

Appendix C

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 70 percent of total construction in 2001 (private new multi-family housing, private residential improvements, private nonresidential construction, farm construction, regulated investor-owned utility construction, and virtually all of public construction). On a monthly basis, directly measured data are available for about 51 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 accuracy of a survey result is determined by the joint effects of these errors.

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. They are presented in the form of relative standard errors in Tables C-1 through C-5. 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 1.6 standard errors below the estimate to 1.6 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 \$100.0 billion in a particular year. According to Table C-1, the relative standard error of this estimate is 2.6 percent. Multiplying \$100.0 billion by .026, we obtain \$2.6 billion as the standard error. To obtain a 90-percent confidence interval, multiply \$2.6 billion by 1.6 and add and subtract the result from \$100.0 billion, yielding limits of \$95.8 billion and \$104.2 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 average imputation rates for major components are as follows: private nonresidential construction, 49 percent; state and locally owned public construction, 33 percent; private new multi-family construction, 42 percent; private residential improvements, 15 percent; and federal construction, 53 percent. Each of these imputation 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.

Other potential sources of bias are the upward adjustment of 26 percent made to the private nonresidential construction and the adjustment of the state and local owned public construction to the construction outlays from the Annual Survey of Government Finances and the adjustment of federal construction to agency totals in order to account for construction projects not included in their respective sampling frames. The adjustment for the nonresidential construction results from a coverage evaluation sample; hence, the estimated percentage adjustment is subject to sampling error and nonsampling errors associated with the evaluation study. In addition, the percentage was estimated from data collected during a limited time period; therefore, these adjustments do not reflect any recent changes in the proportion of projects not included in the frame.

For state and locally owned construction, construction outlays from the Survey of Government Finances are available only through Fiscal Year 1999. (Outlays are included if a government agency's fiscal year ending date falls within July 1998 to June 1999 inclusive. As a result, the adjustment to the construction outlay levels of this survey must be projected ahead for 4 years from 1999 through April 2003. The relationship between the state and locally owned value-in-place and the capital outlays estimate changes from year to year so that revisions of 4 to 5 percent are expected in state and local construction and substantially larger revisions can be expected in the individual types of construction. In addition, because of the definition of fiscal year for the Survey of Government Finances, the reported capital outlays do not correspond to any 12 month period but result from capital outlays made over a 26 month period. There are also definitional and timing differences between the concepts of capital outlays and value put in place.

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.

Table C-1. **Annual Relative Standard Errors by Detailed Types of Construction**
(Percent)

Type of Construction	Private	State and Local
Total Construction	0.9	1.0
Residential	1.7	4.3
New single family	2.3	(NA)
New multi-family	4.9	(NA)
Multi-family	(NA)	4.4
Improvements	4.7	(NA)
Lodging	3.4	(NA)
Office	2.6	4.4
General	2.8	(NA)
Financial	7.0	(NA)
Commercial	1.8	8.2
Automotive	5.8	8.2
Sales	12.1	(NA)
Service/parts	8.2	(NA)
Parking	12.4	8.2
Food/beverage	5.2	(NA)
Food	7.5	(NA)
Dining/drinking	9.0	(NA)
Fast food	14.1	(NA)
Multi-retail	3.9	(NA)
General merchandise	6.0	(NA)
Shopping center	5.5	(NA)
Shopping mall	9.8	(NA)
Other commercial	5.5	(NA)
Drug store	11.1	(NA)
Building supply store	7.3	(NA)
Other stores	8.7	(NA)
Warehouse	3.0	26.3
General commercial	3.2	(NA)
Mini-storage	11.9	(NA)
Farm	(NA)	(NA)
Health Care	3.0	4.5
Hospital	4.2	5.5
Medical building	6.8	10.0
Special care	7.1	15.0

Table C-1. **Annual Relative Standard Errors by Detailed Types of Construction**
(Percent)

