The Revisions to GDP, GDI, and Their Major Components

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THE NATIONAL income and product accounts (NIPAs) provide a timely, comprehensive, and accurate picture of the condition of the U.S. economy. The two featured measures, gross domestic product (GDP) and gross domestic income (GDI), are measures of the same concept of total activity in the U.S. economy. GDP measures activity as the sum of all final expenditures in the economy; it is detailed on the product side of the domestic income and product account. GDI measures activity as the sum of all incomes generated in production; it is detailed on the income side of the account. By design, the flows of final expenditures and incomes generated are equal. Thus GDP and GDI give the same measure of economic activity, but in practice, they differ because each is estimated from largely different source data. The difference between GDP and GDI is allocated to the income side of the domestic income and product account and is known as the statistical discrepancy.

Measuring the accuracy of national account estimates is challenging because it is impossible to know the true values of the estimates. This measurement challenge is long standing and derives from three principal facts about the compilation of the estimates. First, the earliest GDP and GDI estimates are based on partial and preliminary data and on trend projections when data are not available. Second, the source data for the early estimates in the NIPAs come from a mixture of survey, tax, and other business and administrative data as well as various indicators, such as heating degree days; these data are subject to a mix of sampling and nonsampling errors and biases that cannot be assessed. Third, the NIPAs are regularly revised to reflect changes in the economic concepts and methods necessary for the accounts to provide an accurate picture of

the evolving U.S. economy.[1] For example, in the 2013 comprehensive revision of the NIPAs, a new category of investment, "intellectual property products," was formed; it consists of research and development; entertainment, literary, and artistic originals; and software. In addition, seasonal adjustment factors were updated to reflect changing seasonal patterns.

Given the measurement challenges, accuracy cannot be assessed by conventional statistical measures, such as standard errors. Instead, the Bureau of Economic Analysis (BEA) focuses on the reliability of the estimates, which can be assessed by examining the sizes and patterns of revisions to estimates (see the box "Accuracy, Reliability, and Uncertainty"). Because the revisions are repeated estimations of the economic activity in a period, their pattern and magnitude provide a measure of the reliability of the estimates. Some revisions are due to the replacements of early extrapolations for missing source data or preliminary survey data or the replacement of indirect indicators with revised and more complete data, such as annual data and census data. However, some of the revisions are the result of updates to the concepts on which the accounts are based. The revisions to concepts and definitions can be substantial. In the 2013 comprehensive revision, the dollar level of GDP was revised up an average of 3.1 percent in 1993–2012, mainly because of the recognition of research and development and the creation of artistic and literary originals as investment.

BEA's principal standard of reliability is based on the revisions from its early estimates to its "latest" estimates, most of which have been through at least one comprehensive revision (see the box "Vintages and Timing of Revisions" for a detailed revision schedule).

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1. For example, the accounts contain no entry for business investment in computer software before 1959; the amount of software prior to that year was negligible. But by 2012, business investment in software was 1.7 percent of the size of GDP; the level and rates of growth of the economy were raised when software investment was first included in the accounts in the late 1990s.

Because the latest vintage incorporates the most recent comprehensive revision, it incorporates all the available source data that are believed to be the most reliable.

According to the results in the following sections, both the pattern and the magnitude of the revisions in-dicate that the early estimates are reliable. That is, the revisions do not substantively change BEA's measures of long-term growth, the picture of business cycles, and the trends in major components of GDP and GDI. In short, the early estimates provide a consistent and reliable picture of general economic activity. Given the

Accuracy, Reliability, and Uncertainty

The estimates of gross domestic product (GDP) that the Bureau of Economic Analysis (BEA) releases are used not only by policymakers to set public policy, but they are also used by the private sector and households in their financial and production planning. Given the important role that GDP estimates play in the economy, an obvious question is: "How accurate are the GDP estimates?" From a statistical perspective, when one speaks of the accuracy of an estimate, one is usually referring to the difference between the estimate and some "true" value. For example, the difference between a sample mean and a popula-tion mean that is taken as the true value. For survey-based data that have such means, various statistical meth-ods can be used to assess the differences, such as the con-struction of confidence intervals around the sample mean. Because GDP is constructed from survey, nonsur-vey, and administrative data, its "true" value can never be observed, so its accuracy cannot be assessed. Therefore, the concept of reliability is used.

Reliability concerns the repeated estimation of an event. Over time, BEA acquires more and better informa-tion about GDP and is therefore able to revise its estimate of GDP; each revision is believed to be a better estimate of the true value of GDP. The subsequent revised esti-mates can be viewed as repeated estimates of the aggre-gate economic activity for that quarter. By assessing the performance of these revised estimates, BEA can assess the reliability of estimates.

The reliability of the GDP estimates is assessed by studying the revision patterns, seeking to answer the questions: how similar are the repeated estimates of GDP for a given quarter, and do they tell the same story? Quantitatively, reliability is assessed by measuring the revision magnitudes and the corresponding means and standard deviations. Qualitatively, it can be assessed by looking at such measures as the frequency of directional changes in the estimates.

The fact that BEA provides a sequence over time of estimates for a given quarter—referred to as vintage esti-mates—implies that users of the data should understand that there is some uncertainty surrounding any estimate at a point in time. To assess that uncertainty, standard statistical measures of mean and standard deviations of revisions can be calculated (see appendix tables A and B), and this information can be used to construct confidence intervals for any estimate. For example, consider the mean difference between the advance estimate and the second quarterly estimate of real GDP for the 1993–2015 period. Appendix table B shows that the mean difference between these two estimates is 0.06 percentage point. Using the standard deviation of the revision between the advance and second estimates (available in appendix table A), 0.79 percentage points, and assuming a normal distribution, one can construct a 90 percent confidence interval for this particular mean revision as:

$$\bar{x} \pm z_{\alpha/2} s = 0.06 \pm 1.465 \times 0.79 = 0.06 \pm 1.30$$

where $\bar{x}$ is the mean revision, $z_{\alpha/2}$ is the standard normal distribution critical value for a 90 percent confidence interval ($\alpha = 0.1$), and s is the standard deviation.

Using a 90 percent confidence criterion, the revision between the advance and second estimates falls between –1.24 percentage points and 1.36 percentage points. This is an expression of uncertainty regarding the advance estimates, and with this information, one can estimate a range for the second estimate given the advance estimate. For example, the advance estimate for the first quarter of 2016 was 0.54 percent at an annual rate. Using the above formula, one could say that with 90 percent confidence, the second estimate would be between –0.7 percent and 1.90 percent. In fact, the second estimate was 0.84 per-cent.

Given the uncertainty about the GDP estimate, one may ask why BEA produces point estimates instead of interval estimates, such as above. In his review of the then new estimates of national income, Kuznets (1948) remarked "The very fact that the estimates are cast in the form of unique series and not of ranges, is itself an invita-tion to treat them as firm results and tend to discourage questioning whether a total of x billion might just as well read $x + a$ or $x - a$." Recently some academic scholars have criticized the practice of providing point estimates (see Manski 2015). Although interval estimates would inform users of the uncertainty surrounding the esti-mates, most users prefer point estimates, so they are fea-tured. However, as illustrated above BEA provides the information that enables interested users to construct their own interval estimate.

general accuracy of the early estimates, policymakers should be able to rely on these estimates as accurate measures of economic activity.

Chart 1 provides an illustration of this point by plotting advance estimates of real GDP growth over 23 years, 1993 to 2015, against the latest estimates. The graph shows that, with few exceptions (such as the Great Recession period), the overall pattern of movement in GDP is little changed by revisions. A similar picture emerges for the third estimate of GDI versus the latest estimates (chart 2).

More specifically, BEA judges the qualitative reliability of its early estimates by whether they present the same general picture of economic activity as the latest estimates in terms of the following:
- Long-term growth rates
- Trends in saving, investment, government spending, corporate profits, and other key components of GDP and GDI
- Broad features of the business cycle, including the timing and depth of recessions, the strength of recoveries, and the major components contributing

Chart 1. Percent Change in Real Gross Domestic Product, 1993–2015

U.S. Bureau of Economic Analysis
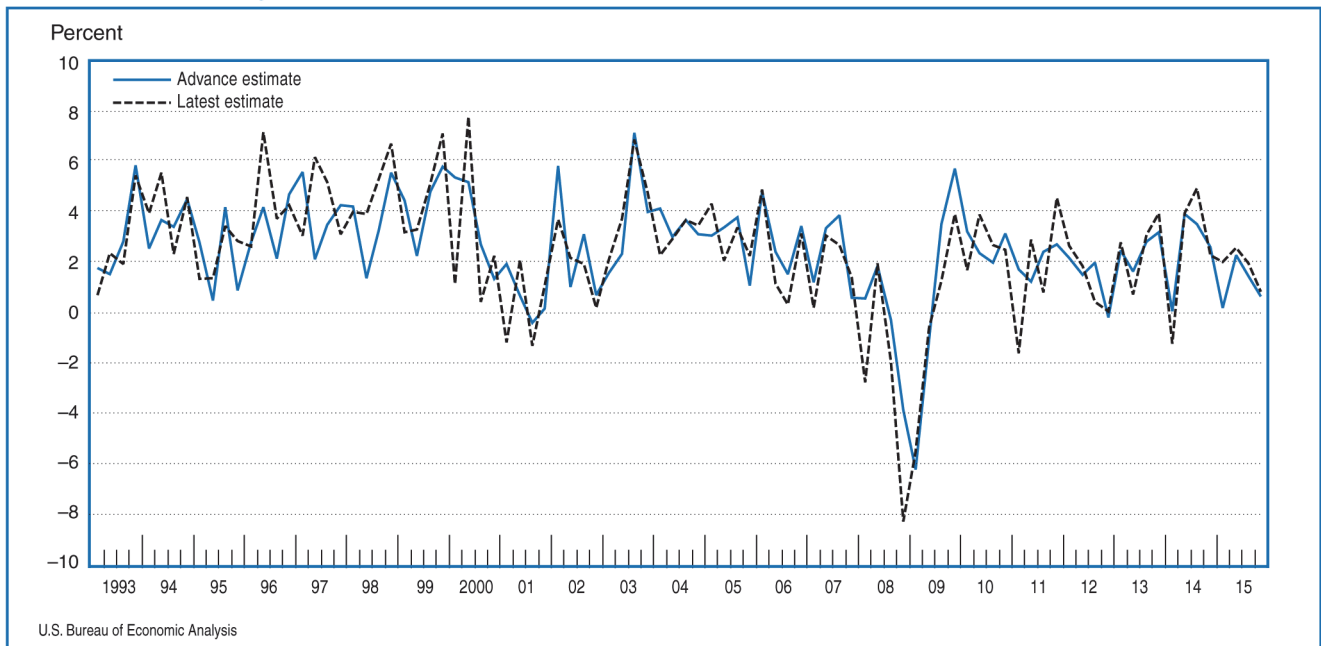
Chart 2. Percent Change in Gross Domestic Income, 1993–2015

U.S. Bureau of Economic Analysis
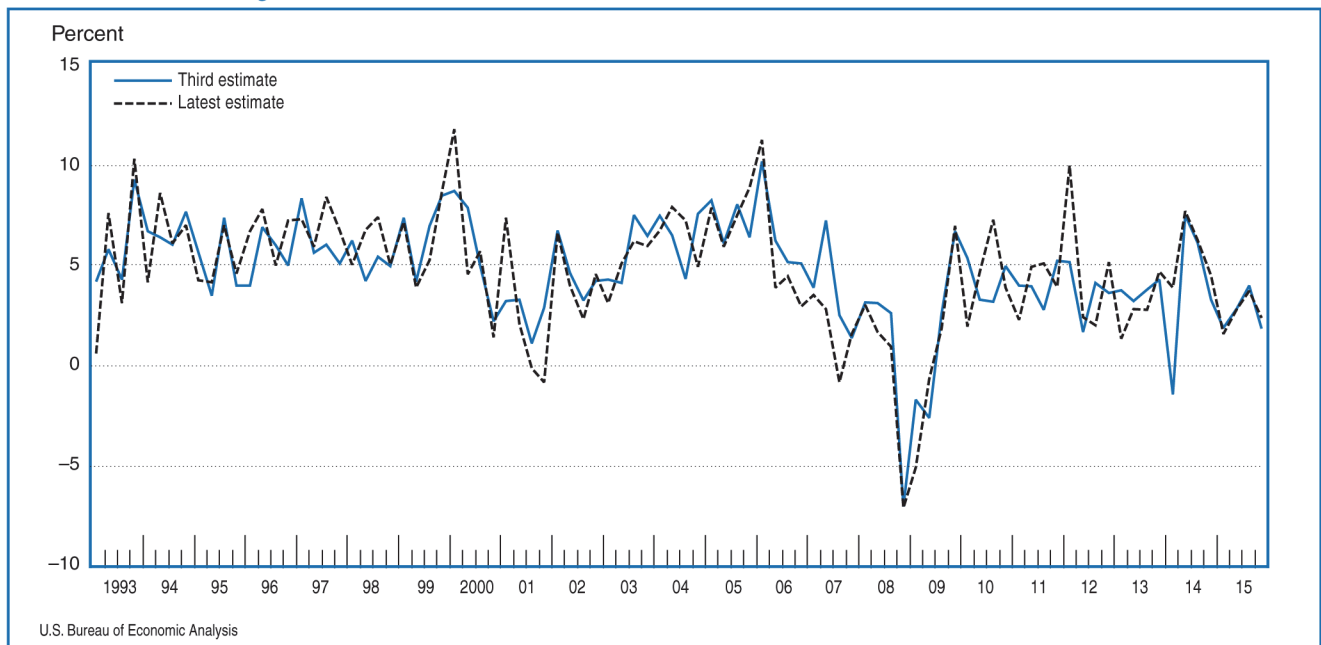
to growth and contractions

- The patterns of quarterly growth, including whether growth in any particular period is high or low relative to trend, is accelerating or decelerating, or is positive or negative

For information about the qualitative measures of reliability of the three vintages of the current quarterly estimates, see "Summary and Conclusions."

