

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 description of the condition of the U.S. economy. Their two featured measures—gross domestic product (GDP) and gross domestic income (GDI)—are summary measures of the same concept of economic activity. 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 domestic income and product account. In principle, GDP and GDI give the same measure of economic activity, but in practice, they differ because each is estimated from different source data.¹

Measuring the accuracy of national accounts estimates is a long-standing challenge for three main reasons. One, the early GDP and GDI estimates are based on partial data and are intended to provide an “early read” on the general picture of economic activity for decision-makers. These early estimates are revised as more complete and accurate source data become available. Two, the source data for the national accounts come from a mix of survey, tax, and other business and administrative data; these source data are subject to a mix of sampling and nonsampling errors and biases that cannot be measured in terms of standard errors. Three, the national accounts are regularly revised to reflect the changes in the economic concepts and methods necessary for these accounts to provide a picture of the evolving U.S. economy that is relevant and accurate for today’s economy. These updates range from expanding the definition of investment from investments in plant and equipment to include investments in computer software to updating seasonal adjustment factors to reflect the most recent seasonal patterns.

Accuracy, as a result, cannot be assessed by conventional statistical measures, such as standard errors. It can, however, be assessed by examining magnitudes

and patterns of revisions. Some of the revisions to the estimates are due to the replacement of early extrapolations for missing source data or preliminary sample survey results with more complete and accurate annual and benchmark data. However, some of the revisions to GDP and GDI are the result of updates to the concepts against which the early estimates are benchmarked. These revisions to concepts and definitions can be significant. In the last six comprehensive revisions (2009, 2003, 1999, 1995, 1991, and 1985), the average change in the levels of current-dollar GDP for selected periods was 2 percent, and of that change, about one-third resulted from changes in concepts and definitions and about two-thirds resulted from statistical revisions. (For the 1996 and 1999 comprehensive revisions, the changes due to definitional changes exceeded those due to statistical revisions.)

BEA’s standard of accuracy is based on a comparison of its early estimates to its “latest” estimates, which are revised to incorporate the most up-to-date concepts, statistical methods, and the most complete and accurate source data. These revisions are indications of the accuracy of BEA’s early estimates; that is, these 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 provide a consistent and accurate picture of general economic activity. Economic policy decisions should not need to be reconsidered in the light of revisions to GDP estimates, and policymakers should be able to rely on the early estimates as accurate indicators of the state of the economy. More specifically, BEA judges the accuracy of its early estimates by whether they present the same general picture of economic activity as its 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 to growth and contractions

1. Neither GDP nor GDI is a measure of welfare. BEA has previously published articles by Edward Dennison (1971) and Arthur Okun (1971) that argued that it is not possible to modify the NIPAs to produce unambiguous measures of welfare.

- The pattern 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

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 third estimate (see the box “Vintages and Timing of Revisions”). Because the latest available estimates incorporate the estimates from the most recent comprehensive revision, they incorporate all the available source data that are believed to be the most reliable. Thus, the latest available estimates are assumed to be the best estimates and are used as the standards for accuracy.

Over the long run, this study finds the following results:

- Revisions to long-term growth rates are small, averaging less than 0.1 percentage point for average growth rates over the comprehensive benchmark revisions between 1985 and 2009.
- There are no substantial revisions—as measured by the shares of GDP or GDI—in key measures, such as investment and government expenditures or the national saving rate.
- The revisions to the contributions of key components of GDP growth are small and do not substantially change the ordinal rankings of the components’ contributions to growth over expansions and contractions.
- The overall pattern of change in GDP over business cycles is little changed by the revisions (charts 1 and 2).

In the short run, there are three vintages of “current quarterly” estimates of GDP, the advance, the second, and the third estimates. 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 with data. The three vintages of GDP estimates successfully indicate the following:

- The direction of change in real GDP 97 percent of the time
- The acceleration or deceleration of growth about 72 percent of the time
- The relative magnitude of growth—whether it was above, near, or below trend (near trend is less than one standard deviation from the mean) more than four-fifths of the time
- The cyclical peaks before five of the six recessions in 1969–2006

Vintages and Timing of Revisions

The Bureau of Economic Analysis (BEA) 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 are revised.

For GDI, BEA prepares a fourth vintage of quarterly estimates. These revised estimates, which incorporate data from the Quarterly Census of Employment and Wages, are released with the second estimates of GDP for a quarter. These revised estimates are available beginning with the estimates for the first quarter of 2002.

BEA initially prepares four vintages of annual estimates—early annual, first annual, second annual, and third annual estimates. For GDP and GDI, the early annual estimates for a year are the sum of the third quar-

terly estimates for that year. The estimates of GDP are released in March with the third estimates for the fourth quarter of the year. The estimates of GDI are released with the release of the fourth estimate for the fourth quarter of the year in late May. In most years, the quarterly estimates for the first quarter of the previous year is from the first current annual estimate released the previous summer.) 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 not revised or released again until the next comprehensive revision.

Annual NIPA revisions 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 2009. It presented revised annual estimates for 1929–2008 and revised quarterly estimates for 1947–2008. The latest available estimates are the comprehensive revision estimates for 1947–2006, the third annual estimates for 2007, the second annual estimates for 2008, and the first annual estimates for 2009.

- The cyclical troughs of four of the six recessions²

In addition, regardless of vintage, average absolute revisions to GDP and GDI are generally smaller than those to most of their components, because revisions to the components tend to offset each other.

The early quarterly estimates are replaced successively with three vintages of “current annual” estimates that are primarily based on increasingly complete annual source data. For a description of GDP source data and the revision process see Grimm and Weadock (2006). For a description of a similar progression of

2. No major measure of economic activity has captured the cyclical peaks and troughs in all the postwar recessions. This applies to the quarterly measures of GDP and GDI and to the four monthly measures emphasized by the Business Cycle Dating Committee of the National Bureau of Economic Research in determining peaks and troughs; see Grimm (2005).

source data for GDI, see Holdren and Grimm (2008).

Revisions are typically measured in percent changes at annual rates. This avoids distortions arising from the trend growth in economic activity that would otherwise make revisions to later year estimates seem relatively larger than those of earlier estimates. For example, a 1-percentage-point revision to current-dollar GDP for 2009 would be worth about four times as many dollars as a 1-percentage-point revision to GDP for 1983.

Other findings in this study include the following:

- Revisions in both current-dollar and real GDP and their major components are roughly similar to each other.
- Revisions before and during recessions are similar to revisions in 1983–2009.