Type of Construction	Private	State and Local
Educational	3.8	2.1
Preschool	16.1	(NA)
Primary/secondary	7.7	3.0
Elementary	(NA)	7.0
Middle/junior high	(NA)	8.4
High	(NA)	5.7
Higher education	5.4	4.8
Instructional	7.7	7.5
Parking	(NA)	20.8
Administration	(NA)	20.4
Dormitory	12.0	8.4
Library	(NA)	20.0
Student union/cafeteria	(NA)	14.9
Sports/recreation	15.4	6.8
Infrastructure	(NA)	12.2
Other educational	19.2	15.9
Library/archive	(NA)	22.5
Gallery/museum	19.2	(NA)
Religious	3.1	(NA)
House of worship	3.6	(NA)
Other religious	7.2	(NA)
Auxiliary building	11.2	(NA)
Public Safety	7.8	3.2
Correctional	(NA)	3.5
Detention	(NA)	4.2
Police/sheriff	(NA)	7.5
Other public safety	(NA)	9.2
Fire/rescue	(NA)	10.1
Amusement and Recreation	3.7	3.1
Theme/amusement park	15.1	(NA)
Sports	8.9	5.5
Fitness	10.9	(NA)
Performance/meeting center	11.0	3.7
Convention center	(NA)	3.7
Social center	9.1	8.0
Neighborhood center	(NA)	9.7
Park/camp	(NA)	8.6
Movie theater/studio	7.0	(NA)

Table C-1. **Annual Relative Standard Errors by Detailed Types of Construction**
(Percent)

Type of Construction	Private	State and Local
Transportation	5.3	2.3
Air	5.3	3.6
Passenger terminal	(NA)	4.9
Runway	(NA)	6.0
Land	11.1	2.8
Passenger terminal	(NA)	5.5
Mass transit	(NA)	2.8
Railroad	(NA)	7.5
Water	(NA)	11.9
Dock/marina	(NA)	13.2
Dry dock/marine terminal	(NA)	20.0
Railroad	(NA)	(NA)
Communications	(NA)	(NA)
Power	2.5	9.8
Electric	2.5	10.5
Distribution	(NA)	17.2
Gas	8.4	(NA)
Oil	(NA)	(NA)
Highway and Street	(NA)	2.1
Pavement	(NA)	2.8
Lighting	(NA)	21.8
Retaining wall	(NA)	37.1
Tunnel	(NA)	3.6
Bridge	(NA)	7.2
Toll/weigh	(NA)	23.7
Maintenance building	(NA)	15.5
Rest facility	(NA)	14.2
Sewage and Waste Disposal	16.2	2.9
Sewage/dry waste	(NA)	3.9
Plant	(NA)	6.1
Line/pump station	(NA)	6.4
Waste water	(NA)	5.7
Plant	(NA)	6.1
Line/drain	(NA)	14.2
Water Supply	19.1	3.0
Plant	(NA)	6.3
Well	(NA)	21.6
Line	(NA)	5.7
Pump station	(NA)	13.0
Reservoir	(NA)	14.8
Tank/tower	(NA)	15.5

Table C-1. **Annual Relative Standard Errors by Detailed Types of Construction**
(Percent)

Type of Construction	Private	State and Local
Conservation and Development	(NA)	8.8
Dam/levee	(NA)	15.5
Breakwater/jetty	(NA)	13.7
Dredging	(NA)	14.5
Manufacturing	2.4	(NA)
Food/beverage/tobacco	8.1	(NA)
Textile/apparel/leather & allied	11.1	(NA)
Wood	19.8	(NA)
Paper	10.3	(NA)
Print/publishing	19.3	(NA)
Petroleum/coal	19.2	(NA)
Chemical	8.8	(NA)
Plastic/rubber	4.5	(NA)
Nonmetallic mineral	7.7	(NA)
Primary metal	4.6	(NA)
Fabricated metal	8.0	(NA)
Machinery	11.4	(NA)
Computer/electronic/electrical	5.3	(NA)
Transportation equipment	8.4	(NA)
Furniture	13.4	(NA)
Miscellaneous	8.6	(NA)

Table C-2. **Standard Errors and Coefficients of Variance for Major Construction Types**