Quantitatively, revisions are measured as the changes from an earlier vintage of a given estimate to a later vintage of that estimate, for example from the advance estimate to the latest estimate. There are three early vintages of "current quarterly" estimates of GDP—the advance estimates (released roughly a month after the quarter ends), the second estimates (released roughly 2 months after the quarter ends), and the third estimates (released roughly 3 months after the quarter ends). Each estimate is produced using a wide mix of source data—preliminary survey results, such as the Census Bureau's Survey of Retail Sales and Services, and manufacturers' shipments, various indicators, trade industry data and more—that are later revised to reflect more complete information or to replace trend projections.

The mean absolute revisions (MARs) to the annual rates of change of both current-dollar and real GDP—the average of the revisions without regard to sign from the current quarterly estimates to the latest estimates—range from 1.21 percentage points to 1.31 percentage points for 1993–2015 (table 1). (See the box "Mean Revisions, Mean Absolute Revisions, and Standard Deviations"). The mean revisions (MRs)—the average allowing both positive and negative values for the revisions—range between –0.15 percentage point and 0.14 percentage point (table 1). The MRs indicate whether the revisions are generally positive or negative. Because revisions may be offsetting, the MRs are much smaller than the MARs. The MARs among the current quarterly estimates are smaller than the MARs from the current quarterly estimates to the latest estimates. For example, the MAR from the advance estimates to the second estimates of real GDP is 0.57 percentage point, the MAR from the advance estimates to the third estimates is 0.65 percentage point, and the MAR from the second estimates to the third estimates is 0.25 percentage point (table 3).

Vintages and Timing of Revisions

The Bureau of Economic Analysis prepares quarterly and annual estimates of gross domestic product (GDP) and gross domestic income (GDI). It prepares three current quarterly vintages of GDP estimates—advance, second, and third estimates. The advance estimates for a quarter are released about a month after the quarter ends. The second estimates for the quarter are released about 2 months after the quarter ends. And the third estimates are released about 3 months after the quarter ends. In addition, as part of the annual revision of the national income and product accounts (NIPAs) that are released in late July of each year, the quarterly estimates for the 3 preceding years—and possibly more—are revised.

For GDI, the timing of its quarterly releases differs from GDP due to data availability. GDI incorporates information from the quarterly census of employment and wages. Three current quarterly vintages are prepared – second, third, and fourth estimates. The vintages are named as such to match the GDP vintage timing. The initial release of GDI estimates (second estimates) comes out at the same time as the second estimates of GDP for any given quarter. The next release of GDI estimates (third estimates) comes out when the third estimates of GDP become available. The last release of GDI estimates (fourth estimates) comes out about two months after the third estimates of GDP are released. Note that due to lack of data, for each fourth quarter, the second estimates are not prepared. These revised estimates for GDI are available beginning with the estimates for the first quarter of 2002.

BEA prepares four vintages of annual estimates—early annual, first annual, second annual, and third annual estimates. For GDP and GDI, the early estimates are the sum of the third quarterly estimates for that year. The early annual estimates of GDP are released in March along with the third estimates for the fourth quarter of that year. The early annual estimates of GDI are released with the release of the fourth estimates for the fourth quarter of the year in late May. The current annual estimates for the 3 preceding years are revised as part of the annual NIPA revision. After the third annual revision of the estimates for a year is released, these estimates are generally not revised or released again until the next comprehensive revision. Occasionally, however, revisions extend further back in time.

Annual NIPA revision estimates are superseded by comprehensive NIPA revisions, which occur about every 5 years. These revisions incorporate changes in definitions, in classifications, and in statistical methodology. The most recent comprehensive revision was released in late July 2013 and an analysis of the comprehensive revision can be found in the August 2014 SURVEY OF CURRENT BUSINESS. It presented revised annual estimates for 1929–2012 and revised quarterly estimates for 1947–2012. The next comprehensive revision is scheduled to be July 2018. Note that the "latest available" estimates referred to in this study are from the comprehensive revision estimates of 2013 up to the fourth quarter of 2010. Beyond that, the "latest available" estimates are the most recent annual revision or the most recent current quarterly estimate.

The MR for real GDP from the advance estimates to the latest estimates is just –0.07 percentage point; it is not statistically different than zero (table 1). Much of the MR to the latest estimates is the result of revisions from comprehensive revisions. The MRs from the second and third estimates to the latest estimates are –0.13 percentage points and –0.15 percentage points, respectively (table 1). To put these MRs into context for 1993–2015, the mean growth of real GDP (latest estimates) over this period was 2.50 percent, and the growth rates ranged from –8.19 percent to 7.77 percent.

The remainder of this article discusses (1) revisions to quarterly estimates of GDP and its components, (2) revisions to annual estimates of GDP and its components, (3) revisions to quarterly estimates of GDI and its components, (4) revisions to annual estimates of GDI and its components, and (5) the revisions to the weighted average of GDP and GDI. These sections are followed by a summary and conclusions.

Revisions to Quarterly Estimates of GDP

Mean absolute revisions

Table 1 presents revisions for real and current-dollar GDP and their components. For all three current quarterly vintages for 1993–2015, the MARs for both current-dollar GDP and real GDP are somewhat larger than 1.20 percentage points. The MARs for current-dollar GDP are slightly larger than the MARs for real GDP for all current quarterly vintages except for the third vintage. For current-dollar measures, the MARs decline slightly but steadily from the advance to the third estimates, while for real measures, the MARs increase slightly from the advance to the third estimates.[2] The decline in MARs with successive vintages is expected, as BEA receives and incorporates more and better source data with each vintage.

The MARs for current-dollar personal consumption expenditures (PCE) are about 0.30 percentage point smaller than those for the corresponding vintages of current-dollar GDP; the MARs are 0.98 percentage point for the advance estimate, 0.89 percentage point for the second estimate and 0.86 percentage point for the third estimate. The MARs for real PCE are slightly smaller—0.96 percentage point, 0.86 percentage point, and 0.82 percentage point for the advance, second, and third vintages, respectively. MARs for both current-

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2. This is somewhat different from the results in the last BEA revision study, which was published in 2014 (see Fixler, Greenaway-McGreevey, and Grimm 2014). It found that MARs decrease with successive estimates for both current-dollar and real GDP.

Table 1. Revisions and Standard Deviation of Revisions, Early Vintages to the Latest Estimates, Changes in Gross Domestic Product and Its Major Components, 1993–2015

[Percentage points]

	Mean absolute revision		Mean revision		Standard deviation	
	Current-dollar	Real	Current-dollar	Real	Current-dollar	Real
Gross domestic product						
Advance	1.31	1.21	0.14	–0.07	1.63	1.54
Second	1.25	1.23	–0.02	–0.13	1.54	1.53
Third	1.23	1.24	–0.08	–0.15	1.54	1.51
Personal consumption expenditures						
Advance	0.98	0.96	–0.06	–0.11	1.24	1.18
Second	0.89	0.86	–0.09	–0.13	1.13	1.06
Third	0.86	0.82	–0.11	–0.12	1.12	1.04
Durable goods						
Advance	3.93	4.10	–0.28	–0.27	5.07	5.23
Second	3.96	4.12	–0.19	–0.16	4.95	5.10
Third	3.89	4.12	–0.27	–0.33	4.88	5.17
Nondurable goods						
Advance	1.98	1.63	–0.19	0.00	2.57	2.22
Second	1.85	1.56	–0.33	–0.04	2.35	2.17
Third	1.87	1.51	–0.35	–0.12	2.42	2.13
Services						
Advance	0.94	0.89	–0.05	–0.17	1.23	1.11
Second	0.89	0.86	–0.05	–0.22	1.19	1.12
Third	0.78	0.76	–0.07	–0.16	1.05	1.00
Gross private domestic investment						
Advance	5.06	4.99	0.60	–0.35	6.53	6.67
Second	5.67	5.76	–0.17	–0.78	6.89	7.02
Third	5.56	5.63	–0.28	–0.83	6.70	6.81
Fixed investment						
Advance	2.81	2.94	0.78	0.04	3.68	3.81
Second	2.75	2.95	0.06	–0.56	3.61	3.71
Third	2.75	2.99	–0.21	–0.77	3.55	3.64
Nonresidential						
Advance	3.43	3.59	0.44	–0.24	4.44	4.56
Second	3.60	3.80	–0.35	–0.93	4.49	4.59
Third	3.59	3.80	–0.56	–1.12	4.46	4.51
Structures						
Advance	7.59	6.96	2.59	1.43	10.03	9.26
Second	7.22	6.96	1.34	0.29	9.96	9.58
Third	7.20	6.48	0.79	0.19	9.90	8.74
Equipment and intellectual property products						
Advance	3.77	4.85	–0.20	–0.20	4.70	6.17
Second	4.15	5.07	–0.89	–0.88	5.05	6.35
Third	4.02	5.15	–1.01	–0.98	4.97	6.38
Residential						
Advance	4.33	4.15	1.43	0.58	5.12	5.16
Second	3.85	3.77	0.90	0.29	4.63	4.74
Third	3.61	3.54	0.51	0.03	4.52	4.54
Change in private inventories[1]	....	....	....	....	....	....
Net exports of goods and services[1]						
Exports						
Advance	3.86	3.53	1.32	1.09	5.09	4.68
Second	3.13	3.06	0.37	0.24	4.13	4.06
Third	3.11	3.08	0.24	0.13	3.99	3.96
Imports						
Advance	4.08	3.92	0.68	0.73	5.33	5.02
Second	3.07	2.80	0.16	–0.11	4.45	3.80
Third	3.01	2.76	0.16	0.00	4.01	3.72
Government consumption expenditures and gross investment						
Advance	1.62	1.59	0.31	0.01	2.00	1.95
Second	1.57	1.55	0.14	–0.08	2.02	1.96
Third	1.57	1.52	0.12	–0.04	2.02	1.93
Federal						
Advance	2.91	2.85	–0.05	–0.12	3.64	3.61
Second	2.91	2.98	–0.15	–0.06	3.80	3.75
Third	2.88	2.91	–0.12	0.01	3.75	3.68
Defense						
Advance	4.01	3.77	–0.07	–0.41	5.54	5.07
Second	3.96	3.60	–0.11	–0.24	5.49	4.91
Third	3.87	3.47	–0.05	–0.17	5.43	4.84
Nondefense						
Advance	4.06	3.98	0.33	0.22	5.55	5.26
Second	4.20	4.17	0.03	0.00	5.83	5.55
Third	4.32	4.29	–0.01	0.07	5.86	5.55
State and local						
Advance	1.89	1.59	0.56	0.11	2.34	2.06
Second	1.69	1.56	0.33	–0.06	2.20	1.97
Third	1.72	1.50	0.31	–0.05	2.20	1.93

1. Percent changes cannot be calculated because of the presence of both positive and negative values.

dollar and real measures tend to decline slightly with successive vintages.

Within PCE, the MARs for durable goods are noticeably larger, about 3.93 percentage points for current-dollar durable goods and 4.10 percentage points for real durable goods; these MARs do not decline with successive vintages. Also notable is that durable goods is the only category within PCE in which the MARs are larger for the real measure than for the current-dollar measure.

The MARs for nondurable goods are larger than those for all PCE and tend to decline with successive vintages of estimates. The MAR for the advance estimate is nearly 2.00 percentage points, and those for the second and third estimates are close to 1.90 percentage points. The MARs for the real estimates are approximately 0.30 percentage point smaller than those for current-dollar estimates.

The MARs for services are the smallest of those for all the PCE components shown. The MARs for current-dollar services are approximately 0.90 percentage point for the advance and second estimates and 0.80 percentage point for the third estimate. The MARs for the corresponding real estimates are slightly smaller, but the differences are less than 0.10 percentage point. The MARs for services decline with successive vintages.

The MARs for gross private domestic investment are relatively large; they range from around 5.00 percentage points to 5.80 percentage points for both current-dollar and real investment. Both increase by approximately two-thirds of a percentage point from the advance estimate to the second estimate, then decrease by a tenth of a percentage point with the third estimate. The MARs for fixed investment are smaller; they cluster near 2.80 percentage points for current-dollar estimates and near 3.00 percentage points for real estimates. The smaller sizes are the result of excluding inventory investment, which in a previous study was found, using an alternative methodology, to have larger revisions; see Fixler, Greenaway-McGreevey, and Grimm (2011).

Within fixed investment, MARs for current-dollar nonresidential range from 3.43 percentage points to 3.60 percentage points, while real nonresidential MARs increase from 3.59 percentage points to 3.80 percentage points from the advance estimate to the third estimate. Additionally, MARs for current-dollar structures decrease from 7.59 percentage points for the advance estimates to 7.22 percentage points for the second estimates and 7.20 percent for the third estimates. MARs for real structures are slightly lower—decreasing from 6.96 percentage points for the advance and second estimates to 6.48 percentage points for the third estimate.

In the category "equipment and intellectual property products," MARs for the current-dollar revisions are between 3.77 percentage points and 4.02 percentage points over the three vintages and increase from the advance estimate to the third estimate. MARs for the real estimates are slightly higher and range from 4.85 percentage points to 5.15 percentage points, again increasing from the advance estimate to the third estimate.

