9%	65.1%	66.9%	67.1%	65.4%	548
200-299	55.0%	57.7%	63.9%	67.6%	68.4%	71.9%	68.1%	474
100-199	49.5%	57.7%	58.4%	57.9%	66.2%	71.8%	64.2%	573
50-99	67.3%	69.4%	68.7%	69.3%	72.9%	75.7%	72.2%	541
25-49	43.0%	53.0%	55.1%	64.0%	68.0%	73.7%	66.5%	571
5-24	48.4%	55.5%	58.6%	59.2%	59.5%	55.0%	57.5%	1,118
2-4	44.6%	41.0%	43.5%	48.8%	50.5%	56.2%	50.9%	130

We did not look at relative bias for multifamily structures due to the lack of a suitable frame variable. While we could attempt a model, any such model would be highly dependent on imputed values which would limit the value of any results we may be able to obtain.

6. Future Work

While evidence for nonresponse bias is present throughout the survey, we do see some areas that may be viable for targeting. In general, noncertainties display a larger relative bias than certainties but are also smaller; it would be worth allocating resources towards published estimates that are primarily driven by noncertainty projects. Nonresponse bias is present in all types of construction, with the relative rankings shifting depending on the definition of response used and the time of measurement. This makes it difficult to suggest any types of construction to focus nonresponse bias reduction efforts on. However, we see that Health Care, Religious, and Power projects tend to have larger relative biases regardless of the response definition used; this suggests that looking at these three construction types should be helpful.

While nonresponse bias estimates are not available for multifamily structures, we are able to look at response rates. While both certainties and non-certainties have similar unit response rates, the quantity response rate for certainties is lower, suggesting that we may want to distribute more resources to nonresponse follow-up for certainties.

These results can also feed into future work on imputation. Ideally imputation will eliminate almost all nonresponse error from our estimates, although this is an ideal that will never be achieved in reality. When conducting imputation research, the results from this study could be used as a baseline for measuring how well the imputes are doing.

Finally, VIP will be making use of the Account Manager Program, where analysts develop relationships with specific businesses in order to obtain better responses from those businesses. We hope to see response rates improve with this program, which should lead to some improvement in the nonresponse bias.

7. References

Construction Spending (VIP) Survey Website, https://www.census.gov/construction/c30/vip_csec_9798.html

Survey of Construction (SOC) Website, https://www.census.gov/econ/overview/co0400.html