Reliability of the Estimates

The statistics on the value of construction put in place result from direct measurement and indirect estimation. A series results from direct measurement when it is based on reports of the actual value of construction progress or construction expenditures obtained from a complete census or sample survey. All other series are developed by indirect estimation using related construction statistics.

On an annual basis, the estimates for series directly measured monthly, quarterly, or annually accounted for about 74 percent of total construction in 2015 (private new multi-family housing, private residential improvements, private nonresidential construction, regulated investor-owned utility construction, and virtually all of public construction). On a monthly basis, directly measured data are available for about 58 percent of the value-in-place estimates.

Some of the directly measured monthly construction value-in-place estimates are based on samples. Estimates from these samples may differ from statistics that would have been obtained from a complete census using the same schedules and procedures. An estimate based on a sample survey is subject to both sampling error and nonsampling error. The joint effects of these errors determine the accuracy of a survey result.

MEASURE OF SAMPLING ERRORS

Sampling error reflects the fact that only a particular sample was surveyed rather than the entire population. Each sample selected for the monthly value-in-place survey is one of a large number of similar probability samples that, by chance, might have been selected under the same specifications. Estimates derived from the different samples would differ from one another. The standard error, or sampling error, of a survey estimate is a measure of the variation among the estimates from all possible samples and, thus, is a measure of the precision with which an estimate from a particular sample approximates the average from all possible samples.

Estimates of the standard errors for the monthly, year-to-date and annual estimates were computed from the sample data for selected statistics in this report. The relative standard error equals the standard error divided by the estimated value to which it refers.

The sample estimate and an estimate of its standard error allow us to construct interval estimates with prescribed confidence that the interval includes the average result of all possible samples with the same size and design. A 90-percent confidence interval is defined to be from 1.645 standard errors below the estimate to 1.645 standard errors above the estimate. If all possible samples were selected and surveyed under essentially the same conditions and all the respective 90-percent confidence intervals were generated, then approximately nine-tenths of the intervals would include the average value of all sample estimates and approximately one-tenth would not include this estimate. For example, suppose the tables showed that the annual VIP estimate for ‘‘total private office construction” was $10.0 billion in a particular year. The relative standard error of this estimate is 2.0 percent. Multiplying $10.0 billion by .02, we obtain $200 million as the standard error. To obtain a 90-percent confidence interval, multiply $200 million by 1.645 and add and subtract the result from $10.0 billion, yielding limits of $9.67 billion and $10.33 billion. The average value of the monthly VIP estimate for ‘‘total private office construction’’ may or may not be contained in this computed interval, but one can say that the average is included in the constructed interval with a specified confidence of 90 percent. No standard errors are shown for farm construction or regulated investor-owned utility construction because the estimates are based on a complete enumeration.

NONSAMPLING ERRORS

As calculated for this report, the coefficient of variation estimates sampling variation, but does not measure all nonsampling error in the data. Nonsampling error consists of both a variance component and a bias component. Bias is the difference, averaged over all possible samples of the same size and

design, between the estimate and the true value being estimated. Nonsampling errors are usually attributed to many possible sources: (1) coverage error—failure to accurately represent all population units in the sample, (2) inability to obtain information about all sample cases, (3) response errors, possibly due to definitional difficulties or misreporting, (4) mistakes in recording or coding the data obtained, and (5) other errors of coverage, collection and nonresponse, response, processing, or imputing for missing or inconsistent data. These nonsampling errors also occur in complete censuses. Although no direct measures of these errors have been obtained, precautionary steps were taken in all phases of the collection, processing, and tabulation of the data to minimize their influence.