The MARs for residential structures investment are, in general, modestly smaller than those for equipment and intellectual property products investment. These estimates decline across successive vintages for both

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Mean Revisions, Mean Absolute Revisions, and Standard Deviations

By convention, revisions are calculated as the later vintage estimates less the earlier vintage estimates; that is, for any time t, the revision is

$$R_t = L_t - E_t$$

where L is the percent change in the later vintage quarterly or annual estimates, and E is the percent change in the earlier vintage estimates. Percent changes in quarterly estimates are at annual rates, this corresponds to the convention generally used for the estimates.

The mean revision is the average of the revisions in the sample period.

$$MR = \Sigma_t\, R_t\, / n,\ t = 1, \ldots, n$$

The revisions can be positive or negative, so they may be offsetting. As a result, it is also useful to look at the mean absolute revision, which is the average of the absolute revisions in the sample period.

$$MAR = \Sigma_t \left| R_t \right| / n,\ t = 1, \ldots, n$$

For some purposes, it is also useful to calculate the standard deviation of the revisions. The standard deviation is the square root of the variance of the revisions. In turn, the variance is the average of the square of the deviation of the revisions about their mean.

$$SD(R) = Var(R)^{1/2}$$

and

$$Var(R) = \Sigma_t (R_t - MR)^2 / n,\ t = 1, \ldots, n$$

The mean absolute revision and the standard deviations are complementary measure of the distribution of the revision around their mean.

current-dollar estimates and real estimates.

The MARs for current-dollar estimates of exports and imports for the three current quarterly vintages range from 3.01 percentage points to 4.08 percentage points. The MARs for the corresponding real estimates tend to be slightly smaller, with the differences between 0.03 percentage point and 0.33 percentage point for each vintage. It is important to note that the MARs decrease with each successive vintage, both for the current-dollar and real estimates.

The MARs for government consumption expenditures and gross investment show a slight tendency to decline with each successive vintage. The MARs for federal expenditures for current-dollar estimates and real estimates are higher. They range from 2.85 percentage points to 2.98 percentage points; these estimates are relatively constant across all three vintages. The MARs for defense range from 3.87 percentage points to 4.01 percentage points in current dollars and from 3.47 percentage points to 3.77 percentage points in real dollars; these MARs decrease across the vintages. Finally, the MARs for nondefense spending increase across the three vintages for both real estimates (from 3.98 percentage points to 4.29 percentage points) and current-dollar estimates (from 4.06 percentage points to 4.32 percentage points).

The MARs for state and local government expenditures for the current-dollar advance estimate is 1.89 percentage points and around 1.70 percentage points for both the second and third estimates. The MARs for

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Revisions to Monthly Estimates of Price Indexes for Personal Consumption Expenditures

Given the attention paid to the Bureau of Economic Analysis (BEA)'s price indexes for personal consumption expenditures (PCE) by the Federal Reserve Board in setting monetary policy, users may be interested in the reliability of these measures. The reliability measures are the mean revisions (MRs) and the mean absolute revisions (MARs) for the PCE price index and PCEX price index (PCE excluding food and energy) for the current monthly estimates to later vintage estimates. The MRs and MARs are calculated using monthly data for June 2000 to December 2015. The reported revisions are measured in terms of percent change from preceding month, which is how the price indexes are reported in official BEA press releases.[1]

The pattern of revisions is fairly intuitive. MRs and MARs for both PCE and PCEX increase for any vintage of estimates as progressively later vintages of estimates are used as the standards. Revisions to PCEX tend to be substantially smaller than revisions to PCE, as the more volatile components of food and energy are removed from the price series.

It should be noted that there are no negative MR values; that is, on average, these price indexes are revised upwards for successive vintages. The MRs for PCE range from 0.002 percentage point (second to third estimate) to 0.012 percentage point (first to latest estimate), while the MRs for PCEX range from 0.001 percentage point (second to third estimate) to 0.017 percentage point (first to latest estimate). The MARs for PCE range from 0.015 percentage point (second to third estimate) to 0.076 percentage point (first to latest estimate); for PCEX, they range from 0.016 percentage point (second to third esti-

mate) to 0.053 percentage point (first to latest estimate).

It is somewhat curious that the MRs for both price indexes are positive. Given the complexity of putting the price indexes together, it is not clear whether there is a systemic source for the positive MRs. However, the Quarterly Services Survey (QSS) data from the Census Bureau features prominently in the PCE price indexes estimates, so the timing of when BEA receives the advance and final QSS may have played a role. With the first monthly estimate, analysts at BEA often have had to use wage and population proxies as place holders until QSS data become available, and the practice was to be conservative when proxies are being used. Hence, the first monthly estimate may have erred on the side of caution so as to not overstate price increases, leading to mostly positive revisions later on.

Average Revisions to Successive Vintages of Monthly Estimates of Annualized Percent Changes in Price Indexes for PCE and PCE Excluding Food and Energy

	Vintage of revision used as standard		
	Second estimate	Third estimate	Latest estimate
Mean revision			
PCE			
First monthly estimate	0.007	0.008	0.012
Second monthly estimate	....	0.002	0.006
Third monthly estimate	....	....	0.004
PCE excluding food and energy			
First monthly estimate	0.006	0.006	0.017
Second monthly estimate	....	0.001	0.011
Third monthly estimate	....	....	0.010
Mean absolute revision			
PCE			
First monthly estimate	0.018	0.025	0.076
Second monthly estimate	....	0.015	0.069
Third monthly estimate	....	....	0.066
PCE excluding food and energy			
First monthly estimate	0.018	0.025	0.053
Second monthly estimate	....	0.016	0.047
Third monthly estimate	....	....	0.042

PCE Personal consumption expenditures

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1. Information on PCE price indexes are given in the press releases for Personal Income and Outlays. Note that in the press releases, the percentage changes are reported only up to 1 decimal place, which masks relatively small revisions in the underlying indexes used to calculate them. Hence 3 decimal places are reported in the table here to allow for greater clarity.

the real estimates decrease across vintages, from 1.59 percentage points for the advance estimate to 1.50 percentage points for the third estimate.

Tables 2 and 3 present expanded information about the MARs of real and current-dollar GDP, including MARs for all vintages of estimates to any later estimate.

Table 2 shows that the MARs for the various vintages of current-dollar estimates all increase with later vintages. Specifically, the increase in MARs is largest from earlier current quarterly estimates to the first annual estimate. The increase in MARs tapers off following the first annual estimate. The reason for the large jump in MARs from earlier estimates to the first annual estimate is that comprehensive revisions of the NIPAs are made in 5-year intervals; as a result, the first annual revision estimates contain the redefinitions and reclassifications about one-fifth of the time; the second annual revision estimates, about two-fifths of the time; and the third annual revision estimates, about three-fifths of the time. Thus, the MARs for the successive annual revision estimates increasingly reflect the effects of these changes as well as the incorporation of annual data that are available with 1-to-3 year lags.

These same patterns generally hold true for the ma-

Table 2. Mean Absolute Revisions to Successive Vintages of Changes in Current-Dollar GDP and Its Major Components, 1993–2015

[Percentage points]

	Second	Third	First annual	Second annual	Third annual	Latest
Gross domestic product						
Advance	0.55	0.68	0.91	1.04	1.18	1.31
Second		0.29	0.74	0.92	1.12	1.25
Third			0.73	0.93	1.10	1.23
First annual				0.64	0.83	0.97
Second annual					0.47	0.82
Third annual						0.62
Personal consumption expenditures						
Advance	0.31	0.40	0.72	0.85	0.91	0.98
Second		0.26	0.65	0.74	0.82	0.89
Third			0.59	0.74	0.82	0.86
First annual				0.53	0.63	0.74
Second annual					0.44	0.62
Third annual						0.55
Durables						
Advance	1.06	1.11	2.78	3.31	3.58	3.93
Second		0.35	2.51	3.10	3.64	3.96
Third			2.61	3.16	3.57	3.89
First annual				2.25	2.53	3.00
Second annual					1.77	2.45
Third annual						1.73
Nonduables						
Advance	0.64	0.66	1.16	1.61	1.83	1.98
Second		0.24	0.96	1.46	1.69	1.85
Third			0.93	1.45	1.71	1.87
First annual				1.06	1.37	1.69
Second annual					0.79	1.21
Third annual						1.07
Services						
Advance	0.26	0.48	0.74	0.94	0.93	0.94
Second		0.38	0.76	0.91	0.89	0.89
Third			0.63	0.82	0.80	0.78
First annual				0.51	0.68	0.70
Second annual					0.48	0.69
Third annual						0.57
Gross private domestic investment						
Advance	2.95	3.17	4.77	5.32	5.49	5.06
Second		1.04	4.37	5.13	5.74	5.67
Third			4.09	4.91	5.62	5.56
First annual				3.17	3.77	4.35
Second annual					2.77	3.49
Third annual						2.80
Fixed investment						
Advance	1.30	1.62	2.45	2.68	2.88	2.81
Second		0.68	2.03	2.45	2.79	2.75
Third			1.88	2.43	2.76	2.75
First annual				1.85	2.37	2.41
Second annual					1.40	1.80
Third annual						1.69
Fixed nonresidential investment						
Advance	1.66	1.90	3.01	3.49	3.78	3.43
Second		0.83	2.53	3.24	3.65	3.60
Third			2.45	3.20	3.66	3.59
First annual				2.37	3.10	2.88
Second annual					1.92	2.21
Third annual						2.22
Nonresidential structures investment						
Advance	3.73	4.31	6.74	7.87	8.13	7.59
Second		1.88	6.57	7.36	7.76	7.22
Third			6.05	6.97	7.59	7.20
First annual				4.36	5.03	5.36
Second annual					2.48	3.39
Third annual						3.24

	Second	Third	First annual	Second annual	Third annual	Latest
Equipment and intellectual property investment						
Advance	1.75	2.02	3.27	3.61	3.64	3.77
Second		0.79	2.73	3.64	3.93	4.15
Third			2.57	3.55	3.96	4.02
First annual				2.86	3.45	3.58
Second annual					2.25	2.66
Third annual						1.99
Residential investment						
Advance	1.31	1.74	3.40	3.71	3.85	4.33
Second		0.80	2.84	3.26	3.39	3.85
Third			2.56	3.00	3.06	3.61
First annual				2.09	2.65	3.36
Second annual					1.42	2.50
Third annual						2.01
Exports						
Advance	2.09	2.45	3.30	3.57	3.98	3.86
Second		1.02	2.44	2.50	3.30	3.13
Third			2.38	2.48	3.16	3.11
First annual				1.96	2.83	2.87
Second annual					1.73	1.98
Third annual						2.11
Imports						
Advance	2.56	2.64	3.34	3.89	3.95	4.08
Second		1.11	2.38	2.85	2.82	3.07
Third			2.11	2.60	2.57	3.01
First annual				1.78	1.93	2.54
Second annual					1.06	1.77
Third annual						1.45
Government consumption expenditures and gross investment						
Advance	0.66	0.72	1.21	1.31	1.61	1.62
Second		0.25	1.10	1.26	1.59	1.57
Third			1.08	1.26	1.57	1.57
First annual				0.77	1.24	1.39
Second annual					0.90	1.15
Third annual						1.07
Federal government						
Advance	0.90	0.84	2.43	2.68	3.13	2.91
Second		0.27	2.32	2.65	3.08	2.91
Third			2.37	2.74	3.14	2.88
First annual				1.52	2.41	2.48
Second annual					1.46	2.05
Third annual						1.95
Federal defense						
Advance	0.82	0.88	2.86	3.50	3.93	4.01
Second		0.30	2.82	3.48	3.94	3.96
Third			2.74	3.51	3.97	3.87
First annual				1.64	2.52	3.16
Second annual					1.42	2.62
Third annual						2.25
Federal nondefense						
Advance	1.66	1.67	4.37	4.70	5.18	4.06
Second		0.40	4.38	4.69	4.93	4.20
Third			4.36	4.65	5.00	4.32
First annual				2.59	3.66	3.65
Second annual					2.26	3.16
Third annual						3.97
State and local government						
Advance	0.71	0.85	1.19	1.39	1.67	1.89
Second		0.35	1.00	1.35	1.53	1.69
Third			0.96	1.30	1.56	1.72
First annual				0.82	1.28	1.52
Second annual					1.03	1.33
Third annual						1.21

Vintage of revision used as standard

jor components and subcomponents of current-dollar GDP. The MARs for PCE tend to be modestly lower than those for GDP. The MARs for durable goods PCE are the largest among the subcomponents of total PCE. In fact, they are several times larger than the MARs for total PCE. The MARs for nondurable goods PCE are almost twice the MARs of PCE but are smaller than the MARs for durable goods. The MARs for services PCE is comparable with that of total PCE.

The MARs for gross private domestic investment are substantially larger than the MARs for all other components of GDP and about 4 to 5 times as large as the MARs for current-dollar GDP. The MARs for fixed investment are about half of the corresponding MARs for gross private domestic investment; the differences reflect the exclusion of change in private inventories, which are subject to large unmeasurable (in percent changes) revisions. Within fixed nonresidential investment, the MARs for nonresidential structures investment are about twice as large as the MARs for equipment and intellectual property investment. For residential investment, the size of the MARs are comparable with the size of those for nonresidential investment. However, the MARs for residential investment from the earlier vintages to the first annual estimates and beyond are larger than those for nonresidential investment.

For exports and imports, the patterns of MARs are roughly the same and are similar to the patterns for the other components of GDP. The MARs of the advance estimate to later vintages of imports estimates are slightly larger than those for exports. The MARs of the second estimate and beyond to later vintages of imports estimates are, however, smaller than the corresponding MARs for exports.

The patterns of MARs for government consumption expenditures and gross investment are also similar to those for GDP, though the MARs are slightly larger. The patterns of MARs for the components and subcomponents of government are roughly similar to the aggregate but with larger values, particularly for federal nondefense. The MARs for state and local government are smaller than the MARs for other government components and more similar in size to the MARs for the government consumption expenditures and gross investment aggregate. Relatively little new information comes in for the later estimates, and the sizes of the revisions reflect this.