Chart 1. Percent Change in Real Gross Domestic Product, 1983–1996

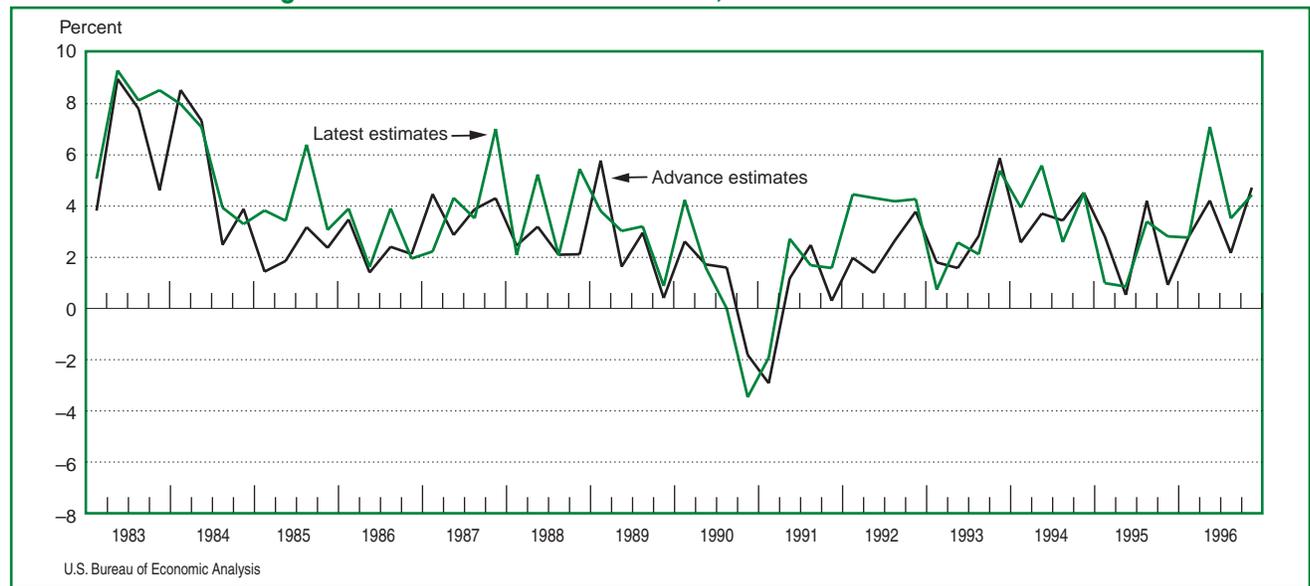
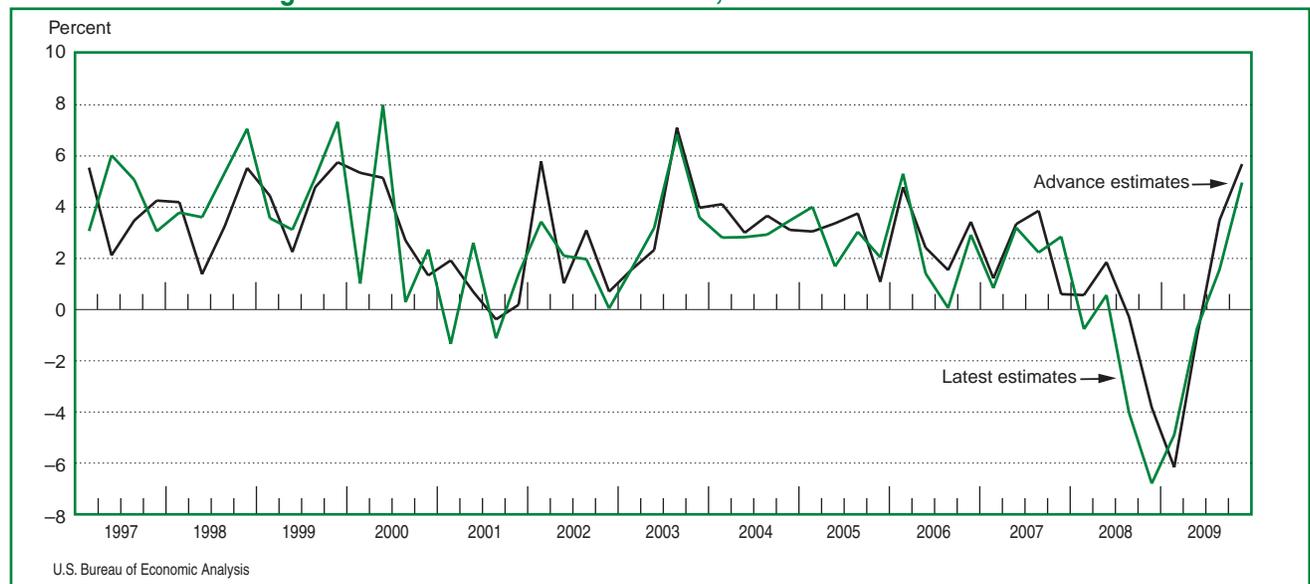


Chart 2. Percent Change in Real Gross Domestic Product, 1997–2009



- Revisions to the contributions of the major components of GDP are small in comparison to their year-to-year fluctuations, and the ordinal rankings of the sizes of the contributions of the components are stable across vintages of estimates.
- The ratios of GDI to its major components retain their patterns from the current quarterly estimates to those in place before and after the 2009 comprehensive NIPA revision.
- For some purposes, an average of GDP and GDI is superior to either measure alone.

The mean absolute revisions (MARs) to the annual rates of change—that is, taking the average of the revisions without regard to sign—from the current quarterly estimates for 1983–2009 to the latest available estimates of current-dollar and real GDP and GDI have averaged modestly more than 1 percentage point. That represents a decline from about 3 percentage points for pre-1960 values for current-dollar GDP (see Fixler and Grimm 2008).

The MARs within the current quarterly estimates are somewhat smaller. For example, the MAR from the advance estimates to the second estimates of real GDP is 0.5 percentage point, and the MAR from the advance estimates to the third estimates is 0.6 percentage point. The MAR from the second estimates to the third estimates is 0.3 percentage point.

The MAR is a measure of accuracy that reflects both the mean and the spread of the revision so that even if the revision is zero on average, the MAR will not be zero, because the variance of the revision will be positive. In order to assess whether the revision is zero on average, it is necessary to use another measure of estimate accuracy, such as the mean revision.

Mean revisions (MRs) indicate whether the revisions are generally positive or negative. Because revisions may be offsetting, the MRs are much smaller than the MARs. The MR from the advance estimates to the latest estimates of GDP is 0.3 percentage point. As discussed below, much of this MR reflects revisions that stem from the comprehensive revisions. The MRs from both the second and third estimates to the latest available estimates are both somewhat more than 0.1 percentage point.

To put these MRs into context, for 1983–2009, the mean growth rate of real GDP was 2.8 percent.³ The growth rates ranged from –6.8 percent to 9.3 percent.

The remainder of this article discusses (1) revisions to quarterly estimates of GDP, (2) revisions to annual estimates of GDP, (3) revisions to quarterly estimates of GDI, (4) revisions to annual estimates of GDI, (5) the relationships of the quarterly estimates of GDP and

to those of GDI, (6) revisions to quarterly estimates of the price indexes for GDP, and (7) an alternative method for examining revisions to current-dollar estimates of GDP. These sections are followed by a brief summary and conclusions.

Revisions to Quarterly Estimates of GDP

The measures of reliability featured here are MRs and MARs from the earlier estimates to the latest available estimates (see the box “Mean Revisions, Mean Absolute Revisions, Standard Deviations, and Correlations of Revisions”). Standard deviations of the revisions are also shown in selected tables and provide supplementary information to that provided by MARs. The three measures are shown for revisions from the three current quarterly estimates to the latest available estimates.

The measures of revisions for real and current-dollar GDP and its major components are shown in table 1. In 1983–2009, for all three current quarterly vintages, the MARs for current-dollar GDP are about 1.1 percentage points, and those for real GDP are about 1.3 percentage points. The standard deviations have a similar pattern, with those for current-dollar GDP being about 1.4 percentage points and those for real GDP being about 1.6 percentage points. Thus, there are essentially no reductions in MARs or standard deviations from the advance estimates to the second and third estimates of both current-dollar and real GDP even though some additional or revised source data are incorporated and some trend-based projections are replaced with source data (see Grimm and Weadock 2006).

The lack of declines in the MARs of GDP in successive vintages of current quarterly estimates is a phenomenon that has been noted in nearly all of BEA’s analyses of revisions. Alan Young (1996) suggested reasons why the sizes of later current quarterly estimates have revisions that are similar to those of earlier vintage revisions. One reason is that the judgmental trend-based estimates used for some portions of the estimates are not subject to revisions due to revised seasonal adjustment factors; an earlier revision study found that revisions to the seasonal adjustments were roughly as large as revisions to seasonally unadjusted estimates. (In addition to the studies listed in the references to this article, see earlier studies by BEA in the references of Fixler and Grimm 2002, 27.)

Another analysis of the reliability of early estimates that incorporate highly incomplete information can be made by comparing MARs of the various vintages with MARs of the average forecasts of the Survey of Professional Forecasters—that are available on the Web site of the Federal Reserve Bank of Philadelphia.