Type of Construction	Coefficient of variance (percent)		Standard error (percent)		
	Monthly estimate	Year-to-date estimate	Year-to-date change	Month-to-month change	Month-to-month change from prev. year
Total Construction	1.0	0.8	1.0	0.9	1.2
Residential	5.7	5.8	NA	4.7	NA
Lodging	4.7	2.5	NA	2.0	NA
Office	2.7	2.3	NA	1.8	NA
Commercial	2.8	2.5	NA	2.0	NA
Health care	3.0	2.6	NA	1.6	NA
Educational	2.5	2.0	NA	2.7	NA
Religious	4.2	3.9	NA	3.3	NA
Public safety	5.2	2.7	NA	3.2	NA
Amusement and recreation	3.2	2.9	NA	2.7	NA
Transportation	3.1	2.4	NA	2.5	NA
Communication	NA	NA	NA	NA	NA
Power	2.3	2.5	NA	0.9	NA
Highway and street	3.7	2.8	NA	5.1	NA
Sewage and waste disposal	4.4	3.9	NA	4.5	NA
Water supply	4.3	3.6	NA	5.9	NA
Conservation and development	7.1	4.6	NA	4.7	NA
Manufacturing	4.1	3.3	NA	2.1	NA
Total Private Construction	1.2	1.1	1.3	0.8	1.4
Residential	5.0	4.0	6.0	6.0	6.0
Lodging	4.9	2.6	3.2	2.0	4.0
Office	2.9	2.6	2.1	2.0	2.4
Commercial	2.9	2.7	3.0	1.9	3.3
Health care	3.5	3.0	4.9	2.0	4.9
Educational	4.0	3.8	5.5	4.3	7.0
Religious	4.2	3.9	5.3	3.3	5.2
Amusement and recreation	5.4	4.9	5.6	5.2	7.0
Transportation	5.9	6.4	6.3	4.3	7.7
Communication	NA	NA	NA	NA	NA
Power	1.5	2.5	4.4	0.8	2.8
Manufacturing	4.1	3.3	2.1	2.1	2.1
Total Public Construction	1.5	1.1	1.8	1.6	2.3
Residential	5.9	5.8	NA	4.7	NA
Office	7.2	4.0	NA	4.7	NA
Commercial	14.5	10.6	NA	17.8	NA
Health care	4.6	4.1	NA	2.9	NA
Educational	2.9	2.4	NA	3.2	NA
Public safety	5.3	2.7	NA	3.3	NA
Amusement and recreation	3.8	3.4	NA	2.9	NA
Transportation	3.5	2.6	NA	2.8	NA
Power	18.2	8.0	NA	7.7	NA
Highway and street	3.7	2.8	NA	5.1	NA
Sewage and waste disposal	4.5	4.0	NA	4.6	NA
Water supply	4.5	3.7	NA	5.7	NA
Conservation and development	7.4	4.6	NA	4.7	NA
Manufacturing	30.0	41.3	NA	9.6	NA

NA Not applicable

Table C-3. Standard Errors and Coefficients of Variance for Private Construction

Type of Construction	Coefficient of variance (percent)		Standard error (percent)		
	Monthly estimate	Year-to-date estimate	Year-to-date change	Month-to-month change	Month-to-month change from prev. year
Total Private Construction	1.2	1.1	1.3	0.8	1.4
Residential (inc. Improvements)	5.0	4.0	6.0	6.0	6.0
New single family	5.0	4.0	6.0	6.0	6.0
New multi-family	7.9	7.0	6.0	6.0	12.0
Lodging	4.9	2.6	3.2	2.0	4.0
Office	2.9	2.6	2.1	2.0	2.4
General	3.0	2.9	2.2	2.0	2.5
Financial	12.4	10.4	12.8	8.8	12.0
Commercial (inc. Farm)	2.9	2.7	3.0	1.9	3.3
Automotive	10.0	9.3	10.7	5.6	13.7
Sales	17.1	11.7	23.3	6.4	23.2
Service/parts	17.5	18.6	15.7	14.3	21.5
Parking	14.2	11.8	10.7	5.6	14.5
Food/beverage	9.3	6.6	8.7	7.4	8.3
Food	12.1	9.0	13.1	7.4	14.8
Dining/drinking	17.3	12.9	15.9	14.7	11.0
Multi-retail	5.0	4.4	5.9	3.2	6.9
General merchandise	6.9	4.9	6.3	4.8	7.4
Shopping center	7.6	7.2	7.4	6.1	10.0
Shopping mall	11.2	8.7	17.6	6.2	18.3
Other commercial	8.1	9.3	9.4	4.1	8.8
Drug store	20.7	15.2	23.3	11.5	25.2
Building supply store	8.3	9.6	10.1	6.3	11.8
Other stores	13.6	14.4	14.5	5.2	13.1
Warehouse	4.8	3.6	3.8	2.9	4.0
General commercial	5.1	3.9	4.0	3.1	4.2
Mini-storage	14.8	11.9	14.4	11.9	16.0
Health Care	3.5	3.0	4.9	2.0	4.9
Hospital	4.4	3.4	5.8	2.2	6.7
Medical building	9.7	7.2	10.7	4.1	9.8
Special care	10.2	9.6	11.4	6.1	11.7
Educational	4.0	3.8	5.5	4.3	7.0
Preschool	23.1	21.1	17.1	11.3	13.4
Primary/secondary	9.2	9.4	13.4	5.7	12.5
Higher education	5.0	5.2	7.6	6.5	11.7
Instructional	6.3	7.6	9.7	10.9	19.3
Dormitory	11.7	12.4	14.7	9.0	15.9
Sports/recreation	15.4	13.2	26.3	8.5	31.5
Other educational	13.8	12.4	16.9	12.3	20.2
Gallery/museum	13.8	14.5	22.8	18.4	28.8
Religious	4.2	3.9	5.3	3.3	5.2
House of worship	5.2	5.0	6.6	4.1	6.2
Other religious	8.9	7.7	8.9	7.0	10.3
Auxiliary building	12.2	9.9	14.8	8.3	16.6