A major source of nonsampling error in the published estimates is due to the need to impute data for nonrespondents and for late and inconsistent reports. For preliminary value-in-place estimates, the 2015 average imputation rates for major components are as follows: private nonresidential construction, 52 percent; state and locally owned public construction, 17 percent; private new multi-family construction, 30 percent; private residential improvements, 3 percent; and federal construction, 23 percent. The average unit response rates for 2015 are as follows: private nonresidential construction, 42 percent; state and locally owned public construction, 81 percent; multi-family construction, 43 percent; residential improvements, 68 percent; and federal construction, 78 percent. Each of these rates is not an explicit indication of the potential error in statistics, but the degree of uncertainty regarding the accuracy of the statistics increases as the percentage of imputation increases or the percentage of responses decreases.

Other potential sources of bias are (1) the upward adjustment of 25 percent made to the private nonresidential construction; (2) upward adjustments made to the state and local owned public construction: highway construction is increased by a factor of 1.25, education construction is increased by a factor of 1.20, sewer and water constructions are increased by a factor of 1.24, power construction is increased by a factor of 5.85, housing and hotel constructions are increased by a factor of 2.51, transportation construction is increased by a factor of 1.53, and the others category is increased by a factor of 1.20; and (3) the adjustment of federal construction to agency totals in order to account for construction projects not included in their respective sampling frames. The adjustments for the nonresidential and state and local owned constructions result from coverage evaluation samples; hence, the estimated adjustments are subject to sampling errors and nonsampling errors associated with the evaluation studies. In addition, the adjustments were estimated from data collected during fixed time periods; therefore, they do not reflect any changes in the proportion of projects not included in the frames.

Consequently, even though the private nonresidential and state and local owned construction adjustments are designed to reduce the bias due to the failure to include projects in the sampling frames, for the above stated reasons, these adjustment procedures, themselves, may introduce a bias in the current estimates of value in place.

Furthermore, additional nonsampling errors may be introduced into the estimates because the procedures such as phasing, extrapolating, and forecasting used to develop the indirectly measured series are subject to the validity of the underlying assumptions made and mathematical models used. No explicit measures of the effects of these procedures are available.