In summary, several characteristics of the pattern of revisions hold true generally but not universally. The difference in revisions from the second to the third vintages of estimates are typically the smallest for most adjacent pair of vintages. For any given vintage, the MARs tend to increase as later and later vintages are used as the standards of revisions. For any vintage of later estimates, the MARs tend to decrease in size as later and later vintages of estimates are used as the earlier estimates; that is, for any row (vintage of earlier estimates) in table 2, moving across columns of later and later estimates results in increasingly large MARs, and for any given column (vintage of later estimates), going down rows generally results in decreasing MARs.

Table 3 presents MARs for real GDP and its components. The sizes of the MARs are close to those of MARs for current-dollar GDP. The patterns are also similar to the current-dollar MARs patterns. The similarities reflect the fact that revisions to deflators used to construct the real estimates are quite small in comparison with the current-dollar revisions; most estimates of the components of GDP are prepared in current dollars and then deflated.

Table 4 provides additional information about the revisions from earlier vintages of estimates to the latest estimates. Column 1 and column 2 show the standard deviations of the latest estimates of real and current-dollar GDP and its components and subcomponents at the same level of detail as in table 1 and table 2. These are measures of the volatility of the estimates. They range from 1.53 percentage points for real PCE services to 15.27 percentage points for current-dollar structures investment.

Columns 3 and 4 of table 4 expand the information in columns 5 and 6 of table 1 by presenting standard deviations of the three annual revision vintages of estimates. The standard deviations show wide variation in size, ranging from 0.66 percentage point for current-dollar PCE and 0.58 percentage point for real PCE to 10.03 percentage points for current-dollar structures investment and 9.58 percentage points for real structures investment. The standard deviations may be scaled by dividing the standard deviations of the revisions by the standard deviation of the estimates in order to facilitate comparisons among components. When the standard deviations of revisions are scaled, the resulting standard deviations for each component and subcomponent have relatively small ranges—0.16 percentage point (imports) to 0.90 percentage point (federal nondefense) for current-dollar GDP and 0.23 percentage point (residential investment) to 1.23 percentage points (state and local) for real GDP. Thus, the more volatile components of GDP (those with larger standard deviation of estimates) also tend to have more variable revisions (larger standard deviation of revisions).

Mean revisions

In addition to MARs, table 1 presents MRs for real and current-dollar GDP. The reported MRs are generally

much smaller than the MARs for GDP because the MARs are functions of both the MRs and the variances of the estimates, which by definition are positive. Mean revisions also reflect individual revisions, which are both positive and negative and thus tend to offset one another. For most of the measures shown here, there is little or no tendency for MRs to become smaller with successive vintages of estimates. Note that the MRs for GDP and components reflect definitional changes that are part of comprehensive revisions made to improve the estimates. The definitional revisions have generally,

but not universally, raised the rates of change of GDP and some components.

The MRs for both current-dollar GDP and real GDP are generally negative. The MR for the advance estimates of current-dollar GDP is 0.14 percentage point, and the MR for real GDP is –0.07 percentage point. The MRs for the second and third current-dollar estimates of GDP are –0.02 percentage point and –0.08 percentage point, respectively, and the corresponding MRs for real GDP are –0.13 percentage point and –0.15 percentage point, respectively. The

Table 3. Mean Absolute Revisions to Successive Vintages of Changes in Real GDP and Its Components in 1993–2015

[Percentage points]

	Vintage of revision used as standard							Vintage of revision used as standard					
	Second	Third	First annual	Second annual	Third annual	Latest		Second	Third	First annual	Second annual	Third annual	Latest
Gross domestic product							**Equipment and intellectual property investment**						
Advance	0.57	0.65	0.91	1.01	1.18	1.21	Advance	1.85	2.08	3.90	3.89	4.33	4.85
Second		0.25	0.82	1.03	1.22	1.23	Second		0.78	3.36	4.37	4.66	5.07
Third			0.84	1.03	1.20	1.24	Third			3.20	4.29	4.79	5.15
First annual				0.72	0.89	0.97	First annual				3.24	4.15	4.48
Second annual					0.64	0.93	Second annual					3.07	3.74
Third annual						0.62	Third annual						2.77
Personal consumption expenditures							**Residential investment**						
Advance	0.30	0.39	0.76	0.84	0.92	0.96	Advance	1.38	1.72	3.30	4.05	3.63	4.15
Second		0.24	0.71	0.78	0.81	0.86	Second		0.82	2.79	3.77	3.68	3.77
Third			0.67	0.75	0.79	0.82	Third			2.50	3.56	3.43	3.54
First annual				0.50	0.60	0.71	First annual				2.79	3.25	3.46
Second annual					0.41	0.59	Second annual					2.21	2.94
Third annual						0.48	Third annual						2.20
Durables							**Exports**						
Advance	1.10	1.22	2.98	3.75	3.84	4.10	Advance	2.00	2.39	2.86	3.29	3.44	3.53
Second		0.44	2.65	3.44	3.78	4.12	Second		1.00	2.15	2.58	2.87	3.06
Third			2.83	3.37	3.77	4.12	Third			2.17	2.54	2.82	3.08
First annual				2.64	2.70	3.10	First annual				1.68	2.08	2.47
Second annual					2.45	3.08	Second annual					1.25	1.93
Third annual						2.04	Third annual						1.47
Nonduables							**Imports**						
Advance	0.70	0.67	1.08	1.34	1.42	1.63	Advance	2.53	2.78	3.76	3.87	4.04	3.92
Second		0.30	1.03	1.31	1.38	1.56	Second		0.86	2.38	2.62	2.76	2.80
Third			0.92	1.23	1.31	1.51	Third			2.23	2.50	2.60	2.76
First annual				0.86	1.09	1.42	First annual				1.80	2.13	2.28
Second annual					0.68	1.13	Second annual					1.42	1.96
Third annual						1.03	Third annual						1.75
Services							**Government consumption expenditures and gross investment**						
Advance	0.27	0.46	0.76	0.93	0.84	0.89	Advance	0.66	0.69	1.09	1.30	1.60	1.59
Second		0.34	0.77	0.93	0.86	0.86	Second		0.24	0.94	1.23	1.56	1.55
Third			0.66	0.82	0.79	0.76	Third			0.89	1.22	1.57	1.52
First annual				0.48	0.63	0.70	First annual				0.79	1.25	1.28
Second annual					0.48	0.68	Second annual					0.88	0.97
Third annual						0.52	Third annual						0.93
Gross private domestic investment							**Federal government**						
Advance	2.84	3.02	5.14	5.34	5.58	4.99	Advance	0.99	0.90	2.19	2.50	3.02	2.85
Second		1.03	4.55	5.04	5.78	5.76	Second		0.32	2.03	2.50	3.07	2.98
Third			4.30	4.80	5.65	5.63	Third			2.04	2.54	3.11	2.91
First annual				3.27	4.30	4.61	First annual				1.52	2.23	2.17
Second annual					2.73	3.57	Second annual					1.47	1.85
Third annual						2.83	Third annual						1.78
Fixed investment							**Federal defense**						
Advance	1.21	1.51	2.58	2.76	2.96	2.94	Advance	0.93	0.98	2.53	3.70	3.42	3.77
Second		0.65	2.17	2.57	2.98	2.95	Second		0.35	2.25	3.56	3.31	3.60
Third			2.05	2.60	2.99	2.99	Third			2.21	3.57	3.28	3.47
First annual				1.96	2.50	2.50	First annual				2.67	2.87	3.12
Second annual					1.56	1.89	Second annual					2.14	2.78
Third annual						1.67	Third annual						2.20
Fixed nonresidential investment							**Federal nondefense**						
Advance	1.60	1.86	3.21	3.56	3.63	3.59	Advance	1.67	1.67	4.18	4.51	4.77	3.98
Second		0.77	2.71	3.35	3.68	3.80	Second		0.46	4.08	4.44	4.57	4.17
Third			2.58	3.32	3.64	3.80	Third			4.09	4.40	4.66	4.29
First annual				2.60	3.20	3.16	First annual				2.35	3.05	3.54
Second annual					1.75	2.08	Second annual					1.97	3.12
Third annual						2.00	Third annual						3.88
Nonresidential structures investment							**State and local government**						
Advance	3.74	4.09	6.59	7.12	7.30	6.96	Advance	0.68	0.79	1.38	1.32	1.66	1.59
Second		2.15	6.86	7.10	7.11	6.96	Second		0.33	1.24	1.25	1.50	1.56
Third			5.89	6.31	6.47	6.48	Third			1.14	1.15	1.47	1.50
First annual				4.03	4.56	4.97	First annual				1.11	1.59	1.68
Second annual					2.31	3.09	Second annual					0.97	1.07
Third annual						2.96	Third annual						0.88

MRs for the components and subcomponents of real and current-dollar GDP are generally small, except for the MRs of current-dollar structures investment, which are substantially larger. The signs of the MRs vary across subcomponents and often vary with successive vintages.

Table 1 also presents the standard deviations of revisions. They are somewhat larger than the MARs for GDP and its components. The pattern observed for the MARs discussed in the previous section also holds true in general for the standard deviations. For example, within PCE, durable goods have the largest standard deviations, while services have the smallest. And the largest standard deviations are observed for gross private domestic investment and its subcomponents.

The standard deviations in table 1 can be used to test whether the MRs are statistically significant.[3] The revisions that underlie the reported MRs appear to be normally distributed, and the MRs are not statistically significant for GDP or any of its components or subcomponents. This is true for both current-dollar GDP and real GDP.

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3. Given a normal distribution, the standard deviation is a component of the statistic that tests the hypotheses that the MR is significantly different from zero. More specifically, test statistic = (observed – 0)/computed standard deviation.

Table 4. Standard Deviations of Revisions, Early Vintages to the Latest Estimates, and Changes in GDP and Its Major Components, 1993–2015

[Percentage points]

	Standard deviation of estimates		Standard deviation of revisions		Scaled standard deviation	
	Current-dollar	Real	Current-dollar	Real	Current-dollar	Real
Gross domestic product	2.71	2.48	...	...	...	...
Advance			1.63	1.54	0.60	0.62
Second			1.54	1.53	0.57	0.62
Third			1.54	1.51	0.57	0.61
First annual			1.23	1.22	0.45	0.49
Second annual			1.04	1.16	0.38	0.47
Third annual			0.81	0.77	0.30	0.31
Personal consumption expenditures	2.58	2.00				
Advance			1.24	1.18	0.48	0.59
Second			1.13	1.06	0.44	0.53
Third			1.12	1.04	0.43	0.52
First annual			0.97	0.94	0.38	0.47
Second annual			0.77	0.72	0.30	0.36
Third annual			0.66	0.58	0.26	0.29
Durable goods	8.46	8.68				
Advance			5.07	5.23	0.60	0.60
Second			4.95	5.10	0.58	0.59
Third			4.88	5.17	0.58	0.60
First annual			3.96	4.02	0.47	0.46
Second annual			3.41	5.01	0.40	0.58
Third annual			2.37	2.98	0.28	0.34
Nondurable goods	5.37	2.54				
Advance			2.57	2.22	0.48	0.87
Second			2.35	2.17	0.44	0.85
Third			2.42	2.13	0.45	0.84
First annual			2.23	1.92	0.42	0.76
Second annual			1.65	1.46	0.31	0.57
Third annual			1.40	1.31	0.26	0.52
Services	1.92	1.53				
Advance			1.23	1.11	0.64	0.73
Second			1.19	1.12	0.62	0.73
Third			1.05	1.00	0.54	0.65
First annual			0.90	0.90	0.47	0.59
Second annual			0.87	0.84	0.45	0.55
Third annual			0.79	0.65	0.41	0.42
Gross private domestic investment	12.35	12.20				
Advance			6.53	6.67	0.53	0.55
Second			6.89	7.02	0.56	0.58
Third			6.70	6.81	0.54	0.56
First annual			5.83	6.08	0.47	0.50
Second annual			4.63	4.69	0.37	0.38
Third annual			3.65	3.68	0.30	0.30
Fixed investment	8.06	7.61				
Advance			3.68	3.81	0.46	0.50
Second			3.61	3.71	0.45	0.49
Third			3.55	3.64	0.44	0.48
First annual			3.17	3.25	0.39	0.43
Second annual			2.26	2.42	0.28	0.32
Third annual			2.12	2.10	0.26	0.28
Fixed nonresidential investment	8.22	7.90				
Advance			4.44	4.56	0.54	0.58
Second			4.49	4.59	0.55	0.58
Third			4.46	4.51	0.54	0.57
First annual			3.86	4.04	0.47	0.51
Second annual			2.76	2.59	0.34	0.33
Third annual			2.94	2.53	0.36	0.32
Structures investment	15.27	13.19				
Advance			10.03	9.26	0.66	0.70
Second			9.96	9.58	0.65	0.73
Third			9.90	8.74	0.65	0.66
First annual			7.01	6.43	0.46	0.49
Second annual			4.33	4.08	0.28	0.31
Third annual			4.11	3.75	0.27	0.28