3. This growth rate was affected by the most recent recession. The growth rate from 1983 to 2007 was 3.1 percent.

Mean Revisions, Mean Absolute Revisions, Standard Deviations, and Correlations of Revisions

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 change or percent change in the later vintage quarterly or annual estimates, and E is the change or 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.

$$MR = \sum_t R_t / n, t = 1, \dots, n$$

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.

$$MAR = \sum_t |R_t| / n, t = 1, \dots, n$$

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

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

Correlations between revisions to two GDP components, R_i and R_j , may be calculated to examine the relationship between the revisions. Let MR_i and MR_j be the mean revisions of R_i and R_j , respectively. The correlation coefficient of the two sets of revisions is

$$Corr_{ij} = [\sum_t (R_{it} - MR_i)(R_{jt} - MR_j)] / [\{\sum_t (R_{it} - MR_i)^2 (R_{jt} - MR_j)^2\}^{1/2}], t = 1, \dots, n.$$

Table 1. Average Revisions to Quarterly Estimates of GDP and Its Major Components in 1983–2009

[Percentage points]

	Mean revision		Standard deviation		Mean absolute revision			Mean revision		Standard deviation		Mean absolute revision	
	Current-dollar	Real	Current-dollar	Real	Current-dollar	Real		Current-dollar	Real	Current-dollar	Real	Current-dollar	Real
Gross domestic product							Second.....	* -1.06	* -1.27	5.20	5.85	4.13	4.53
Advance.....	* 0.31	0.21	1.41	1.62	1.16	1.31	Third.....	* -1.42	* -1.65	5.01	5.68	4.14	4.60
Second.....	0.13	0.10	1.35	1.60	1.06	1.29	Residential						
Third.....	0.14	0.12	1.39	1.62	1.06	1.32	Advance.....	0.19	-0.48	6.10	6.00	4.68	4.46
Personal consumption expenditures							Second.....	0.10	-0.24	5.67	6.08	4.31	4.67
Advance.....	0.29	0.20	1.52	1.49	1.18	1.19	Third.....	-0.01	-0.38	6.01	6.14	4.13	4.49
Second.....	0.20	0.11	1.47	1.41	1.11	1.09	Change in private inventories¹						
Third.....	0.21	0.14	1.51	1.43	1.10	1.11	Net exports of goods and services¹						
Durable goods							Exports						
Advance.....	0.40	0.36	5.39	5.43	4.17	4.09	Advance.....	* 1.92	* 1.74	5.47	5.38	4.55	4.36
Second.....	0.36	0.30	5.25	5.26	4.17	4.13	Second.....	0.72	0.69	4.87	4.74	3.81	3.62
Third.....	0.30	0.21	5.35	5.36	4.15	4.12	Third.....	0.36	0.36	4.88	4.82	3.85	3.69
Nondurable goods							Imports						
Advance.....	0.18	0.45	2.62	2.60	1.99	2.02	Advance.....	0.69	0.10	9.10	9.81	6.02	6.55
Second.....	-0.07	0.21	2.38	2.39	1.75	1.88	Second.....	0.23	-0.81	8.34	10.31	5.17	5.86
Third.....	-0.05	0.24	2.43	2.39	1.76	1.86	Third.....	-0.24	-1.03	8.57	10.43	5.11	5.81
Services							Government consumption expenditures and gross investment						
Advance.....	0.08	-0.04	1.68	1.34	1.19	1.02	Advance.....	0.34	0.37	3.43	3.93	2.24	2.55
Second.....	0.08	-0.09	1.70	1.34	1.14	1.03	Second.....	0.10	0.14	3.44	3.85	2.23	2.46
Third.....	0.09	0.00	1.67	1.43	1.13	1.04	Third.....	0.18	0.32	3.40	3.87	2.26	2.50
Gross private domestic investment							Federal						
Advance.....	-0.46	-0.85	9.11	9.10	6.88	6.82	Advance.....	0.25	-0.06	7.68	8.88	4.80	5.28
Second.....	-0.63	-0.92	9.05	9.26	7.18	7.22	Second.....	-0.07	-0.18	7.88	8.85	4.93	5.31
Third.....	-0.71	-1.10	9.12	9.20	7.18	7.07	Third.....	0.16	0.15	7.78	8.81	4.95	5.33
Fixed investment							Defense						
Advance.....	0.12	-0.49	3.58	3.84	2.80	3.01	Advance.....	0.27	-0.47	3.40	4.60	3.52	3.01
Second.....	-0.35	* -0.83	3.34	3.65	2.59	2.90	Second.....	0.22	-0.19	3.45	3.95	3.35	2.81
Third.....	-0.52	* -1.05	3.40	3.68	2.57	3.03	Third.....	0.32	-0.16	3.47	4.03	3.36	2.78
Nonresidential							Nondefense²						
Advance.....	0.02	-0.51	4.30	4.75	3.46	3.75	Advance.....	-2.74	0.26	37.24	39.21	15.47	17.73
Second.....	-0.66	* -1.10	4.34	4.74	3.54	3.79	Second.....	-3.87	0.04	37.63	40.13	16.01	18.09
Third.....	* -0.82	* -1.34	4.25	4.72	3.40	3.85	Third.....	-2.88	0.13	34.97	38.41	15.62	17.69
Structures							State and local						
Advance.....	* 0.96	0.41	8.42	7.72	6.91	5.92	Advance.....	0.35	* 0.46	2.22	2.14	1.71	1.72
Second.....	0.13	-0.02	7.95	7.17	6.27	5.39	Second.....	0.16	0.29	2.08	2.14	1.54	1.69
Third.....	0.15	0.19	7.69	6.58	6.21	5.14	Third.....	0.18	0.34	2.10	2.16	1.58	1.69
Equipment and software													
Advance.....	-0.25	-0.48	4.90	5.75	3.83	4.38							

* Significant at p-values ≤ 0.05 .

1. Percentage changes cannot be calculated because of negative values in some quarters.

2. A 1991 change in the accounting treatment of purchases and sales of agricultural goods by the Commodity

Credit Corporation affected nondefense revisions, but not GDP revisions.

The MARs for the advance, second, and third estimates for 1992–2009 are 4.54, 4.57, and 4.56, respectively.

These average forecasts are based on a number of private forecasts and are made soon after the advance estimates for the previous quarter. The MARs for these forecasts in 1983–2009 are 1.6 percentage points for real GDP and 1.9 percentage points for current-dollar GDP; these MARs are only moderately larger than the MARs for the current quarterly vintage estimates.

The MARs for current-dollar personal consumption expenditures (PCE) are only slightly larger than those for GDP, at 1.1 percentage points to 1.2 percentage points, and the MARs for real PCE are 0.1 percentage point to 0.2 percentage point smaller than those for all the vintages of the GDP estimates for 1983–2001. Similarly, the standard deviations for current-dollar PCE are about 0.1 percentage point larger than those for current-dollar GDP, and the standard deviations for real PCE are about 0.1 percentage point smaller than those for real GDP. The MARs for both current-dollar and real PCE are about 1.2 percentage points for the advance estimates and 1.1 percentage points for the second and third estimates.

The MARs for most major components of GDP are generally similar for both current-dollar and real estimates, usually within a few tenths of a percentage point of one another. Because most estimates are prepared in current dollars and deflated to obtain real estimates and because the deflators are also subject to revisions, it is generally best to emphasize the current-dollar revisions. Unless otherwise specified, the following discussion is valid for both current-dollar and real estimates.

The reclassification of the detailed components of PCE as part of the 2009 comprehensive revision affected the composition of the three major components of PCE, but not total PCE. The effects of the reclassification appear to be minimal with regard to revisions to the major PCE components in both current and real dollars, though these effects cannot be separated from the effects of other changes. The MARs for PCE for durable goods declined slightly, those for nondurable goods increased slightly, and those for services were largely unchanged; the MARs are generally within about 0.1 percentage point of those in the previous study (see Fixler and Grimm 2008). The MARs for durable goods are more than twice those for nondurable goods and four times those for services.

The MARs for gross private domestic investment are considerably larger than those for PCE and its major components; they range from 6.8 to 7.2 percentage points. As will be further discussed below, these large MARs reflect large revisions to change in private inventories. MARs for fixed investment, which excludes change in private inventories, are less than half as large as those for total investment. Within fixed investment,

the MARs for both nonresidential investment and residential investment are both noticeably larger than the total, with those for residential investment being larger. Within nonresidential investment, the MARs for both structures and equipment and software investment are considerably larger than the MARs for total nonresidential fixed investment. At all levels of disaggregation, there is little or no tendency for the MARs to decline for later vintages.