Analysis of Revisions to Monthly Seasonally Adjusted Annual Rate Estimates

Type of Construction	Percent Changes between estimates - last 12 months					
	Preliminary versus second revision			First Revision versus second revision		
	Range			Range		
	From	To	Median	From	To	Median
Total Construction	-1.7	3.8	0.8	-2.4	2.5	0.2
Residential	-3.3	7.7	1.4	-4.9	7.6	0.8
Nonresidential	-1.5	3.8	-0.2	-0.9	1.4	-0.3
Lodging	-3.2	6.6	0.6	-3.2	2.8	0.3
Office	-1.5	4.3	0.8	-2.7	1.8	0.0
Commercial	-1.1	7.0	3.1	-1.3	3.4	-0.2
Health care	-3.9	5.1	-0.4	-3.2	2.4	-0.6
Educational	-3.3	5.9	0.8	-2.0	2.0	0.6
Religious	-4.5	10.0	0.1	-4.7	10.6	0.2
Public safety	-4.0	5.6	0.7	-2.3	2.9	0.4
Amusement and recreation	-3.5	2.9	-0.1	-2.2	1.4	-0.8
Transportation	-2.4	2.3	-0.8	-2.9	1.7	-0.1
Communication	-0.6	25.9	0.2	-0.3	6.2	0.1
Power	-3.0	4.3	0.6	-1.4	3.8	0.7
Highway and street	-9.9	5.0	-1.2	-2.7	3.2	0.3
Sewage and waste disposal	-4.7	7.3	0.3	-2.4	3.8	-1.3
Water supply	-5.9	4.7	-0.4	-1.8	3.5	0.4
Conservation and development	-11.4	10.6	0.2	-4.7	6.3	1.9
Manufacturing	-7.5	10.2	-2.4	-5.0	0.7	-1.4
Total Private Construction	-1.1	4.4	0.9	-2.9	3.6	0.2
Residential	-3.5	7.9	1.4	-5.0	7.8	0.8
Nonresidential	-1.9	4.9	0.1	-1.1	0.9	-0.5
Lodging	-3.2	6.8	1.7	-3.2	2.8	0.2
Office	-1.9	5.5	1.7	-3.1	2.1	0.4
Commercial	-1.1	6.9	2.5	-1.5	3.7	-0.3
Health Care	-4.3	6.7	-1.0	-2.8	3.4	-0.7
Educational	-5.7	12.1	0.2	-4.1	6.6	0.5
Religious	-4.5	10.0	0.1	-4.7	10.6	0.2
Amusement and Recreation	-6.2	4.7	-2.5	-4.0	1.9	-0.4
Transportation	-5.5	4.2	-2.6	-4.6	2.2	0.1
Communication	-0.6	26.4	0.3	-0.1	6.3	0.2
Power	-3.9	4.7	0.9	-1.3	2.2	0.6
Manufacturing	-7.6	10.3	-2.5	-5.0	0.7	-1.4
Total Public Construction	-3.5	3.0	0.9	-1.0	2.1	-0.1
Residential	-0.9	10.8	2.1	-1.5	8.2	0.6
Nonresidential	-3.6	3.1	0.9	-1.2	2.2	-0.2
Office	-4.9	1.4	-2.1	-4.0	1.7	-0.6
Commercial	-16.5	23.1	4.4	-3.3	20.1	2.2
Health care	-6.7	5.4	-0.3	-4.4	1.1	-1.0
Educational	-3.3	6.3	1.3	-1.4	2.3	0.7
Public safety	-3.5	5.3	0.6	-2.3	2.9	0.6
Amusement and recreation	-3.1	3.7	-0.6	-1.9	0.9	-0.3
Transportation	-2.0	3.8	0.2	-3.9	2.0	0.3
Power	-18.1	24.0	1.9	-10.2	18.0	0.7
Highway and street	-9.9	4.9	-1.3	-2.7	3.1	0.3
Sewage and waste disposal	-4.9	5.9	0.3	-2.6	3.8	-1.2
Water supply	-5.6	5.1	-0.6	-2.2	3.8	0.3
Conservation and development	-12.7	10.8	-0.5	-5.1	6.3	1.9