	Standard deviation of estimates		Standard deviation of revisions		Scaled standard deviation	
	Current-dollar	Real	Current-dollar	Real	Current-dollar	Real
Equipment and intellectual property products	8.12	11.95	...	...	...	...
Advance			4.70	6.17	0.58	0.52
Second			5.05	6.35	0.62	0.53
Third			4.97	6.38	0.61	0.53
First annual			4.70	5.75	0.58	0.48
Second annual			3.37	5.06	0.42	0.42
Third annual			2.57	3.69	0.32	0.31
Residential investment	14.57	13.30				
Advance			5.12	5.16	0.35	0.39
Second			4.63	4.74	0.32	0.36
Third			4.52	4.54	0.31	0.34
First annual			4.30	4.92	0.30	0.37
Second annual			3.28	4.06	0.23	0.31
Third annual			2.67	3.12	0.18	0.23
Net exports of goods and services						
Exports	11.47	8.90				
Advance			5.09	4.68	0.44	0.53
Second			4.13	4.06	0.36	0.46
Third			3.99	3.96	0.35	0.44
First annual			3.85	3.24	0.34	0.36
Second annual			2.64	2.63	0.23	0.29
Third annual			5.60	2.30	0.49	0.26
Imports	12.89	8.53				
Advance			5.33	5.02	0.41	0.59
Second			4.45	3.80	0.35	0.45
Third			4.01	3.72	0.31	0.44
First annual			3.51	3.03	0.27	0.36
Second annual			2.34	2.61	0.18	0.31
Third annual			2.04	2.17	0.16	0.26
Government consumption expenditures and gross investment	3.60	3.15				
Advance			2.00	1.95	0.56	0.62
Second			2.02	1.96	0.56	0.62
Third			2.02	1.93	0.56	0.61
First annual			1.73	1.62	0.48	0.51
Second annual			1.48	1.32	0.41	0.42
Third annual			1.36	1.14	0.38	0.36
Federal	7.02	6.73				
Advance			3.64	3.61	0.52	0.54
Second			3.80	3.75	0.54	0.56
Third			3.75	3.68	0.53	0.55
First annual			3.20	3.12	0.46	0.46
Second annual			2.66	2.57	0.38	0.38
Third annual			2.67	2.22	0.38	0.33
Defense	9.63	9.28				
Advance			5.54	5.07	0.58	0.55
Second			5.49	4.91	0.57	0.53
Third			5.43	4.84	0.56	0.52
First annual			4.18	4.45	0.43	0.48
Second annual			3.62	4.17	0.38	0.45
Third annual			2.93	2.81	0.30	0.30
Nondefense	6.52	6.32				
Advance			5.55	5.26	0.85	0.83
Second			5.83	5.55	0.89	0.88
Third			5.86	5.55	0.90	0.88
First annual			4.84	4.60	0.74	0.73
Second annual			4.34	4.23	0.67	0.67
Third annual			4.93	4.91	0.76	0.78
State and local	3.36	2.77				
Advance			2.34	2.06	0.70	0.75
Second			2.20	1.97	0.66	0.71
Third			2.20	1.93	0.66	0.70
First annual			1.92	3.39	0.57	1.23
Second annual			1.69	1.38	0.50	0.50
Third annual			1.51	1.16	0.45	0.42

Table 5 and table 6 offer supplemental pictures of the revisions. Table 5 focuses on the advance to latest estimates of real GDP and its major components, providing additional information about the distribution of the revisions. In table 5, the number and proportion of observations that falls within the ± 1 standard deviation range of the MRs are reported. The revisions appear to hover around the mean and the proportions approximate what would be observed for normally distributed random variables.[4]

Table 5. Distribution of Revisions Around Mean Revision, Advance Estimates to the Latest Estimates, Changes in Real GDP and Its Major Components, 1993–2015

	Percent			Number of quarters within 1 standard deviation	Percent of quarters within 1 standard deviation
	−1 standard deviation	Mean	+1 standard deviation		
Gross domestic product	**−1.61**	**−0.07**	**1.47**	**66**	**72**
Personal consumption expenditure.....	−1.29	−0.11	1.07	60	65
Gross private domestic investment.....	−7.02	−0.35	6.32	66	72
Net exports of goods and services					
Exports	−3.59	1.09	5.77	66	72
Imports	−4.29	0.73	5.75	68	74
Government consumption expenditures and gross investment					
Federal	−3.73	−0.12	3.49	66	72
State and local................................	−1.95	0.11	2.17	67	73

NOTE. Total number of quarters in the sample is 92.

Table 6 compares the advance estimates of real GDP with the revisions from those advance estimates to the latest estimates. The table shows no apparent relationship between the two. The majority of the advance estimates cluster between 0 percent and 4 percent, while the revisions (advance to latest) cluster between −2 percentage points and 2 percentage points. The lack of any observable correlation between the advance estimates and revisions is an indication that there is nothing systematic about revisions that are correlated with the size of advance estimates.

Table 6. Distribution of Advance Estimates of Real GDP and Revisions (Advanced to Latest Estimates), 1993–2015

[Number of quarters]

Revision (percentage points)	Advanced estimate (percentage points)				
	Less than 0	0 to 2	2 to 4	4 to 6	More than 6
Greater than 2	0	1	2	2	0
0 to 2	3	16	18	6	0
−2 to 0	2	6	18	8	1
−4 to −2	0	3	2	2	0
Less than −4..	1	0	0	1	0

NOTE. Total number of quarters in the sample is 92.

4. For normal distributions, approximately 68 percent of the data should fall within 1 standard deviation from the mean. The numbers in table 5 are generally higher than 68 percent, suggesting that the revisions center more tightly around the mean than a normally distributed variable.

Revisions by quarter

Additional insights into the nature and distribution of revisions may be gained by analyzing the revision statistics by quarter. For the analysis in this subsection, the third annual revision is compared with the advance estimate. That allows one to focus on revisions due to changes only in source data or seasonal factors rather than on revisions due to methodological changes (which would be incorporated into the "latest" estimates that include benchmark revisions).[5]

Source data that are used in the calculation of GDP are provided to BEA over time. The timing of the receipt of this source data varies from quarter to quarter and from component to component. As a result, different average revisions for each quarter of the year are to be expected. For example, the average revisions for the first-quarter estimates may differ from the average revisions for each of the other quarters and for all quarters.

Table 7 features the MRs and MARs for current-dollar GDP and real GDP and major components for all first quarters, all second quarters, all third quarters, all fourth quarters, and for all quarters in the sample period 1993–2013.[6] The table shows that there are indeed wide variations in average revisions by quarter. For example, the MRs for current-dollar GDP range from –0.69 percentage point (first-quarter average) to 0.76 percentage point (second-quarter average). The corresponding range for MARs is a little narrower, from 1.09 percentage points (second-quarter average) to 1.25 percentage points (first-quarter average). The pattern is similar when we look at real GDP, which ranges between –0.95 percentage point (first-quarter average) and 0.63 percentage point (second-quarter average). Real GDP MARs range from 0.93 percentage point (third-quarter average) to 1.41 percentage points (first-quarter average).

For the MRs, the quarter-by-quarter patterns of most of the components and subcomponents of GDP differ considerably. For example, in fixed investment, the MRs for nonresidential investment in structures are large for the first three quarters of the year but are small for the fourth quarter. In contrast, the MRs for

5. Unfortunately, revisions due to changes in seasonal factors cannot be separately analyzed from revisions due to changes in source data, because BEA no longer publishes seasonally unadjusted GDP. However, in Fixler and Grimm (2002), the authors used the previously published seasonally unadjusted GDP data to show that revisions due to seasonal factors tend to offset the revisions to seasonally unadjusted estimates, concluding that revisions to seasonal factors do not appear to be a principal source of volatility in the estimates.

6. Third annual revision data is only available for quarters up to the fourth quarter of 2013, thus the sample period here is 2 years shorter than that used in previous subsections.

fixed residential investment are small for all the quarters except the third quarter. The MRs for current-dollar estimates and real estimates also vary. For example, current-dollar exports have relatively small mean revisions in all quarters except for the fourth quarter, but real exports has large mean revisions for the first and fourth quarters. Even though most components and subcomponents of GDP show considerable variations from quarter to quarter, there are two series that display smaller MRs and little variations from quarter to quarter: PCE services and government consumption expenditures and gross investment. The MRs for these two series are all below 0.73 percentage point in absolute value for both current-dollar and real estimates.

Relatively large and negative MRs for the first quarter for both current-dollar and real GDP are evident in table 7. The MRs for the components suggest that this is probably mainly driven by the large negative MRs for PCE and gross private domestic investment (GPDI) in the first quarter. These two components together would account for more than 80 percent of total GDP. In contrast, the MR for the second quarter for both current-dollar and real GDP is large and positive. This again is probably driven by the positive revisions to PCE and GPDI. The correlation coefficient between the first-quarter GDP MR and the second-quarter GDP MR is −0.25 for current-dollar estimates and −0.18 for real estimates; however, neither of the correlations are significantly different from zero.

Regarding recent discussions among business and public policy analysts about weak first-quarter GDP growth rates that may be related to residual seasonality issues, the pattern observed in table 7 suggests that rather than understating first-quarter GDP growth, the

Table 7. Mean Absolute Revisions and Mean Revisions to Quarterly Changes in GDP and Its Major Components by Quarter of Estimate, Third Annual Estimates Less Advance Estimates, 1993–2015

[Percentage points]

	Mean revisions					Mean absolute revisions				
	Quarters					Quarters				
	Current-dollar estimates									
	First	Second	Third	Fourth	All	First	Second	Third	Fourth	All
Gross domestic product	**−0.69**	**0.76**	**−0.51**	**0.46**	**0.01**	**1.25**	**1.09**	**1.15**	**1.21**	**1.18**
Personal consumption expenditures	**−1.01**	**0.22**	**−0.18**	**0.12**	**−0.21**	**1.25**	**0.93**	**0.81**	**0.63**	**0.91**
Durable goods	−2.43	1.10	−1.63	−0.62	−0.89	4.32	3.82	3.31	2.87	3.58
Nondurable goods	−1.90	0.61	0.25	0.36	−0.17	2.61	1.60	1.46	1.65	1.83
Services	−0.39	−0.01	−0.11	−0.06	−0.14	1.15	0.81	0.93	0.81	0.93
Gross private domestic investment	**−1.86**	**2.72**	**−1.09**	**1.03**	**0.20**	**5.11**	**6.79**	**5.16**	**4.90**	**5.49**
Fixed investment	0.87	0.03	−0.09	0.28	0.27	3.17	2.73	2.35	3.28	2.88
Nonresidential	0.85	−0.24	−1.19	0.62	0.01	4.24	3.73	3.11	4.04	3.78
Structures	3.96	3.72	2.12	0.24	2.51	9.40	8.99	7.28	6.84	8.13
Equipment and software	−0.67	−1.20	−1.67	0.39	−0.79	4.18	3.36	3.01	4.01	3.64
Residential	0.37	0.69	1.33	0.10	0.62	3.65	3.74	3.81	4.19	3.85
Change in private inventories [1]	....	....	....	....	....	....	....	....	....	....
Net exports of goods and services [1]	....	....	....	....	....	....	....	....	....	....
Exports	0.39	0.95	−0.05	2.88	1.04	4.60	2.75	3.75	4.83	3.98
Imports	0.51	−0.39	1.14	1.13	0.60	5.17	3.71	3.34	3.56	3.95
Government consumption expenditures and gross investment	**0.51**	**0.73**	**0.04**	**0.38**	**0.41**	**1.44**	**1.60**	**1.79**	**1.61**	**1.61**
Federal	0.98	0.29	−0.66	0.75	0.34	2.86	2.69	3.15	3.84	3.13
Defense	1.20	−0.18	−0.55	1.31	0.44	5.01	2.61	2.96	5.12	3.93
Nondefense	1.54	1.10	−0.51	−0.31	0.46	7.02	5.00	4.73	3.96	5.18
State and local	0.52	1.04	0.49	0.07	0.53	2.16	1.79	1.51	1.21	1.67
	Real estimates									
	First	Second	Third	Fourth	All	First	Second	Third	Fourth	All
Gross domestic product	**−0.95**	**0.63**	**−0.79**	**−0.11**	**−0.31**	**1.41**	**1.00**	**0.93**	**1.21**	**1.18**
Personal consumption expenditures	**−1.05**	**0.16**	**−0.37**	**−0.25**	**−0.38**	**1.25**	**0.94**	**0.49**	**0.75**	**0.92**
Durable goods	−1.91	1.32	−1.80	−1.01	−0.85	4.76	3.87	3.21	3.16	3.84
Nondurable goods	−1.30	0.63	0.01	0.30	−0.09	2.10	1.09	0.68	1.45	1.42
Services	−0.72	−0.18	−0.27	−0.41	−0.40	1.16	0.72	0.60	0.71	0.84
Gross private domestic investment	**−2.82**	**1.60**	**−2.45**	**0.76**	**−0.73**	**6.00**	**6.02**	**4.40**	**4.88**	**5.58**
Fixed investment	−0.14	−0.71	−0.92	−0.27	−0.51	3.32	2.86	1.96	3.39	2.96
Nonresidential	0.08	−0.86	−1.57	−0.21	−0.64	4.10	3.74	2.61	3.77	3.63
Structures	2.57	2.85	1.13	−0.76	1.45	8.31	8.54	5.31	5.91	7.30
Equipment and software	−0.49	−1.04	−0.59	0.56	−0.39	5.62	3.10	3.40	4.42	4.33
Residential	−0.79	−0.48	0.96	−0.54	−0.21	3.74	3.55	2.61	3.90	3.63
Change in private inventories [1]	....	....	....	....	....	....	....	....	....	....
Net exports of goods and services [1]	....	....	....	....	....	....	....	....	....	....
Exports	2.12	0.97	−0.37	2.73	1.36	3.38	2.71	2.78	4.53	3.44
Imports	0.96	−0.15	0.16	2.18	0.79	4.66	4.24	1.85	4.66	4.04
Government consumption expenditures and gross investment	**0.12**	**0.62**	**−0.58**	**−0.07**	**0.02**	**1.62**	**1.60**	**1.33**	**1.46**	**1.60**
Federal	0.20	0.61	−1.66	0.56	−0.07	2.47	2.25	2.34	3.86	3.02
Defense	−0.51	0.08	−1.19	0.78	−0.21	3.33	2.49	2.87	4.76	3.42
Nondefense	1.16	1.56	−1.41	−0.84	0.12	6.43	4.13	3.25	3.77	4.77
State and local	0.14	0.74	−0.08	−0.36	0.11	2.08	1.64	0.82	1.46	1.66

1. Percent changes cannot be calculated because of the presence of both positive and negative values.

advance estimates tend to overstate it. [7] The negative MR for the first quarter is robust to changes in the vintage being used as the standard; that is, if any other annual estimates (or even the latest estimate) are used in comparison with the advance estimate, the MR for the first quarter remains negative. The results here are indicative of a complex story for weak first-quarter estimates, suggesting that residual seasonality might not be the only cause for the low growth rates.