The MARs for both exports and imports range from somewhat less than 4 percentage points to somewhat more than 6 percentage points; they are generally in the same size range as the components of fixed investment. Unlike those for the investment components, the MARs decline by about a seventh from the advance estimates to the second estimates. The MARs remain about unchanged for the third estimates.

The MARs for total government consumption expenditures and gross investment are roughly twice the size of those for PCE, but smaller than those for the other major components of GDP. The MARs for state and local government consumption expenditures and gross investment are less than half the sizes of those for Federal defense expenditures and much smaller than those for nondefense expenditures. The revisions to the estimates of nondefense expenditures reflect a change in the accounting treatment of purchases and sales of agricultural goods by the Commodity Credit Corporation that was made in 1991. This accounting change is responsible for more than two-thirds of the MARs for nondefense expenditures, but it does not affect the estimates of GDP.

The MRs for GDP and its components are smaller, 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. This occurs because individual revisions are both positive and negative and 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. As discussed below, comprehensive revisions contain definitional revisions that have generally tended to increase both the levels and the growth rates of GDP.

The MRs for both current-dollar and real GDP are rather small and positive. The MR for the advance estimate of current-dollar GDP is 0.3 percentage point and that for real GDP is 0.2 percentage point. The MRs for the second and third estimates of both current-dollar and real GDP are somewhat more than 0.1 percentage point. The MRs of the components and subcomponents of current-dollar and real GDP are both positive and negative, and the sign of the MR may vary with successive vintages. The MRs are generally

less than 1.0 percentage point for most measures and vintages. Larger negative MRs for nondefense expenditures reflect an accounting change in the classification of Commodity Credit Corporation purchases and sales. The modest sizes of the MRs indicate that the successive estimates have preserved the trends of GDP components over time.

The MRs for GDP and its components generally do not indicate bias. These revisions reflect definitional changes that are part of comprehensive revisions that are made to improve the estimates (Fixler 2004). These definitional revisions have generally, but not universally, raised both the levels and rates of change in GDP and some components.

The revisions from the third estimates to the latest available estimates of current-dollar GDP to revisions of its major components are positively correlated (table 2). Because it is not possible to calculate percent changes for change in private inventories, both gross private domestic investment and fixed investment are shown. Revisions to imports are negatively correlated with revisions to GDP, as is expected, because imports are subtracted in the calculation of GDP. Revisions to federal government expenditures are also negatively correlated, but the correlation coefficient is not significantly different from zero.

The standard deviations of revisions are somewhat larger than the MARs for the various components, and the standard deviations for vintages have similar patterns and relationships to those of the MARs (table 1). Standard deviations also can be used to test whether the MRs are statistically significant. For 1983–2009, the MRs for the advance estimates of current-dollar GDP are statistically significant, but the MRs for the advance, second, and third estimates of real GDP are not

statistically significant.⁴ This is the first time that a statistically significant MR has been found for any estimates of GDP.⁵ As reported previously (Fixler and Grimm 2008, 19), the MRs for both the second and third estimates of both current-dollar and real equipment and software investment are also statistically significant. These estimates, in turn, are reflected in statistically significant MRs for both the second and third estimates of real (but not current-dollar) nonresidential fixed investment and fixed investment. The MRs for the advance estimates of current-dollar and real exports and of real state and local government consumption expenditures and gross investment are also statistically significant.

The signs of the correlations of revisions among the components are mixed, with nearly half of them being negative (table 2). These negative correlations are symptomatic of the tendency for revisions to components to offset one another. The offsets, in turn, are why the MARs for various vintages of GDP tend to be smaller than those for all of the major components except PCE.

Comprehensive NIPA revisions tend to increase both the levels and the growth rates of GDP. In the four of the five most recent comprehensive revisions, the MRs for current-dollar GDP were positive, with an average of 0.05 percentage point (table 3). In the periods

Table 2. Correlation Coefficients of Revisions From Third to Latest Quarterly Estimates of Real GDP and Its Major Components in 1983–2009

	GDP	Personal consumption expenditures	Gross private domestic investment	Fixed investment	Exports	Imports	Federal government consumption expenditures and gross investment
Personal consumption expenditures	0.52	.....	.....	.....	.....	.....	.....
Gross private domestic investment.....	0.48	-0.02	.....	.....	.....	.....	.....
Fixed investment.....	0.39	0.11	0.39	.....	.....	.....	.....
Exports.....	0.30	-0.10	0.17	0.13	.....	.....	.....
Imports.....	-0.31	-0.05	0.30	0.04	0.06	.....	.....
Federal government consumption expenditures and gross investment.....	-0.16	-0.13	-0.51	-0.03	-0.20	0.01	.....
State and local government consumption expenditures and gross investment.....	0.33	0.19	-0.03	0.10	-0.15	-0.15	0.00

4. The MRs for the advance to second estimates of current-dollar GDP are significant.

5. Two previous studies reported no statistically significant MRs for any current quarterly estimates of current-dollar or real GDP (see Fixler and Grimm 2005, 2008). The newly significant finding results from the addition to the sample period of about one-third more quarterly estimates, subsequent to the period that was used in the previous studies. With increasing sample size, the likelihood of statistical significance increases.

Table 3. Average Revisions to Quarterly Estimates of Current-Dollar GDP and Its Components in Comprehensive Revisions

[Percentage points]

Year of comprehensive revision GDP	Period	Mean revision	Mean absolute revision
1991	1983:I–1991:III	0.05	0.76
1996	1983:I–1995:III	-0.04	0.60
1999	1983:I–1999:II	0.16	0.54
2003	1983:I–2003:III	0.03	0.56
2009	1983:I–2009:I	0.03	0.43
Average .....	.....	0.05	0.58
2009 comprehensive revision Components	Period	Mean revision	Mean absolute revision
Personal consumption expenditures.....	1983:I–2009:I	0.02	0.30
Nonresidential fixed investment.....	1994:I–2009:I	0.42	0.78
Residential fixed investment.....	1994:I–2009:I	-0.12	0.52
Exports.....	1986:I–2009:I	-0.09	0.79
Imports.....	1986:I–2009:I	0.03	1.45
Government consumption expenditures and gross investment.....	1983:I–2009:I	-0.02	0.42

1. The first quarters of the periods vary because the revisions to estimates of some components were carried back further than others.

covered by the comprehensive revisions, the revisions are cumulative. The MARs for the five comprehensive revisions averaged nearly 0.6 percentage point.

Some of these revisions are due to the benchmarking the NIPA estimates to quinquennial input-output tables, but the MARs also reflect definitional changes and other statistical changes that are a part of comprehensive revisions. For example, a major change in the October 1999 comprehensive revision was the reclassification of business expenditures for software from intermediate consumption (which is not a component of GDP) to fixed investment. (For a discussion of this reclassification, see “Revisions to Annual Estimates of GDP.”)

Although the MR for GDP that resulted from the 2009 comprehensive NIPA revision was 0.03 percentage point, the MRs for the components range from -0.12 percentage point to 0.42 percentage point (table 3). Three of the MRs for the major GDP components were positive and three were negative, and the effects of the positive MRs outweighed those of the negative MRs. The MARs for the components range from 0.30 percentage point for PCE to 1.45 percentage points for imports. The MAR for GDP is smaller than the MARs for a majority of the components because of the negative correlations of the revisions to the components.

It is useful to examine revisions from earlier vintages of the estimates to subsequent vintages. The MARs for the quarterly GDP estimates increase rapidly from the second estimates to the first annual estimates and then more slowly; the MARs for the first annual estimates are at least two-thirds the sizes of those for the latest estimates (table 4). The MARs for the second and third estimates to the successive annual revision estimates continue to increase monotonically; similar monotonic increases from earlier to later vintages of annual revisions estimates also occur, and the MARs for all earlier vintages to the latest estimates are the largest. Because comprehensive benchmark NIPA revisions occur about every 5 years, the first annual revision contains 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 reflect the effects of these benchmark changes as well as the incorporation of increasing amounts of annual data that are available with 1-to-3-year lags.