Analysis of Revisions to Monthly Seasonally Adjusted Annual Rate Estimates

Type of Construction	Percent Changes between estimates - last 12 months					
	Preliminary versus second revision			First Revision versus second revision		
	Range			Range		
	From	To	Median	From	To	Median
Total Private Construction	-1.1	4.4	0.9	-2.9	3.6	0.2
Residential (inc. Improvements)	-3.5	7.9	1.4	-5.0	7.8	0.8
New single family	-0.6	2.0	0.8	-0.2	0.7	0.2
New multi-family	-8.5	8.2	-0.4	-6.9	10.3	-0.7
Nonresidential	-1.9	4.9	0.1	-1.1	0.9	-0.5
Lodging	-3.2	6.8	1.7	-3.2	2.8	0.2
Office	-1.9	5.5	1.7	-3.1	2.1	0.4
General	-2.1	5.5	1.6	-3.1	2.0	0.3
Financial	-4.3	34.2	4.9	-4.6	14.2	0.4
Commercial (inc. Farm)	-1.1	6.9	2.5	-1.5	3.7	-0.3
Automotive	-4.6	8.8	4.3	-5.5	5.0	0.3
Sales	-4.5	25.7	-0.1	-7.4	5.2	-1.3
Service/parts	-10.9	27.1	4.2	-7.6	8.8	2.4
Parking	-17.2	40.8	-1.0	-10.5	29.7	-1.7
Food/beverage	-5.9	20.2	5.9	-1.2	2.7	0.1
Food	-10.3	14.5	1.7	-5.0	3.2	-0.1
Dining/drinking	-20.7	25.4	2.0	-7.3	12.4	-1.6
Multi-retail	-5.9	8.6	2.0	-4.4	6.5	0.0
General merchandise	-19.3	5.8	0.9	-9.8	1.7	-3.5
Shopping center	-4.4	8.1	1.8	-5.2	5.0	-0.4
Shopping mall	-16.0	22.9	2.1	-9.9	26.4	-1.9
Other commercial	-6.2	19.9	5.3	-2.9	5.0	-1.3
Drug store	-20.3	92.3	5.5	-13.9	48.5	-6.3
Building supply store	-6.9	18.8	6.0	-6.4	7.0	0.0
Other stores	-6.5	19.9	8.4	-3.0	7.1	2.1
Warehouse	-1.8	11.9	2.5	-3.7	6.0	-0.5
General commercial	-2.3	13.3	2.8	-4.0	7.2	-0.7
Mini-storage	-7.6	16.5	3.8	-7.3	4.5	-0.4
Health Care	-4.3	6.7	-1.0	-2.8	3.4	-0.7
Hospital	-5.6	5.5	-2.6	-3.6	3.9	-1.3
Medical building	1.0	13.8	7.4	0.0	7.4	2.8
Special care	-10.9	4.3	-0.9	-6.6	2.4	-1.4
Educational	-5.7	12.1	0.2	-4.1	6.6	0.5
Preschool	-20.5	45.0	11.1	-7.7	27.4	6.4
Primary/secondary	-5.4	28.3	4.1	-4.3	9.7	1.2
Higher education	-8.2	8.0	0.9	-5.3	6.1	-0.8
Instructional	-11.6	10.0	2.9	-7.7	7.6	-0.5
Dormitory	-5.2	12.1	1.5	-4.0	6.1	-1.0
Sports/recreation	-19.6	16.5	-1.3	-12.5	19.0	0.7
Other educational	-10.6	19.8	5.3	-8.0	18.1	-2.4
Gallery/museum	-14.4	29.9	4.7	-7.1	27.8	-2.9

Analysis of Revisions to Monthly Seasonally Adjusted Annual Rate Estimates

Type of Construction	Percent Changes between estimates - last 12 months					
	Preliminary versus second revision			First Revision versus second revision		
	Range			Range		
	From	To	Median	From	To	Median
Religious	-4.5	10.0	0.1	-4.7	10.6	0.2
House of worship	-5.3	11.3	2.0	-3.7	10.6	-0.1
Other religious	-13.9	15.1	-1.0	-10.6	10.7	-1.4
Auxiliary building	-6.8	11.6	-1.1	-3.2	10.4	-1.0
Amusement and Recreation	-6.2	4.7	-2.5	-4.0	1.9	-0.4
Theme/amusement park	-21.0	28.3	6.4	-6.1	15.6	0.6
Sports	-15.7	4.2	-3.4	-12.1	3.7	-1.7
Fitness	-15.3	20.8	3.9	-9.0	16.0	2.4
Performance/meeting center	-16.4	23.2	-8.4	-10.7	7.7	-3.6
Social center	-11.1	32.4	0.2	-6.8	15.2	-0.1
Movie theater/studio	-18.1	10.1	-0.7	-14.1	6.4	-4.1
Transportation	-5.5	4.2	-2.6	-4.6	2.2	0.1
Air	-14.3	29.1	0.5	-5.7	21.7	1.1
Land	-5.5	3.4	-3.0	-4.4	2.0	0.0
Communication	-0.6	26.4	0.3	-0.1	6.3	0.2
Power (inc. Gas and Oil)	-3.9	4.7	0.9	-1.3	2.2	0.6
Electric	-0.3	40.8	1.7	-0.6	3.2	1.0
Manufacturing	-7.6	10.3	-2.5	-5.0	0.7	-1.4
Food/beverage/tobacco	-3.4	13.6	2.9	-7.1	5.8	0.9
Chemical	-10.6	20.9	-4.8	-6.7	0.0	-1.9
Plastic/rubber	-10.4	5.5	-1.6	-7.4	8.3	-2.0
Nonmetallic mineral	-10.6	17.5	-5.3	-6.4	3.8	-2.4
Fabricated metal	-49.2	45.2	26.9	-8.4	22.0	6.2
Computer/electronic/electrical	-28.8	14.5	2.8	-21.2	7.0	0.2
Transportation equipment	-15.4	3.2	-1.4	-8.9	4.5	-2.5