For the MARs, the patterns observed in table 7 also differ considerably across components of GDP and subcomponents. Although they are difficult to generalize, they are generally consistent with the MRs. PCE services and government consumption expenditures and gross investment have the smallest and least volatile MARs from quarter to quarter. This is true for current-dollar estimates as well as for real estimates.

In sum, the quarter-by-quarter patterns of MRs and MARs for both current-dollar and real GDP and their components typically vary considerably from overall averages, and they fluctuate quite a bit. The variability could be due to the differences in how and when new data are incorporated into each component. In any case, this is a subject that warrants further research.

News versus noise

A common question that economists and data users alike often ask is whether the revisions result from news (new information) or noise (measurement error).[8] Revisions due to news indicate that the sequence of estimates provided by BEA is moving the measure of aggregate economic activity towards its "true" value. Correlations between the vintage growth rates of GDP and the revisions to various quarterly vintages of GDP suggest some answers (table 8). The shaded sections show the correlations between each revision vintage and GDP growth rates published since the revision, and the unshaded sections show the correlations between each revision vintage and GDP growth rates published before the revision. If the shaded section correlations are significant, it indicates the importance of new information ("news"). Meanwhile, if the unshaded section correlations are significant, it indicates the importance of measurement error ("noise"). For both current-dollar and real GDP, the majority of the statistically significant correlations (at the 5 percent

level) are in the shaded section, which indicates that new information drives the revisions. In general, the demonstration that the revisions are due to news supports the assumption that the sequence of estimates moves the estimates toward their "true" value.

However, certain revision vintages appear to be more influenced by noise. Consider the revisions to the quarterly estimates ("advance to second," "second to third," and "third to first annual"). For both current-dollar and real GDP, 8 of the 15 correlations in the shaded section are significant at the 5 percent level. Conversely, in the unshaded section, three of the six correlations are significant for current-dollar GDP, while just two are significant for real GDP. The evidence in favor of the news hypothesis is strongest for the "advance to second" revisions, as the entire shaded row of correlations (for both current-dollar and real GDP estimates) is statistically significant at the 5 percent level, but the single unshaded correlation is not. However, the statistical evidence in favor of the noise hypothesis is stronger for the "third to first annual" revision for current-dollar GDP, as all of the unshaded correlations in this row are significant, while none of the shaded correlations are. For real GDP "third to first annual" revision, the results are more of a mixed bag, with significant correlations in both shaded and unshaded sections.

Table 8. Correlations Between GDP Growth Rates and Revisions in 1993–2015

[Percentage points]

Correlations	Vintage						
	Advance	Second	Third	First annual	Second annual	Third annual	Latest
Current-dollar GDP							
Advance to second...................	0.19	0.44	0.45	0.40	0.42	0.35	0.35
P-value..............................	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Second to third........................	0.07	0.11	0.26	0.20	0.22	0.12	0.18
P-value..............................	0.48	0.28	0.01	0.05	0.04	0.27	0.10
Third to first annual	−0.23	−0.26	−0.28	0.11	0.10	0.18	0.10
P-value..............................	0.02	0.01	0.01	0.31	0.34	0.11	0.34
First annual to second annual	0.09	0.12	0.11	0.08	0.39	0.41	0.33
P-value..............................	0.41	0.28	0.30	0.44	0.00	0.00	0.00
Second annual to third annual	−0.02	−0.06	−0.06	−0.02	0.00	0.24	0.26
P-value..............................	0.85	0.61	0.59	0.85	0.99	0.03	0.02
Third annual to latest	−0.07	−0.09	−0.10	−0.08	−0.15	−0.12	0.16
P-value..............................	0.53	0.44	0.43	0.50	0.21	0.30	0.17
Real GDP							
Advance to second...................	0.16	0.49	0.49	0.35	0.32	0.29	0.29
P-value..............................	0.12	0.00	0.00	0.00	0.00	0.01	0.00
Second to third........................	0.04	0.03	0.19	0.11	0.15	0.04	0.14
P-value..............................	0.72	0.75	0.07	0.28	0.16	0.74	0.19
Third to first annual	−0.13	−0.22	−0.24	0.24	0.16	0.23	0.16
P-value..............................	0.21	0.04	0.02	0.02	0.13	0.04	0.13
First annual to second annual	0.03	0.00	0.01	−0.08	0.29	0.20	0.15
P-value..............................	0.79	0.98	0.89	0.43	0.01	0.07	0.17
Second annual to third annual	−0.04	−0.04	−0.03	0.00	−0.08	0.27	0.28
P-value..............................	0.72	0.75	0.78	0.98	0.47	0.01	0.01
Third annual to latest	−0.07	−0.07	−0.08	−0.09	−0.17	−0.15	0.14
P-value..............................	0.55	0.53	0.52	0.44	0.16	0.21	0.23

GDP Gross domestic product

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7. In recent years, there appears to be a persistent pattern of low first-quarter real GDP growth followed by a rebound in growth rates in the second quarter. Since the data have been seasonally adjusted, there should not be any discernible calendar-based pattern to real GDP growth; that is, any particular quarter should not have consistently higher or lower growth rate than any other quarter. The discovery of this pattern has led many to suggest the presence of residual seasonality in real GDP growth (see Liesman 2015; Rudebusch, Wilson, and Mahedy 2015; and Wolfers 2015, among many others).

8. For a more complete discussion of this issue, see Mankiw and Shapiro (1986).

The picture differs slightly when the revisions to the annual estimates are considered. For current-dollar GDP, the statistical support for the news hypothesis is strong, with all but one of the six correlations in the shaded section statistically significant at the 5 percent level. None of the unshaded section correlations is significant. For real GDP, even though none of the unshaded section correlations are significant, only half of the six correlations in the shaded section are significant. So the evidence supporting the news hypothesis is somewhat weaker. For the "third annual to latest" revision, because none of the correlations are statistically significant (for both current-dollar and real GDP), there is no support for either the news or the noise hypothesis.

Revisions to Annual Estimates of GDP

Summary statistics for revisions of annual estimates for real and current-dollar GDP, and its major components, to the latest estimates are shown in table 9. Like the quarterly estimates, the mean revisions for the annual estimates are small in magnitude and vary in di-

Table 9. Mean Revisions and Mean Absolute Revisions of Annual Estimates of GDP and Its Major Components, Annual Vintages to Latest Estimates, 1993–2015

[Percentage points]

	Mean revision		Mean absolute revision	
	Current-dollar	Real	Current-dollar	Real
Gross domestic product				
Early annual	−0.04	−0.11	0.41	0.47
First annual	−0.05	−0.02	0.35	0.41
Second annual	0.09	0.19	0.28	0.31
Third annual	0.11	0.24	0.23	0.26
Personal consumption expenditures				
Early annual	−0.05	−0.03	0.38	0.37
First annual	−0.12	0.00	0.36	0.37
Second annual	0.02	0.16	0.29	0.34
Third annual	0.13	0.27	0.22	0.31
Gross private domestic investment				
Early annual	−0.20	−0.11	1.67	1.91
First annual	−0.01	−0.02	1.62	1.66
Second annual	0.43	0.19	1.26	1.14
Third annual	0.35	0.24	1.19	1.17
Fixed investment				
Early annual	−0.15	−0.60	1.14	1.33
First annual	−0.07	−0.36	1.04	1.12
Second annual	0.47	0.44	0.98	0.88
Third annual	0.30	0.31	0.81	0.79
Change in private inventories [1]	....	....	....	....
Net exports of goods and services [1]				
Exports				
Early annual	0.23	0.29	0.66	0.83
First annual	0.31	0.20	0.51	0.59
Second annual	0.06	−0.02	0.44	0.47
Third annual	0.05	−0.05	0.39	0.38
Imports				
Early annual	0.16	0.07	0.50	0.68
First annual	0.16	0.03	0.27	0.38
Second annual	0.04	0.21	0.24	0.62
Third annual	0.07	−0.42	0.18	0.55
Federal government				
Early annual	−0.04	0.05	0.49	0.70
First annual	−0.27	−0.06	0.46	0.43
Second annual	−0.25	−0.09	0.38	0.32
Third annual	−0.26	0.02	0.43	0.32
State and local government				
Early annual	0.21	−0.17	0.98	0.84
First annual	0.16	−0.05	0.81	0.73
Second annual	0.16	0.00	0.73	0.60
Third annual	−0.03	−0.06	0.55	0.32

1. Percent changes cannot be calculated because of the presence of both positive and negative values.

rection. The early annual estimates are those that become available in March of the following year and are mostly composed of third current quarterly estimates; thus, their mean revisions are similar to those of previous estimates.

The MARs are considerably smaller than the current quarterly estimates for both real and current-dollar GDP. One reason is that annual frequency estimates are not subject to revisions to seasonal adjustment factors. The MARs show a tendency to decline over each vintage both in current-dollar estimates and real-dollar estimates. Moreover, MARs also decline steadily across vintages for the underlying components. Exceptions are increases from the previous vintage for the third annual estimate of real gross private domestic investment, the second annual estimate of real imports, and the third annual estimate of current-dollar federal government spending. As with total GDP, the MARs of components are much smaller than those for quarterly estimates.

Revisions to Quarterly Estimates of GDI

The MRs and MARs of the revisions to quarterly estimates of GDI are presented in table 10. Note that some values in the table are missing. Advance estimates of GDI are not prepared, and since 1995, second current quarterly estimates of GDI in the fourth quarter of each year have not been prepared mainly because of the lack of reliable source data for estimating corporate profits, which affects several other components of GDI. Advance and second estimates are prepared for the other major components of GDI, such as compensation of employees and proprietors' income. Beginning with the first quarter of 2002, a "fourth" vintage of the estimates for the previous quarter has been prepared using data from the Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW). These data are used to revise the estimates of compensation of employees, national income, and GDI. The fourth vintage is released at the time of the second quarterly estimate for the following quarter. However, the fourth vintage MR and MAR numbers are not shown in table 10.

The MAR for the third quarterly estimates of GDI (to the latest estimate) is 1.45 percentage points. It increases with the first annual estimates and then declines for subsequent estimates. In contrast, the MAR for real GDP (table 3) shows an increase from the advance estimates to the third estimates before declining for the subsequent estimates. The MARs for most of the components of GDI tend to decline with successive vintages of estimates, with a few exceptions: private consumption of fixed capital, proprietors' income, and nonfarm proprietors' income. Another notable obser-

vation from table 10 is that the MARs for GDI components can be significantly larger than the MAR for total GDI. For example, the MARs for corporate profits and net interest are about 10 times larger than those for GDI, and the MARs for private consumption of fixed capital are about 5 times larger than those for GDI.

The MRs for GDI and its major components are much smaller than the corresponding MARs, and the MRs for any given component can have a mixture of positive and negative signs for different vintages. Private consumption of fixed capital and corporate profits have only negative MRs for all vintages; in contrast, taxes on production and imports, proprietors' income, and non farm proprietors' income have only positive MRs for all vintages. Similar to GDP shown in table 1, the MRs do not tend to decline with successive vin-

tages of estimates.

Additional information about the standard deviation measures of GDI estimates is presented in table 11. The scaled standard deviations provide a sense of how volatile the revisions can be, taking into account the variability of the estimates. The scaled standard deviations for GDI are rather small, all less than 1 percentage point for all vintages. For most components of GDI, the scaled standard deviations are slightly larger than those of aggregate GDI. However, in stark contrast to all of the other components, the scaled standard deviations of private consumption of fixed capital are above 6 percentage points for all vintages, and the standard deviations gets larger with each successive vintage.

Table 10. Revisions and Standard Deviation of Revisions, Early Vintages to the Latest Estimates, and Changes in GDI and Its Major Components, 1993–2015

[Percentage points]

	Mean absolute revision	Mean revision	Standard deviation
Gross domestic income			
Third	1.45	−0.05	1.89
First annual	1.53	0.03	1.92
Second annual	1.15	0.17	1.56
Third annual	0.90	0.19	1.24
Private consumption of fixed capital			
Advance	7.20	−0.03	18.88
Second	7.09	−0.09	18.90
Third	7.59	−0.71	23.11
First annual	8.22	−1.55	24.60
Second annual	8.03	−1.38	25.34
Third annual	9.28	−2.63	27.88
Taxes on production and imports			
Advance	2.48	0.15	3.41
Second	2.49	0.21	3.35
Third	2.26	0.29	3.19
First annual	1.93	0.36	2.83
Second annual	1.63	0.24	2.60
Third annual	1.55	0.11	2.77
National income			
Third	2.07	−0.10	3.07
First annual	2.06	0.06	2.83
Second annual	1.76	0.15	2.69
Third annual	1.40	0.20	2.48
Compensation of employees			
Advance	2.45	0.13	3.29
Second	2.36	−0.04	3.13
Third	2.36	−0.05	3.14
First annual	1.53	−0.09	2.14
Second annual	1.22	0.03	1.71
Third annual	1.15	0.06	1.62
Proprietors' income			
Advance	6.42	0.48	8.08
Second	6.62	0.42	8.50
Third	6.59	0.45	8.56
First annual	7.05	0.65	9.13
Second annual	5.79	0.64	7.97
Third annual	4.72	1.38	5.61
Nonfarm proprietors' income			
Advance	5.39	0.51	6.81
Second	5.31	0.45	6.77
Third	5.32	0.50	6.78
First annual	5.92	0.93	7.49
Second annual	5.68	0.63	8.33
Third annual	4.52	1.30	5.78
Corporate profits with IVA and CCAdj			
Third	16.55	−0.90	24.85
First annual	13.45	−0.68	19.88
Second annual	10.07	−0.97	18.23
Third annual	7.85	−0.34	13.45
Net interest and miscellaneous payments			
Advance	14.50	0.36	18.27
Second	11.59	−0.10	15.48
Third	11.73	−0.74	15.46
First annual	10.87	1.46	14.27
Second annual	7.72	1.27	9.62
Third annual	6.07	−1.34	8.53

NOTE. Early annual estimates are available in late April of the following year.