The MARs for the latest estimates decline steadily from the advance estimates of GDP through the third annual estimates. This is consistent with the increasing accuracy of the successive later estimates, assuming

that the latest estimates are the most accurate.

These same patterns generally hold for the five major components of GDP. The MARs for the various vintages of the estimates of PCE to the latest estimates are slightly smaller than those for GDP. The MARs for the latest estimates of government expenditures are modestly larger than MARs for GDP. The MARs for three vintages of fixed investment are roughly twice as large. The MARs for the latest estimates of both exports and imports are up to twice as large for the current quarterly vintages and for the first annual revision estimates. The MARs for the second and third annual revision estimates of exports and imports are only modestly larger than those for fixed investment.

Estimates of GDP components and recent recessions

One indication of the usefulness of early vintage real GDP estimates is provided by their ability to accurately

Table 4. Mean Absolute Revisions to Successive Vintages of Changes in Current-Dollar GDP and Its Components in 1983–2009
[Percentage points]

	Vintage of revision used as standard					
	Second	Third	First annual	Second annual	Third annual	Latest
Gross domestic product						
Advance	0.55	0.68	1.03	1.15	1.16	1.22
Second		0.27	0.82	0.99	1.06	1.13
Third			0.80	0.98	1.06	1.13
First annual				0.62	0.84	1.06
Second annual					0.54	0.96
Third annual						0.88
Personal consumption expenditures						
Advance	0.38	0.44	0.80	1.00	1.10	1.18
Second		0.26	0.78	0.92	1.01	1.11
Third			0.75	0.91	1.01	1.10
First annual				0.61	0.77	1.01
Second annual					0.52	0.87
Third annual						0.72
Fixed investment						
Advance	1.39	1.63	2.51	2.91	2.87	2.80
Second		0.74	1.94	2.61	2.57	2.59
Third			1.82	2.60	2.52	2.57
First annual				1.96	2.50	2.54
Second annual					1.61	2.28
Third annual						2.11
Exports						
Advance	3.00	3.40	4.00	4.34	2.62	4.55
Second		1.57	2.86	3.14	3.62	3.81
Third			2.90	3.35	3.82	3.81
First annual				2.15	2.85	3.57
Second annual					1.87	2.76
Third annual						2.79
Imports						
Advance	3.83	3.92	5.53	5.64	5.95	6.02
Second		1.33	3.96	4.29	4.45	5.17
Third			3.84	4.29	4.27	5.11
First annual				2.42	2.56	3.71
Second annual					1.47	2.57
Third annual						2.41
Government consumption expenditures and gross investment ¹						
Advance	0.75	0.97	1.21	1.26	1.54	1.39
Second		0.29	1.09	1.24	1.52	1.37
Third			1.08	1.21	1.47	1.37
First annual				0.70	1.14	1.22
Second annual					0.87	1.03
Third annual						0.85

1. For 1992–2009, changes in the accounting treatment of Commodity Credit Corporation purchases and sales in earlier years result in MARs for this component that have no effect on the MARs for GDP.

portray the path of real GDP before, during, and after recessions. In most of this study, three recessions in the sample period of 1983–2009 are used. The most recent recession in 2007–2009 is also in this period, but only the first annual revision estimates are available for the full period of decline, and the third annual revision estimates will not be available until the second half of 2012. Vintages of GDP estimates are also available for two earlier recessions, 1980 and 1981–82.⁶ The examination of all five recessions results in some limitations. In particular, this study looks at revisions for just the eight quarters leading up to, and including the peaks of each cycle. It also looks at revisions for the quarters after the peaks until the quarters of the troughs. The study does not look at the periods of recovery after troughs. The 1981–82 recession began just 12 months after the trough of the 1980 recession, and the intervening period is too short to permit a good comparison with the other recoveries. In addition, there are no fully revised data for the period after the trough in 2009. Thus, it is possible to study only three recoveries, and they are sufficiently different from one another so that no strong conclusions can be drawn.

This study thus examines revisions before and during the five recessions, from the third current quarterly to the second annual revision vintage estimates, and to the latest estimates.

Generally, the MARs for GDP and its components in the eight quarters before recessions are smaller to slightly larger than the MARs for all the quarters in the 1983–2009 period. (table 5). This suggests that there is little or no deterioration in accuracy in the periods immediately before recessions or during recessions. However, earlier studies by BEA found that current quarterly estimates in the periods around the troughs of recessions performed somewhat less well than they did around cyclical peaks.

6. Vintage estimates of GDP and its components begin with 1978.

Table 5. Mean Absolute Revisions in the Quarters Before and During Five Recessions in 1980–2009

[Percentage points]

	Eight quarters before the peak		Peak to trough		All quarters in 1983–2009	
	Third quarterly to second annual	Third quarterly to latest quarterly	Third quarterly to second annual ¹	Third quarterly to latest quarterly	Third quarterly to second annual	Third quarterly to latest quarterly
Gross domestic product	0.6	1.6	0.4	0.6	1.1	1.3
Personal consumption expenditures.....	0.5	1.3	0.3	0.4	1	1.1
Gross private domestic investment.....	2.8	5.2	1.6	2.1	5.7	7.1
Exports	2.6	2.4	0.6	1.0	3.5	3.6
Imports	2.2	2.6	0.7	2.3	5.6	5.8
Government consumption expenditures and gross investment.....	2.6	1.3	0.9	0.8	1.8	2.5

1. Four recessions; second annual revision estimates for 2009 have not yet been released.

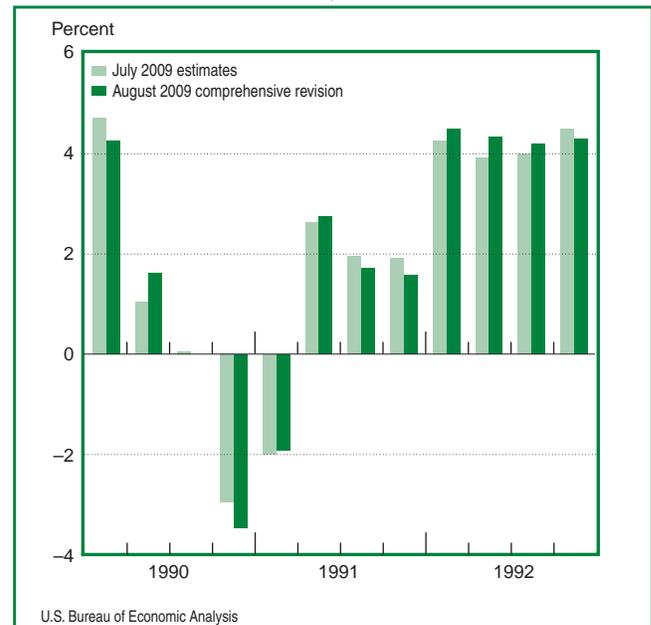
Comprehensive revisions have generally preserved the patterns of change in and around recessions. As indicated in chart 3, the revisions to the rates of change in real GDP in the July 2009 estimates before the August 2009 comprehensive revision and the estimates after the comprehensive revision around the 1990–91 recession were only minor.⁷ The pattern of revisions around the 2001 recession is also preserved, though the small decrease in the third quarter of 2000 was revised up to an even smaller increase (chart 4). The pattern of revisions is again generally preserved before and during the 2007–2009 recession (chart 5); however, in the fourth quarter of 2007 and the first quarter of 2008, the directions of change were reversed.

These revisions include revisions to seasonal adjustments; an earlier study found that revisions to seasonal adjustments were about as large as the revisions to seasonally adjusted GDP (Fixler and Grimm, 2003). It is not possible to measure the effects of revisions to seasonal adjustments during recessions because seasonal adjustment factors are not available for all of the components. According to Fixler and Grimm, it is possible to conclude that the 2009 comprehensive revision preserved the patterns of real GDP in and around the five most recent recessions.⁸

7. Although not shown here, the revisions to real GDP in the 1980 and 1981–82 recessions were quite small, even in comparison with the revisions around the 1990–91 recession.

8. An earlier, unpublished study by BEA found that with the exception of upward revisions to real gross national product in the 1973–75 recession, there has been no tendency to revise away recessions over time.