Table C-3. Standard Errors and Coefficients of Variance for Private Construction

Type of Construction	Coefficient of variance (percent)		Standard error (percent)		
	Monthly estimate	Year-to-date estimate	Year-to-date change	Month-to-month change	Month-to-month change from prev. year
Amusement and Recreation	5.4	4.9	5.6	5.2	7.0
Theme/amusement park	30.8	49.3	22.2	11.9	17.9
Sports	7.7	5.1	17.1	5.2	21.0
Fitness	13.7	12.6	19.9	12.6	20.4
Performance/meeting center	11.6	7.4	15.7	5.2	21.4
Social center	11.8	12.4	13.2	14.6	17.2
Movie theater/studio	13.0	13.7	8.5	17.5	7.0
Transportation	5.9	6.4	6.3	4.3	7.7
Air	5.9	6.4	6.3	4.3	7.7
Land	10.1	14.1	46.2	11.3	60.4
Communication	NA	NA	NA	NA	NA
Power (inc. Gas and Oil)	1.5	2.5	4.4	0.8	2.8
Electric	1.7	2.8	4.5	0.9	2.9
Manufacturing	4.1	3.3	2.1	2.1	2.1
Food/beverage/tobacco	12.8	9.7	6.3	6.8	6.3
Chemical	9.2	5.1	9.2	4.3	8.5
Plastic/rubber	5.7	4.9	2.6	4.9	2.6
Nonmetallic mineral	10.2	8.4	2.1	12.3	2.2
Fabricated metal	12.4	12.0	8.5	6.8	10.0
Computer/electronic/electrical	6.1	4.8	2.4	2.3	2.6
Transportation equipment	8.7	11.3	7.7	3.8	7.5

Table C-4. Standard Errors and Coefficients of Variance for State and Local Construction