Table 11. Standard Deviations of Revisions, Early Vintages to the Latest Estimates, and Changes in GDI and Its Major Components, 1993–2015

[Percentage points]

	Standard deviation of estimates	Standard deviation of revisions	Scaled standard deviation
Gross domestic income	3.08	....	....
Third	....	1.89	0.61
First annual	....	1.92	0.62
Second annual	....	1.56	0.51
Third annual	....	1.24	0.40
Private consumption of fixed capital	3.14	....	....
Advance	....	18.88	6.02
Second	....	18.90	6.02
Third	....	23.11	7.37
First annual	....	24.60	7.84
Second annual	....	25.34	8.08
Third annual	....	27.88	8.89
Taxes on production and imports	3.25	....	....
Advance	....	3.41	1.05
Second	....	3.35	1.03
Third	....	3.19	0.98
First annual	....	2.83	0.87
Second annual	....	2.60	0.80
Third annual	....	2.77	0.85
National income	3.52	....	....
Third	....	3.07	0.87
First annual	....	2.83	0.80
Second annual	....	2.69	0.76
Third annual	....	2.48	0.70
Compensation of employees	3.74	....	....
Advance	....	3.29	0.88
Second	....	3.13	0.84
Third	....	3.14	0.84
First annual	....	2.14	0.57
Second annual	....	1.71	0.46
Third annual	....	1.62	0.43
Proprietors' income	7.84	....	....
Advance	....	8.08	1.03
Second	....	8.50	1.08
Third	....	8.56	1.09
First annual	....	9.13	1.16
Second annual	....	7.97	1.02
Third annual	....	5.61	0.72
Nonfarm proprietors' income	7.15	....	....
Advance	....	6.81	0.95
Second	....	6.77	0.95
Third	....	6.78	0.95
First annual	....	7.49	1.05
Second annual	....	8.33	1.16
Third annual	....	5.78	0.81
Corporate profits with IVA and CCAdj	23.58	....	....
Third	....	24.85	1.05
First annual	....	19.88	0.84
Second annual	....	18.23	0.77
Third annual	....	13.45	0.57
Net interest and miscellaneous payments	16.24	....	....
Advance	....	18.27	1.12
Second	....	15.48	0.95
Third	....	15.46	0.95
First annual	....	14.27	0.88
Second annual	....	9.62	0.59
Third annual	....	8.53	0.53

NOTE. Scaled standard deviation is the standard deviation of the vintage divided by the standard deviation of the latest estimate.

The full mean absolute revision triangle for GDI and its major components is presented in table 12. Note that a fourth vintage is presented for compensation, national income, and total GDI that incorporates data from the QCEW. However, the fourth vintage statistics should be viewed with caution because no fourth estimates were prepared before the first quarter of 2002, and the statistics are not fully compatible with the rest of the entries for 1993–2015.

The patterns of MARs for successive vintages of estimates and vintages of standards in table 12 for GDI are for the most part, similar to those for GDP. However, the whole set of MARs for GDI tends to be modestly larger than the comparable ones for GDP.

Of all the components of GDI, the MARs reported for national income appear to be the smallest, with noticeably sharp drops in MARs moving from the fourth estimate to the first annual estimate, regardless of which vintage is used as the standard. MARs for compensation of employees are similar to those for national income; however, sharp drops in MARs occurs from the third estimate to the fourth estimate, again regardless of which vintage is used as the standard. Even though the MARs for national income and compensation of employees are relatively small, when compared with the other GDI components, they are still larger than the MARs reported for aggregate GDI.

The patterns for GDI and its components are generally similar to the patterns for current-dollar GDP, but there are deviations; that is, the MARs for GDI and its components sometimes decrease from vintage to vintage used as the standards (rows) or increase from vintage to vintage of the estimates for any given standard (columns). Nevertheless, there is a tendency toward increases across rows of table 12 and decreases down the columns. In general, the MARs for the various components and vintages tend to be larger than those for the various GDP components.

Supplemental information about the revisions for GDI are presented in tables 13 and table 14. Table 13 focuses on the third to latest estimate of GDI and its major components and provides additional information about the distribution of the revisions. The revisions appear to hover around the mean and the proportions within one standard deviations from the mean approximate what would be observed for normally distributed random variables.

In table 14, the third estimates of GDI are compared with the revisions from the third estimates to the latest estimates of GDI. The table shows no apparent relationship between the two. The majority of the third estimates cluster between 2 percent and 6 percent, while

Table 12. Mean Absolute Revisions, Changes in GDI and Its Major Components, 1993–2015

[Percentage points]

	Vintage of revision used as standard						
	Second	Third	Fourth*	First annual	Second annual	Third annual	Latest
Gross domestic income							
Third	....	....	1.21	0.90	1.19	1.40	1.45
Fourth	....	....	....	0.95	1.40	1.67	1.56
First annual	....	....	....	....	0.97	1.34	1.53
Second annual	....	....	....	....	....	0.77	1.15
Third annual	....	....	....	....	....	....	0.90
Private consumption of fixed capital							
Advance	0.40	1.18	....	3.77	3.73	4.24	7.20
Second	....	0.89	....	3.70	3.71	4.17	7.09
Third	....	....	....	3.24	3.24	3.65	7.59
First annual	....	....	....	....	2.22	2.64	8.22
Second annual	....	....	....	....	....	1.97	8.03
Third annual	....	....	....	....	....	....	9.28
Taxes on production and imports							
Advance	0.59	1.06	....	1.75	1.79	1.91	2.48
Second	....	0.82	....	1.62	1.74	1.93	2.49
Third	....	....	....	1.36	1.50	1.75	2.26
First annual	....	....	....	....	1.11	1.44	1.93
Second annual	....	....	....	....	....	0.91	1.63
Third annual	....	....	....	....	....	....	1.55
National income							
Third	....	....	1.59	1.31	1.66	1.77	2.07
Fourth	....	....	....	1.53	1.96	2.48	2.66
First annual	....	....	....	....	1.19	1.79	2.06
Second annual	....	....	....	....	....	1.12	1.76
Third annual	....	....	....	....	....	....	1.40
Compensation of employees							
Advance	0.46	0.51	2.22	1.83	1.98	2.16	2.45
Second	....	0.16	2.23	1.71	1.81	2.02	2.36
Third	....	....	2.19	1.69	1.82	2.02	2.36
Fourth	....	....	....	1.03	1.29	1.52	1.54
First annual	....	....	....	....	1.00	1.27	1.53
Second annual	....	....	....	....	....	0.60	1.22
Third annual	....	....	....	....	....	....	1.15
Proprietors' income							
Advance	0.93	1.18	....	3.98	5.84	5.67	6.42
Second	....	0.64	....	3.97	5.98	5.91	6.62
Third	....	....	....	3.82	5.91	5.94	6.59
First annual	....	....	....	....	4.95	5.91	7.05
Second annual	....	....	....	....	....	3.56	5.79
Third annual	....	....	....	....	....	....	4.72
Nonfarm proprietors' income							
Advance	0.52	0.71	....	2.73	4.68	4.83	5.39
Second	....	0.41	....	2.63	4.65	4.73	5.31
Third	....	....	....	2.70	4.65	4.72	5.32
First annual	....	....	....	....	3.49	4.94	5.92
Second annual	....	....	....	....	....	3.73	5.68
Third annual	....	....	....	....	....	....	4.52
Corporate profits with IVA and CCAdj							
Third	....	....	....	8.41	12.37	14.21	16.55
First annual	....	....	....	....	7.16	11.62	13.45
Second annual	....	....	....	....	....	7.99	10.07
Third annual	....	....	....	....	....	....	7.85
Net interest and miscellaneous payments							
Advance	1.66	3.75	....	8.17	11.68	14.29	14.50
Second	....	2.60	....	6.84	9.91	10.92	11.59
Third	....	....	....	6.96	10.09	11.01	11.73
First annual	....	....	....	....	7.88	10.75	10.87
Second annual	....	....	....	....	....	7.14	7.72
Third annual	....	....	....	....	....	....	6.07

* Fourth estimates began in 2002, and apply only to GDI, national income, and compensation of employees.

Table 13. Distribution of Revisions Around Mean Revision, Third Estimates to the Latest Estimates, Changes in GDI and Its Major Components, 1993–2015

	Percent			Number of quarters within 1 standard deviation	Percentage of quarters within 1 standard deviation
	−1 standard deviation	Mean	+1 standard deviation		
Gross domestic income	**−1.94**	**−0.05**	**1.84**	**64**	**70**
Private consumption of fixed capital	−23.79	−0.68	22.43	86	93
Taxes on production and imports	−2.86	0.33	3.52	73	79
National income	−3.13	−0.06	3.01	72	78
Compensation of employees	−3.14	0	3.14	66	72
Proprietors' income	−7.96	0.6	9.16	69	75
Nonfarm proprietors' income	−6.24	0.54	7.32	71	77
Corporate profits with IVA and CCAdj	−25.79	−0.94	23.91	72	78
Net interest and miscellaneous payments	−16.23	−0.77	14.69	64	70

CCAdj Capital consumption adjustment
NOTE. The total number of quarters in the sample is 92.

Table 14. Size of Third Estimates of Changes in GDI Versus Size of Revisions From Third to Latest Estimates of GDI, 1993–2015

[Number of quarters]

Revision (percentage points)	Third estimates (percentage points)					
	Less than 0	0 to 2	2 to 4	4 to 6	6 to 8	More than 8
Greater than 4	1	0	2	1	0	0
2 to 4	0	0	2	3	3	1
0 to 2	1	3	6	9	6	3
–2 to 0	1	2	13	8	11	3
–4 to –2	1	0	3	4	4	0
Less than –4	0	0	0	0	1	0

GDI Gross domestic income
NOTE. The total number of quarters in the sample is 92.

the revisions (third to latest) cluster between –2 percentage points and 2 percentage point. The pattern observed here is somewhat similar to that reported in table 6 for real GDP. There appears to be nothing systematic about revisions to GDI (third to latest) that are correlated with the size of the third estimates.

Revisions to Annual Estimates of GDI

Summary statistics for revisions of annual estimates of GDI growth rates and its major components are presented in table 15. The estimates are expressed in terms of percentage points of the annual estimates. As with the quarterly estimates, the mean revisions are small in magnitude and vary in sign. The early annual estimates are similar to the third current quarterly estimates, and their mean revisions are therefore similar to those of previous estimates of the same vintage.

The MRs for GDI and its components are a fraction of the size of those for the current quarterly estimates. The same pattern is observed when comparing annual estimates of GDP with the quarterly estimates, and the same reasoning applies: annual estimates are not subject to revisions based on changes to seasonal adjustment factors. The MARs for GDI tend to decline with each successive estimate. These declines reflect the incorporation of newly received annual source data that are more complete or are revised from earlier data. In particular, the second annual vintage is the first to incorporate data from the Statistics of Income from the Internal Revenue Service (IRS), so the drop in MARs should be most noticeable moving from the first annual estimate to the second annual estimate for GDI and its components. For example, the MAR for GDI declines 0.27 percentage point from the first annual estimate to the second annual estimate and then increases slightly to the third annual estimate. The MAR for net interest is notable, dropping 3.57 percentage points from the first annual estimate to the second annual estimate and then increasing slightly from the second annual estimate to third annual estimate.

Revisions to Averages of GDP and GDI

In national economic accounting, GDP and GDI are conceptually equal. GDP measures overall economic activity by final expenditures, and GDI measures economic activity by the incomes generated from producing GDP. In practice, GDP and GDI differ because they are constructed using different sources of data. The different source data produce different results for a number of reasons, including sampling errors, coverage differences, and timing differences of when expenditures and incomes are recorded.[9] GDP and GDI are two ways of measuring aggregate economic activity, so while some of BEA's data users prefer one over the other, many users would like to have both sets of information because they complement each other. In response to this demand from its data users, BEA started, in July 2015, to publish a new series that averages GDP and GDI, providing users another way to track U.S. economic growth.

9. For a discussion of the timing of GDP and GDI estimates and the source data available for each estimate, see Fixler, Greenaway-McGreevey, and Grimm. (2014) and Holdren (2014).