Chart 3. Rates of Change in Real Gross Domestic Product Near Recessions, 1990–1992



U.S. Bureau of Economic Analysis

News versus noise

It is often asked whether the revisions result from news (new information) or noise (measurement error).⁹ Answers can be found by looking at correlations between the vintage growth rates of GDP and the revisions to various quarterly vintages of GDP (table 6).¹⁰ The

9. For a more complete discussion, see Mankiw and Shapiro (1986).

10. The most recent revisions for the third annual quarterly estimates are for 2005.

Chart 4. Rates of Change in Real Gross Domestic Product Near Recessions, 2000–2002

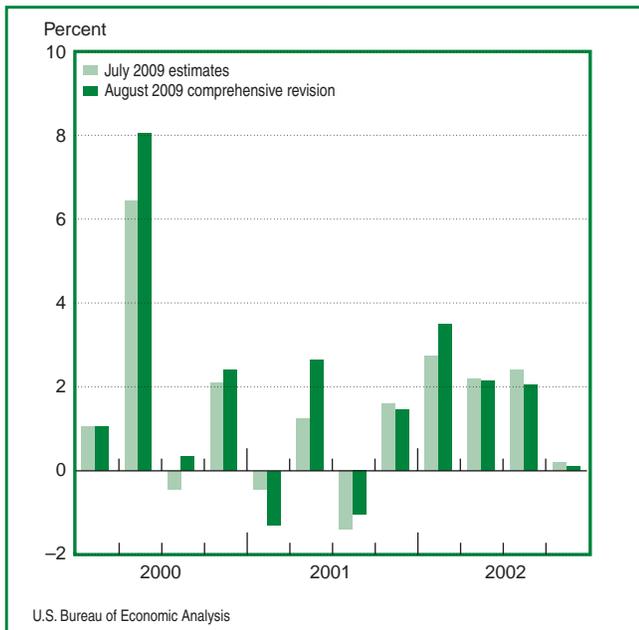
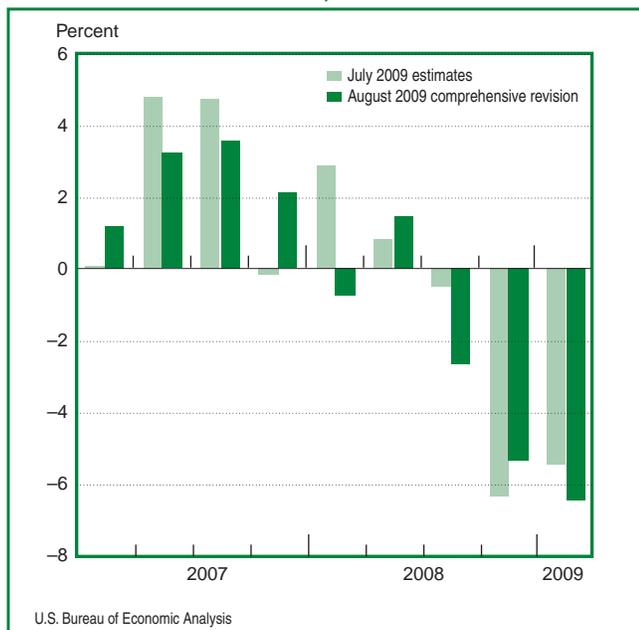


Chart 5. Rates of Change in Real Gross Domestic Product Near Recessions, 2007:I–2009:I



shaded sections show the correlations that if significant, indicate the importance of new information (“news”). The unshaded sections show the correlations that if significant, indicate the importance of measurement error (“noise”). For both current-dollar and real GDP, the majority of the correlations indicate that the importance of news is statistically significant at the 5 percent level.

Consider the revisions to the quarterly estimates (“advance to second,” “second to third,” and “third to first annual”). For current-dollar GDP, 10 of the 15 correlations in the shaded section are significant, and for real GDP, 14 of the 15 correlations in the shaded section are significant, so this is strong evidence in favor of the news hypothesis. Conversely, in the unshaded sections, for current dollar GDP, none of the six correlations is significant, and for real GDP, only two correlations are significant, so there is little statistical evidence in favor of the noise hypothesis.

The picture changes slightly when the revisions to the annual estimates are considered. For both current-dollar and real GDP, the first annual to the second annual revision is significantly correlated with the growth rates in the advance, second, third, and first annual vintages. However, the revision from the first annual

Table 6. Correlations Between GDP Growth Rates and Revisions in 1983–2005

Correlations	Vintage						
	Advance annual	Second annual	Third annual	First annual	Second annual	Third annual	Latest
Current-dollar GDP							
Advance to second	-0.06	0.19	0.22	0.22	0.24	0.19	0.14
P-value	0.54	0.06	0.03	0.04	0.02	0.08	0.19
Second to third.....	0.09	0.16	0.29	0.27	0.25	0.20	0.13
P-value	0.37	0.14	0.01	0.01	0.02	0.06	0.21
Third to first annual	-0.14	-0.14	-0.14	0.28	0.25	0.23	0.12
P-value	0.17	0.18	0.19	0.01	0.02	0.03	0.27
First annual to second annual	-0.26	-0.25	-0.26	-0.30	0.00	0.03	-0.07
P-value	0.01	0.02	0.01	0.00	0.97	0.75	0.48
Second annual to third annual ..	0.05	0.02	0.00	0.04	0.04	0.35	0.26
P-value	0.63	0.84	0.96	0.97	0.69	0.00	0.01
Third annual to latest	0.01	-0.02	-0.05	-0.15	-0.24	-0.30	0.14
P-value	0.95	0.81	0.67	0.13	0.02	0.00	0.20
Real GDP							
Advance to second	0.14	0.42	0.40	0.37	0.36	0.30	0.27
P-value	0.17	0.00	0.00	0.00	0.00	0.00	0.01
Second to third.....	0.26	0.25	0.38	0.30	0.28	0.26	0.20
P-value	0.01	0.02	0.00	0.00	0.01	0.01	0.06
Third to first annual	-0.13	-0.13	-0.14	0.34	0.33	0.35	0.24
P-value	0.20	0.21	0.17	0.00	0.00	0.00	0.02
First annual to second annual ..	-0.22	-0.21	-0.21	-0.23	0.07	-0.05	-0.02
P-value	0.04	0.05	0.04	0.03	0.49	0.62	0.80
Second annual to third annual ..	-0.02	-0.07	-0.07	-0.03	-0.05	0.25	0.24
P-value	0.86	0.51	0.49	0.77	0.63	0.02	0.02
Third annual to latest	-0.14	-0.15	-0.16	-0.28	0.33	0.34	0.14
P-value	0.20	0.16	0.12	0.01	0.00	0.19	0.46

NOTE. Correlations with p-values ≤ 0.05 are shown in bold.

estimates to the second annual estimates is not significantly correlated with the growth rates in the second annual, third annual, and latest vintages; this is strong evidence in favor of the noise hypothesis for this vintage. The correlations for the revision from the second annual estimates to the third annual estimates and the revision from the third annual estimates to latest estimates are ambiguous, with only a few indications of either news or noise.

Revisions to contributions to changes in real GDP

Insight into the robustness of early vintage estimates is provided by comparing the contributions to percent changes in real GDP by its major components. It is desirable that successive vintages of estimates of the contributions maintain similar patterns. Table 7 shows the contributions of GDP's five major components for the years before the most recent recession that began in December 2007 and for the first year of the recession. Each year is an average of four quarters of the contributions of components. The succeeding blocks show the contributions of personal consumption expenditures, gross private domestic investment, exports, imports, and government consumption expenditures and gross investment. For a given year, the revisions across the vintages to the contributions of each component are small in comparison to the year-to-year fluctuations in contributions. The directions (signs) of the contributions stay the same across the vintages. Fur-

ther, the ordinal rankings of the components' contributions (from most positive to most negative) are invariant over the successive vintages. Thus, the early vintage estimates of contributions may be judged as quite robust.