Type of Construction	Coefficient of variance (percent)		Standard error (percent)		
	Monthly estimate	Year-to-date estimate	Year-to-date change	Month-to-month change	Month-to-month change from prev. year
Total State and Local Construction	1.6	1.2	2.0	1.7	2.4
Residential	6.7	6.7	9.2	7.5	10.5
Multi-family	6.7	6.8	9.3	7.6	10.7
Office	8.4	5.2	7.1	5.8	7.7
Commercial	16.7	13.2	14.3	22.7	20.1
Automotive	16.7	13.2	14.3	27.5	24.1
Parking	16.7	13.2	14.3	27.5	24.4
Health Care	5.1	4.6	8.3	3.5	8.3
Hospital	6.1	5.6	10.7	3.7	10.3
Medical building	13.1	11.3	15.7	11.5	21.7
Special care	16.3	14.0	26.7	9.3	26.3
Educational	2.9	2.5	4.2	3.3	5.0
Primary/secondary	3.8	3.2	5.5	4.1	6.4
Elementary	8.0	6.6	11.9	6.8	13.9
Middle/junior high	9.9	10.4	16.4	14.2	15.9
High	5.5	4.9	7.8	4.1	9.3
Higher education	6.3	5.4	7.3	4.5	8.9
Instructional	8.7	7.3	10.6	7.2	12.2
Dormitory	11.8	17.0	22.3	7.2	33.2
Sports/recreation	14.8	5.4	7.3	4.5	8.9
Infrastructure	19.8	17.2	13.5	18.0	14.3
Other educational	16.8	17.7	41.7	16.5	37.0
Library/archive	19.5	21.0	54.3	20.6	49.9
Public Safety	5.9	3.2	6.1	3.7	8.4
Correctional	6.9	3.7	6.6	3.7	8.7
Detention	8.7	4.5	6.7	4.1	8.7
Police/sheriff	8.4	8.2	19.6	6.7	21.5
Other public safety	11.7	9.9	17.7	11.5	17.0
Fire/rescue	12.7	10.9	17.7	12.6	17.9
Amusement and Recreation	3.8	3.5	4.6	2.9	5.1
Sports	7.8	6.7	7.9	5.6	8.7
Performance/meeting center	3.8	3.5	5.8	2.9	5.1
Convention center	3.8	3.5	5.8	2.9	5.1
Social center	9.4	8.9	13.1	7.5	15.0
Neighborhood center	11.2	10.4	13.2	11.2	16.3
Park/camp	11.6	10.5	13.8	10.4	13.5
Transportation	3.6	2.8	5.7	3.0	5.6
Air	5.3	3.2	6.4	4.5	6.7
Passenger terminal	5.3	4.5	6.4	4.0	6.8
Runway	9.0	5.5	11.6	9.7	11.8
Land	3.6	3.2	5.7	3.0	5.6
Passenger terminal	6.2	4.6	7.8	4.5	12.9
Mass transit	3.6	5.3	9.3	3.0	9.6
Water	18.0	15.1	44.2	10.3	46.3
Dock/marina	18.1	15.1	44.2	10.3	59.0

Table C-4. Standard Errors and Coefficients of Variance for State and Local Construction

Type of Construction	Coefficient of variance (percent)		Standard error (percent)		
	Monthly estimate	Year-to-date estimate	Year-to-date change	Month-to-month change	Month-to-month change from prev. year
Power	20.2	8.9	5.0	6.1	7.6
Highway and Street	3.8	2.8	4.6	5.2	5.6
Pavement	4.9	3.5	5.7	7.5	6.9
Lighting	34.1	22.4	33.4	33.3	42.6
Bridge	8.2	5.9	8.6	8.1	9.4
Rest facility	15.7	17.2	24.7	18.3	26.7
Sewage and Waste Disposal	4.3	3.6	5.6	4.8	6.0
Sewage/dry waste	5.6	4.7	6.6	6.2	8.0
Plant	7.8	6.6	9.7	8.8	11.3
Line/pump station	7.6	6.6	9.4	7.6	11.1
Waste water	7.9	7.2	10.3	6.0	9.4
Plant	8.8	8.3	12.9	6.7	12.8
Line/drain	18.9	16.9	12.9	10.3	10.1
Water Supply	4.5	3.8	5.3	5.9	6.7
Plant	6.9	5.3	6.5	5.9	8.2
Line	8.8	7.5	8.6	13.8	10.6
Pump station	19.0	15.8	25.4	23.0	30.1
Conservation and Development	12.0	10.7	14.3	9.8	13.2
Dam/levee	18.4	26.3	29.0	14.0	31.5
Breakwater/jetty	18.7	12.5	27.6	13.0	21.1

Table C-5. Standard Errors and Coefficients of Variance for Federal Construction

Type of Construction	Coefficient of variance (percent)		Standard error (percent)		
	Monthly estimate	Year-to-date estimate	Year-to-date change	Month-to-month change	Month-to-month change from prev. year
Total Federal Construction	3.0	3.1	3.4	2.1	3.8
Residential	10.1	10.2	NA	4.3	NA
Office	3.0	3.2	NA	4.4	NA
Commercial	11.8	13.2	NA	16.9	NA
Health care	7.1	8.8	NA	3.6	NA
Educational	7.1	5.8	NA	6.6	NA
Public safety	4.8	3.9	NA	4.2	NA
Amusement and recreation	14.7	11.5	NA	18.0	NA
Transportation	5.0	5.2	NA	4.0	NA
Power	13.7	16.6	NA	24.1	NA
Highway and street	12.9	13.8	NA	21.0	NA
Conservation and development	3.0	3.1	NA	2.1	NA
Manufacturing	26.9	16.9	NA	6.9	NA