Table 15. Mean Revisions and Mean Absolute Revisions of Annual Estimates of GDI and Its Major Components, Annual Vintages to Latest Estimates, 1993–2015

[Percentage points]

	Mean revision	Mean absolute revision
Gross domestic income		
Early annual	0.07	0.63
First annual	0.06	0.57
Second annual	0.10	0.30
Third annual	0.19	0.38
Private consumption of fixed capital		
Early annual	0.49	1.88
First annual	0.51	1.74
Second annual	0.68	1.48
Third annual	–0.37	1.53
Taxes on production and imports		
Early annual	0.40	1.19
First annual	0.27	0.81
Second annual	0.13	0.70
Third annual	0.02	0.54
National income		
Early annual	0.04	0.74
First annual	0.10	0.67
Second annual	0.12	0.42
Third annual	0.22	0.44
Compensation of employees		
Early annual	–0.11	0.68
First annual	–0.01	0.31
Second annual	0.03	0.31
Third annual	0.03	0.38
Proprietors' income		
Early annual	0.80	2.73
First annual	0.73	3.62
Second annual	0.78	3.25
Third annual	1.47	3.19
Nonfarm proprietors' income		
Early annual	0.68	3.11
First annual	0.79	3.60
Second annual	0.77	3.34
Third annual	1.50	3.27
Rental income of persons		
Corporate profits with IVA and CCAdj		
Early annual	–0.23	6.09
First annual	–0.36	4.70
Second annual	–0.66	2.55
Third annual	0.50	2.95
Net interest and miscellaneous payments		
Early annual	0.14	8.29
First annual	1.15	7.33
Second annual	0.68	3.76
Third annual	–1.36	3.87

CCAdj Capital consumption adjustment   IVA Inventory valuation adjustment

The MRs and MARs of the current-dollar average of GDP and GDI series from the third estimate onwards, compared with subsequent annual revisions and the latest available data, are presented in table 16.[10] In order to conduct a fair comparison across the vintages, the sample period is standardized here as 1993–2013.[11]

10. GDI is not available when the advance estimates of GDP are released, and it is only available for the first three quarters of the year when it is released with the second estimate of GDP. Therefore, for a comparable and continuous quarterly average series, the third estimate would be the earliest vintage.

11. The latest third annual revision data is only available for quarters up to fourth quarter of 2013, so to maintain the same number of observations for each cell in table 16, the sample period is truncated to end in the fourth quarter of 2013. The only exception is the MR or MAR for latest estimate minus the third annual estimate, where the sample is even shorter, from 1993 to 2010, because the third annual estimate would be equivalent to the latest estimate from the fourth quarter of 2010 forward, so if any quarters beyond that is included, the resulting zero revisions would bias the mean revision downwards.

Table 16. Revisions to Successive Vintages of Estimates of Quarterly Changes to Later Vintages of Estimates, 1993:I–2013:IV

[Percentage points]

Mean absolute revisions

Vintage of estimates	Vintage of revision used as standard			
	First annual	Second annual	Third annual	Latest
Average of gross domestic product and gross domestic income	First annual	Second annual	Third annual	Latest
Third	0.68	0.90	0.99	1.07
First annual		0.67	0.88	0.96
Second annual			0.51	0.80
Third annual				0.62
Gross domestic product	First annual	Second annual	Third annual	Latest
Third	0.71	0.93	1.10	1.25
First annual		0.64	0.83	0.99
Second annual			0.47	0.82
Third annual				0.62
Gross domestic income	First annual	Second annual	Third annual	Latest
Third	0.92	1.17	1.40	1.49
First annual		0.97	1.34	1.56
Second annual			0.77	1.15
Third annual				0.90

Mean revisions

Vintage of estimates	Vintage of revision used as standard			
	First annual	Second annual	Third annual	Latest
Average of gross domestic product and gross domestic income	First annual	Second annual	Third annual	Latest
Third	−0.09	−0.26	−0.25	−0.13
First annual		−0.17	−0.16	−0.04
Second annual			0.01	0.13
Third annual				0.15
Gross domestic product	First annual	Second annual	Third annual	Latest
Third	−0.06	−0.21	−0.21	−0.12
First annual		−0.15	−0.15	−0.06
Second annual			0.00	0.09
Third annual				0.10
Gross domestic income	First annual	Second annual	Third annual	Latest
Third	−0.13	−0.31	−0.30	−0.14
First annual		−0.19	−0.18	−0.01
Second annual			0.01	0.17
Third annual				0.19

*Sample size is smaller for the latest estimate minus the third annual because these two estimates are identical from fourth quarter of 2010 forward.

MRs increase when the first annual estimate up to the third annual estimate are used as standards. But for the latest available estimate, the MR declines. Specifically, the MR is −0.09 percentage point for the third vintage when the first annual revision is used as standard. The MR increases to −0.26 percentage point when the second annual revision is used as standard, then hovers around that number with the third annual revision as standard. The MR then falls to −0.13 percentage point when comparing the latest estimate to the third annual estimate. But for the second annual vintage, the MR increases when the latest estimate is used as the standard rather than the third annual estimate (from 0.01 percentage point to 0.13 percentage point). The same patterns are observed if we look at current-dollar GDP and GDI series (reported in table 16 as well). The pattern may be explained by the fact that on average, for both GDP and GDI (and therefore, the average of GDP and GDI), the revisions are negative as later vintages are used as the standard except when moving from the third annual estimate to the latest available estimate. The revision produced by the latest available estimate less the third annual estimate, which includes comprehensive revisions, is on average a relatively large positive number. This reverses some of the negative revisions observed for earlier vintage comparisons.

For the MARs of the average series, as expected, the numbers increase as later and later vintages are used as the standard. The MAR (and the corresponding MR) appears to be smallest going from the second annual estimate to the third annual estimate because by the second annual estimate, there are very little trend-based estimates and very little use of indirect sources; most direct indicators have also been replaced by comprehensive data. So the change in data, moving from the second annual revision to the third annual revision, is minimal and involves only some additional conversion of direct indicators to comprehensive data.

The data shows that the MARs of the average series are smaller than the MARs for GDI for all vintages and smaller or equal to most of the MARs for GDP. If both GDP and GDI are interpreted as the sums of the unobserved true economic activity and of measurement errors, it is possible to infer that the weighted average series of the two is a more reliable measure of activity than either GDP or GDI alone because some of the measurement errors are averaged out, reducing subsequent revisions in the weighted average. However, the better reliability observed using the average of GDP and GDI will not lead to a better understanding of the detailed workings of the economy because there is no

obvious way of distributing the results of the averaging among the major components of GDP and GDI. Thus, the average series can only provide supplemental summary information about the recent course of the aggregate economy.

Summary and Conclusions

The results of this review are generally consistent with those of previous BEA studies.

- The estimates of GDP and GDI appear accurate; the MARs for early vintages to the latest vintage of both measures are between 1.21 percentage points and 1.53 percentage points.
- The MRs for both GDP and GDI for early vintages to the latest vintage are near zero and are not statistically significant. Nonzero values are not indications of bias.
- The MARs and MRs for the individual quarters show substantial differences. First-quarter mean revisions are relatively large and negative, while second-quarter mean revisions are large and positive for both current-dollar and real GDP.
- Revisions to GDP generally appear to be driven by new information rather than by measurement error; thus, BEA revisions provide better measures of aggregate economic activity.
- The MARs for the annual estimates of GDP, GDI, and their major components are less than half of those for the current quarterly estimates; they decline steadily in size from the early annual estimates to the third annual estimates.
- The new average of GDP and GDI series appears to be a more reliable measure of aggregate economic activity, given its lower MARs, compared with those for GDP and for GDI. However, the average series can only be constructed in aggregate because the results of the average cannot be distributed among the major components of GDP and GDI.

In addition to the statistical measures of reliability, BEA examines qualitative measures of reliability that focus on the overall performance of the three vintages of the current quarterly estimates of growth, relative to the latest quarterly estimates of growth. More specifically, the qualitative measures address three questions about current-dollar GDP and current-dollar GDI.

- Does the sign (+/−) of all the current quarterly vintages of estimates of growth match that of the latest estimate? This is a measure of directional reliability. For GDP and GDI, the signs match 96 percent of the time.
- Does the sign of the difference in growth between quarters for all current quarterly estimates match that of the latest? This is a measure of the reliability of the acceleration or deceleration of the estimates. For GDP, the estimates match about 62 percent of the time. For GDI, they match about 67 percent of the time.
- Do the magnitudes of the all the current quarterly estimates fall above, within, or below one standard deviation of the mean growth of the latest estimate over the period? This is a measure of reliability relative to trend. For 1993–2015, the latest estimates of GDP had a mean of 4.51 percent and a standard deviation of 2.72, and the current quarterly vintages fell within one standard deviation of the mean (between1.79 and 7.23) about 81 percent of the time. For GDI, the corresponding mean is 4.68 percent and the standard deviation is 3.09, and the current quarterly vintage fell between one standard deviation from the mean (between 1.59 and 7.77) also about 81 percent of the time.

It is important to note that the frequency counts were based on a comparison between all of the current quarterly vintages for a quarter and the latest quarterly vintage for the quarter. The percentages would have been higher had a two-out-of-three rule been used instead. In addition, for GDI, the comparison is between the third current quarterly estimate and the latest, because there are no advance and second estimates.

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Appendix Table A. Standard Deviations of Revisions to Successive Vintages of Changes in Real GDP in 1993–2015

[Percentage points]

	Vintage of revision used as standard					
	Second	Third	Annual First	Annual Second	Annual Third	Latest
Gross domestic product						
Advance	0.79	0.87	1.16	1.31	1.52	1.54
Second				1.27	1.49	1.53
Third			1.10	1.26	1.46	1.51
First annual				0.90	1.12	1.22
Second annual					0.88	1.16
Third annual						0.77
Personal consumption expenditures						
Advance	0.38	0.51	1.03	1.07	1.07	1.18
Second				0.96	0.94	1.06
Third			0.90	0.97	0.93	1.04
First annual				0.69	0.74	0.94
Second annual					0.54	0.72
Third annual						
Gross private domestic investment						
Advance	3.65	3.77	6.66	6.92	7.35	6.67
Second				6.33	7.17	7.02
Third			5.79	5.98	6.86	6.81
First annual				4.26	5.58	6.08
Second annual					3.67	4.69
Third annual						3.68
Fixed investment						
Advance	1.51	1.79	3.26	3.42	3.80	3.81
Second				3.09	3.62	3.71
Third			2.68	3.03	3.56	3.64
First annual				2.24	2.93	3.25
Second annual					2.16	2.42
Third annual						2.10
Exports						
Advance	2.51	2.80	3.66	4.22	4.39	4.68
Second				3.36	3.73	4.06
Third			2.67	3.21	3.56	3.96
First annual				2.30	2.75	3.24
Second annual					1.57	2.63
Third annual						2.30
Imports						
Advance	3.39	3.67	4.85	4.99	5.13	5.02
Second				3.70	3.80	3.80
Third			3.20	3.59	3.60	3.72
First annual				2.58	3.00	3.03
Second annual					2.10	2.61
Third annual						2.17
Federal government						
Advance	1.85	1.76	2.98	3.11	3.78	3.61
Second				3.11	3.76	3.75
Third			2.73	3.11	3.80	3.68
First annual				2.21	2.94	3.12
Second annual					2.12	2.57
Third annual						2.22
State and local government						
Advance	0.89	1.03	3.37	1.71	2.08	2.06
Second				1.57	1.92	1.97
Third			3.13	1.45	1.86	1.93
First annual				3.05	3.44	3.39
Second annual					1.43	1.38
Third annual						1.16

Appendix Table B. Mean Revisions to Successive Vintages of Changes in Real GDP in 1993–2015

[Percentage points]

	Vintage of revision used as standard					
	Second	Third	Annual First	Annual Second	Annual Third	Latest
Gross domestic product						
Advance	0.06	0.08	0.02	–0.27	–0.31	–0.07
Second		0.02	–0.04	–0.32	–0.37	–0.13
Third			–0.06	–0.33	–0.38	–0.15
First annual				–0.26		–0.10
Second annual					–0.03	0.17
Third annual						0.23
Personal consumption expenditures						
Advance	0.02	0.01	–0.08	–0.21	–0.38	–0.11
Second		–0.01	–0.10	–0.24	–0.40	–0.13
Third			–0.10	–0.22	–0.39	–0.12
First annual				–0.13	–0.27	–0.03
Second annual					–0.12	0.10
Third annual						0.26
Gross private domestic investment						
Advance	0.43	0.48	0.40	–0.92	–0.73	–0.35
Second		0.05	–0.03	–1.26	–1.11	–0.78
Third			–0.08	–1.30	–1.13	–0.83
First annual				–1.16	–0.97	–0.78
Second annual					0.20	0.39
Third annual						0.23
Fixed investment						
Advance	0.59	0.81	0.89	–0.46	–0.51	0.04
Second		0.22	0.29	–1.03	–1.03	–0.56
Third			0.08	–1.23	–1.19	–0.77
First annual				–1.25	–1.20	–0.89
Second annual					0.10	0.38
Third annual						0.34
Exports						
Advance	0.85	0.97	0.77	1.27	1.36	1.09
Second		0.12	–0.08	0.36	0.40	0.24
Third			–0.20	0.26	0.29	0.13
First annual				0.40	0.42	0.34
Second annual					0.03	–0.06
Third annual						–0.11
Imports						
Advance	0.84	0.73	0.59	0.81	0.79	0.73
Second		–0.11	–0.25	–0.05	–0.07	–0.11
Third			–0.14	0.09	0.09	0.00
First annual				0.22	0.22	0.14
Second annual					0.03	–0.08
Third annual						–0.12
Federal government						
Advance	–0.06	–0.13	0.09	–0.11	–0.07	–0.12
Second		–0.07	0.15	–0.05	–0.01	–0.06
Third			0.22	0.03	0.07	0.01
First annual				–0.16	–0.18	–0.22
Second annual					–0.04	–0.07
Third annual						
State and local government						
Advance	0.17	0.16	–0.05	–0.11	0.11	0.11
Second				–0.27	–0.07	–0.06
Third			–0.20	–0.25	–0.04	–0.05
First annual				0.02	0.25	0.16
Second annual					0.24	0.15
Third annual						–0.11