Analysis of Revisions to Monthly Seasonally Adjusted Annual Rate Estimates

Type of Construction	Percent Changes between estimates - last 12 months					
	Preliminary versus second revision			First Revision versus second revision		
	Range			Range		
	From	To	Median	From	To	Median
Total State and Local Construction	-3.3	3.3	0.8	-1.2	2.3	-0.1
Residential	-0.6	12.2	2.7	-1.2	9.6	0.8
Multi-family	-2.6	15.0	1.2	-1.4	12.0	0.6
Nonresidential	-3.6	3.4	0.8	-1.2	2.4	-0.1
Office	-6.3	4.8	-2.8	-2.9	1.8	-0.6
Commercial	-21.8	43.4	4.8	-6.3	38.2	0.1
Automotive	-24.9	73.7	5.7	-13.4	54.5	-1.2
Parking	-25.5	83.4	7.9	-13.9	58.2	-1.4
Health Care	-7.5	10.9	-1.2	-3.9	0.5	-1.2
Hospital	-7.3	8.3	-2.9	-5.6	0.4	-2.1
Medical building	-15.6	34.6	7.6	-6.8	12.0	2.6
Special care	-11.6	13.6	-4.6	-16.9	5.8	-1.2
Educational	-3.3	6.5	1.3	-1.3	2.3	0.7
Primary/secondary	-4.6	7.2	2.0	-1.3	3.3	1.0
Elementary	-3.3	10.0	1.4	-1.3	5.2	1.5
Middle/junior high	-6.9	14.2	2.8	-5.1	6.9	1.0
High	-4.7	8.4	0.6	-2.7	4.6	0.8
Higher education	-5.2	9.8	0.4	-3.6	2.5	0.3
Instructional	-7.0	8.0	-0.1	-3.4	2.4	-1.2
Dormitory	-6.3	18.1	3.6	-4.8	14.8	-0.8
Sports/recreation	-8.8	6.7	-1.7	-5.2	3.7	-0.9
Infrastructure	-22.9	18.2	-9.4	-13.2	22.3	-5.7
Other educational	-9.0	21.5	8.6	-5.4	14.8	2.2
Library/archive	-7.5	26.8	9.6	-6.9	20.3	1.0
Public Safety	-3.2	9.1	2.5	-2.7	5.7	1.8
Correctional	-3.9	7.1	4.2	-1.9	9.3	1.9
Detention	-16.1	14.2	-2.5	-4.9	12.4	-0.4
Police/sheriff	-5.6	24.6	3.5	-2.3	12.8	2.9
Other public safety	-6.4	12.4	2.4	-4.2	6.5	0.7
Fire/rescue	-4.6	10.8	3.9	-4.9	6.0	1.1
Amusement and Recreation	-3.9	3.6	-0.4	-1.9	1.1	-0.7
Sports	-3.1	9.6	1.9	-4.8	3.6	1.1
Performance/meeting center	-19.7	15.0	-4.8	-5.5	6.9	-1.1
Convention center	-9.4	13.9	-3.2	-4.1	13.8	-0.9
Social center	-6.3	11.3	0.9	-6.3	7.2	0.0
Neighborhood center	-7.3	9.7	-0.2	-6.4	8.3	-0.6
Park/camp	-8.5	7.5	1.7	-5.1	2.1	-0.9
Transportation	-2.2	4.0	-0.1	-4.3	2.2	0.3
Air	-3.0	7.6	2.6	-3.4	2.3	0.3
Passenger terminal	-5.9	14.0	2.1	-4.2	4.5	0.3
Runway	-13.6	11.5	3.8	-3.0	3.5	-0.5
Land	-7.3	2.7	-2.9	-6.5	3.0	-0.6
Passenger terminal	-8.5	18.3	-0.2	-3.6	14.8	-0.3
Mass transit	-14.8	2.6	-4.4	-10.2	9.6	-1.0
Water	-2.8	20.6	5.6	-3.1	14.8	1.0
Dock/marina	-11.5	19.5	4.7	-4.9	8.2	1.4