Revisions to Annual Estimates of GDP

The MRs, MARs, and standard deviations for the "early" annual estimates and the three succeeding current annual estimates are shown in table 8. The estimates are in percentage changes of annual estimates of current-dollar GDP and real GDP and their major components. The revisions to these estimates reflect the 2010 annual NIPA revision.

The MARs for both current-dollar GDP and real GDP are much smaller than the MARs and standard deviations for the three current quarterly vintages. Like the annual revision of the quarterly estimates of current-dollar GDP and real GDP and their major components, the MARs tend to decline with successive vintages of estimates; however, the tendencies of the revisions to components of GDP are not entirely monotonic. The smaller revisions to the components reflect two factors: (1) annual estimates are unaffected by revisions to seasonal adjustments, and (2) revisions that affect the quarterly estimates, such as the replacement of extrapolations with interpolations between annual estimates, do not affect annual estimates.¹¹

The patterns of the standard deviations for both the annual estimates and for the quarterly estimates are similar, but the deviations for the vintages of the annual estimates are smaller than those for the vintages of the current quarterly estimates. However, the MRs for the vintages of the annual estimates are generally in the same size range as those for the vintages of the current quarterly estimates. The MRs for the annual estimates of both current-dollar GDP and real GDP are all positive, and those for the annual revisions to the real GDP estimates are about 0.1 percentage point larger than those for current-dollar GDP estimates.¹² Most of the MRs are positive, but the MRs for the first two annual vintages of estimates of both current-dollar and real fixed investment are negative.

The effects of definitional changes on trends in growth can be examined by looking at revisions to the ratios of various components to GDP from the early annual estimates to the latest estimates. Most changes have had only modest effects on the trends that existed

Table 7. Contributions to Percent Change in Real GDP

[Percentage points]¹

Vintage	2005	2006	2007	2008
Gross domestic product				
Third quarterly.....	3.2	3.2	2.5	-0.8
Second annual.....	2.9	2.5	2.5	-2.7
Latest.....	2.7	2.5	2.3	-2.7
Personal consumption expenditures				
Third quarterly.....	2.1	2.6	1.9	-1.0
Second annual.....	2.1	2.2	1.6	-1.3
Latest.....	1.9	2.3	1.2	-1.3
Gross private domestic investment				
Third quarterly.....	1.1	-0.3	-0.6	-1.6
Second annual.....	1.0	-0.7	-0.5	-2.8
Latest.....	0.9	-0.5	-0.3	-2.7
Exports				
Third quarterly.....	0.7	1.0	1.0	-0.2
Second annual.....	0.7	1.0	1.2	-0.6
Latest.....	0.7	1.1	1.1	-0.4
Imports				
Third quarterly.....	-0.7	-0.6	-0.2	1.4
Second annual.....	-0.9	-0.5	-0.2	1.5
Latest.....	-0.8	-0.7	-0.1	1.0
Government consumption expenditures and gross investment				
Third quarterly.....	0.2	0.5	0.5	0.7
Second annual.....	0.2	0.4	0.5	0.6
Latest.....	0.1	0.3	0.4	0.6

1. Gross domestic product estimates are averages of percent changes for the four quarters of each year and vintage. Contributions of components are averages of percent change contribution for the four quarters of each year and vintage.

11. Fixler and Grimm (2002) found that revisions to seasonal adjustments were about as important as revisions to source data in determining the overall revisions to estimates.

12. These positive MRs are statistically significant and this, too, is consistent with the tendency for the growth rates of GDP to be revised up at the times of comprehensive revisions.

before the changes. For example, even though there have been a number of definitional changes that affected the estimates of government consumption expenditures and gross investment—such as the changed treatment of Commodity Credit Corporation purchases and sales—the ratio of government consumption expenditures and investment to GDP has changed little (chart 6); it has maintained its general pattern over time, and there are only modest year-to-year deviations in the ratio from early annual estimates to latest estimates. Typically, this is the effect that most of the definitional changes have on GDP.

Some changes, however, have had larger effects on trends in growth. For example, the change to fixed investment in the 1999 comprehensive revision affected in the trend in growth (business expenditures for software were added to fixed investment). Until 1999, the pattern of the trend in growth from the early annual

estimates of fixed investment to the latest estimates is generally the same; the early annual estimates are well below the latest estimates. For 1999 forward, the early and latest annual estimates differ little because both vintages of estimates incorporated the change. Including business expenditures on software as investment raised GDP by slightly less than 0.5 percent in 1983, about 1.5 percent in 1998, and nearly 2.0 percent in 2009. Thus, the reclassification of software noticeably increased both the levels and growth rates of GDP and raised the ratio of fixed investment to GDP.

Another perspective on MRs can be obtained by scaling the MRs for GDP and its major components by the mean percent changes in the measures. No particular trends in the MRs for GDP and its components are evident, though the absolute value of the MRs for GDP increases steadily from the early annual estimates—which are first published in April of the

Table 8. Average Revisions to Annual Estimates of GDP and Its Major Components in 1983–2009

[Percentage points]

	Mean revision		Standard deviation		Mean absolute revision			Mean revision		Standard deviation		Mean absolute revision	
	Current-dollar	Real	Current-dollar	Real	Current-dollar	Real		Current-dollar	Real	Current-dollar	Real	Current-dollar	Real
Gross domestic product													
Early annual.....	0.18	0.18	0.57	0.72	0.45	0.62							
First annual.....	0.17	0.27	0.44	0.56	0.39	0.53							
Second annual.....	0.20	0.34	0.42	0.47	0.30	0.48							
Third annual.....	0.17	0.35	0.33	0.32	0.28	0.39							
Personal consumption expenditures													
Early annual.....	0.30	0.28	0.69	0.68	0.55	0.56							
First annual.....	0.23	0.35	0.54	0.56	0.42	0.54							
Second annual.....	0.21	0.36	0.46	0.41	0.40	0.36							
Third annual.....	0.21	0.39	0.36	0.29	0.31	0.39							
Durable goods													
Early annual.....	0.48	0.60	1.22	1.33	1.06	1.16							
First annual.....	0.29	0.38	1.21	1.08	1.01	0.92							
Second annual.....	0.34	0.40	1.00	0.92	0.90	0.83							
Third annual.....	0.34	0.48	1.02	0.95	0.94	0.86							
Nondurable goods													
Early annual.....	-0.16	0.16	0.75	0.98	0.63	0.78							
First annual.....	-0.22	0.14	0.72	0.88	0.61	0.76							
Second annual.....	-0.15	0.20	0.60	0.59	0.50	0.55							
Third annual.....	-0.18	0.20	0.57	0.50	0.46	0.44							
Services													
Early annual.....	0.32	0.25	0.89	0.84	0.68	0.61							
First annual.....	0.25	0.38	0.68	0.63	0.54	0.58							
Second annual.....	0.18	0.35	0.74	0.58	0.55	0.53							
Third annual.....	0.17	0.38	0.53	0.44	0.34	0.43							
Gross private domestic investment													
Early annual.....	-0.27	-0.61	2.32	2.21	1.97	1.91							
First annual.....	-0.17	-0.38	2.20	2.17	1.84	1.74							
Second annual.....	0.23	0.25	1.66	1.64	1.39	1.35							
Third annual.....	0.15	0.24	1.43	1.39	1.09	1.13							
Fixed investment													
Early annual.....	-0.25	-0.64	1.32	1.44	1.12	1.34							
First annual.....	-0.28	-0.53	1.39	1.36	1.14	1.21							
Second annual.....	0.41	0.35	0.97	1.11	0.87	0.96							
Third annual.....	0.30	0.31	0.97	0.97	0.81	0.77							
Nonresidential													
Early annual.....	-0.54	-0.16	2.03	3.24	1.76	2.59							
First annual.....	-0.35	0.06	1.76	3.08	1.48	2.22							
Second annual.....	0.60	1.47	1.25	2.90	1.19	2.14							
Third annual.....	0.45	0.41	1.20	3.36	1.02	1.89							
Residential													
Early annual.....	0.41	-0.09	1.67	1.80	1.50	1.51							
First annual.....	0.01	-0.29	1.18	1.40	0.86	1.11							
Second annual.....	0.18	0.13	1.16	1.03	0.76	0.68							
Third annual.....	0.22	0.17	1.15	1.02	0.77	0.65							
Change in private inventories¹													
Net exports of goods and services¹													
Exports													
Early annual.....	0.34	0.34	1.03	1.53	0.78	1.13							
First annual.....	0.47	0.35	0.82	1.35	0.68	1.04							
Second annual.....	0.19	0.00	0.82	1.31	0.56	0.82							
Third annual.....	-0.10	-0.22	1.01	1.42	0.59	0.79							
Imports													
Early annual.....	0.34	-0.22	0.78	1.36	0.60	1.04							
First annual.....	0.24	-0.10	0.57	1.01	0.41	0.73							
Second annual.....	0.13	0.16	0.53	1.40	0.35	0.86							
Third annual.....	0.03	-0.34	0.57	1.50	0.35	0.82							
Government consumption expenditures and gross investment													
Early annual.....	0.16	0.37	0.75	1.02	0.61	0.76							
First annual.....	0.07	0.24	0.77	0.99	0.57	0.65							
Second annual.....	0.11	0.22	0.81	0.87	0.59	0.66							
Third annual.....	0.04	0.14	0.77	0.77	0.46	0.49							
Federal													
Early annual.....	0.25	0.27	1.38	1.71	0.98	1.30							
First annual.....	0.05	0.19	1.57	1.94	0.88	1.21							
Second annual.....	0.14	0.23	1.57	1.81	0.83	1.17							
Third annual.....	0.17	0.17	1.74	1.83	0.90	1.09							
Defense													
Early annual.....	0.07	0.02	0.71	1.14	0.62	0.95							
First annual.....	-0.04	0.05	0.71	0.92	0.49	0.74							
Second annual.....	0.03	0.13	0.71	0.68	0.41	0.46							
Third annual.....	0.07	0.05	0.77	0.50	0.40	0.31							
Nondefense													
Early annual.....	0.47	0.28	5.53	5.21	3.70	3.41							
First annual.....	0.11	-0.19	6.25	4.76	3.43	2.69							
Second annual.....	0.40	0.27	6.21	4.81	3.18	2.57							
Third annual.....	0.33	-0.01	6.68	5.03	3.47	2.78							
State and local													
Early annual.....	0.15	0.29	1.03	1.20	0.89	1.01							
First annual.....	0.12	0.27	0.82	0.94	0.65	0.80							
Second annual.....	0.10	0.19	0.85	0.86	0.66	0.71							
Third annual.....	-0.04	0.11	0.55	0.58	0.45	0.42							