Analysis of Revisions to Monthly Seasonally Adjusted Annual Rate Estimates

Type of Construction	Percent Changes between estimates - last 12 months					
	Preliminary versus second revision			First Revision versus second revision		
	Range			Range		
	From	To	Median	From	To	Median
Power	-19.8	24.2	1.9	-11.0	19.4	0.5
Highway and Street	-10.1	5.1	-1.2	-2.8	3.2	0.3
Pavement	-12.3	10.8	0.1	-2.4	6.6	-0.1
Lighting	-27.1	59.2	-9.6	-14.1	35.9	-1.8
Bridge	-6.0	2.9	-1.8	-2.8	2.4	-0.7
Rest facility	-26.6	13.0	-0.9	-25.0	14.5	-3.1
Sewage and Waste Disposal	-5.2	6.2	0.0	-2.8	4.0	-1.3
Sewage/dry waste	-2.8	6.7	0.6	-2.9	1.8	-1.0
Plant	-8.1	5.4	-1.5	-4.9	3.4	-0.6
Line/pump station	-4.5	9.3	1.3	-2.9	3.1	-1.4
Waste water	-9.4	11.8	-3.2	-4.5	7.1	-1.9
Plant	-8.2	4.9	-3.6	-3.4	1.0	-2.7
Line/drain	-13.1	31.9	2.3	-7.5	24.4	-1.3
Water Supply	-5.6	5.3	-0.6	-2.2	3.8	0.2
Plant	-9.1	9.5	-3.3	-3.8	9.2	-1.3
Line	-7.9	9.4	3.5	-3.8	4.5	1.5
Pump station	-17.8	18.0	-7.6	-11.6	4.5	-3.3
Conservation and Development	-7.6	14.7	-1.7	-4.7	7.4	-0.2
Dam/levee	-21.8	12.3	-3.1	-9.8	7.9	-3.6
Breakwater/jetty	-14.1	16.2	3.7	-3.5	27.7	0.4

Analysis of Revisions to Monthly Seasonally Adjusted Annual Rate Estimates

Type of Construction	Percent Changes between estimates - last 12 months					
	Preliminary versus second revision			First Revision versus second revision		
	Range			Range		
	From	To	Median	From	To	Median
Total Federal Construction	-9.3	3.4	0.2	-3.2	2.2	0.4
Residential	-15.0	10.6	1.8	-6.9	7.7	-0.1
Nonresidential	-9.3	3.4	-0.2	-3.1	2.2	0.2
Office	-18.4	5.6	-1.1	-7.5	4.1	-1.9
Commercial	-8.6	7.9	2.4	-3.0	4.7	2.0
Health care	-9.9	7.1	1.0	-5.8	6.3	-0.1
Educational	-14.2	11.2	-0.9	-4.8	5.2	-1.7
Public safety	-11.2	7.5	-3.1	-6.3	1.2	-2.2
Amusement and recreation	-21.6	11.0	1.8	-9.2	12.9	-0.2
Transportation	-2.7	8.9	2.1	-6.3	4.0	0.0
Power	-6.6	22.7	2.0	-4.3	9.7	3.1
Highway and street	-18.5	58.1	-4.5	-13.6	20.2	-3.8
Conservation and development	-16.6	8.5	2.2	-7.7	7.7	3.0