1. Percentage changes cannot be calculated because of negative values in some quarters.

following year—to the third annual revisions (table 9).

Table 9. Mean Revisions, Mean Percent Changes, and the Absolute Values of Their Ratios in 1983–2009
[Latest estimates less annual estimates]

	Early annual	First annual	Second annual	Third annual
Gross domestic product				
Mean revision ¹	0.18	0.27	0.34	0.35
Mean percent change ¹	2.79	2.71	2.86	2.99
Absolute value ²	0.06	0.10	0.12	0.12
Personal consumption expenditures				
Mean revision ¹	0.28	0.35	0.36	0.39
Mean percent change ¹	2.97	2.91	3.07	3.21
Absolute value ²	0.09	0.12	0.12	0.12
Gross private domestic investment				
Mean revision ¹	-0.61	-0.38	0.25	0.24
Mean percent change ¹	4.09	3.85	4.25	4.82
Absolute value ²	0.15	0.10	0.06	0.05
Exports				
Mean revision ¹	0.34	0.35	0.00	-0.22
Mean percent change ¹	5.58	5.58	6.50	6.72
Absolute value ²	0.06	0.06	0.00	0.03
Imports				
Mean revision ¹	-0.22	-0.10	0.16	-0.34
Mean percent change ¹	6.81	6.69	7.23	8.10
Absolute value ²	0.03	0.01	0.02	0.04
Government consumption expenditures and gross investment				
Mean revision ¹	0.37	0.24	0.22	0.14
Mean percent change ¹	1.89	2.03	2.08	2.13
Absolute value ²	0.20	0.12	0.11	0.07

1. Percentage points.
2. Absolute value is calculated as mean revision divided by mean percent change.

Definitional revisions as part of comprehensive NIPA revisions tend to result in increases in the growth rates of GDP. However, absolute values of the MRs of three of the five components are larger for the third annual estimates than they are for the early annual estimates

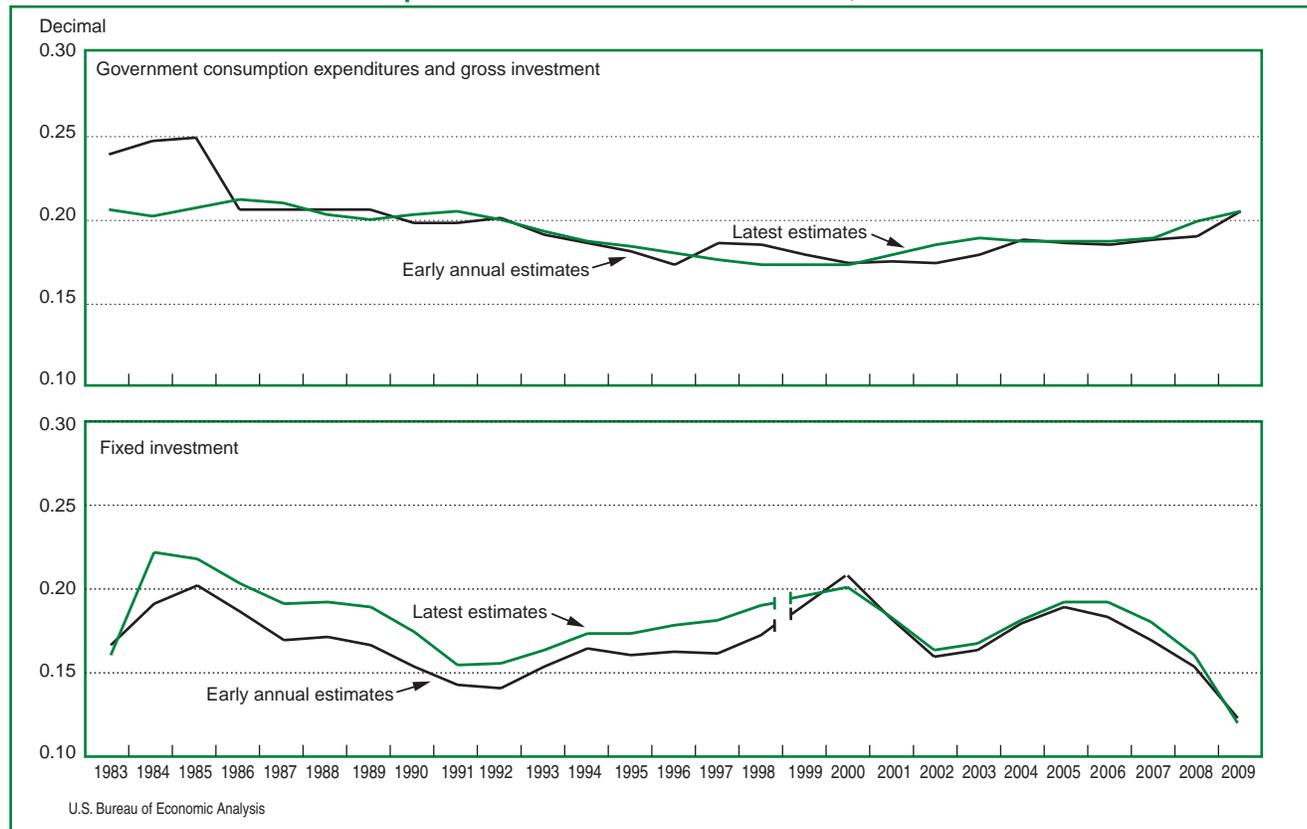
The mean percent changes, however, vary over the various vintages of estimates. From the early annual estimates to the first annual estimates, the mean percent changes for GDP and all the major components except government consumption expenditures and gross investment decline. For both the second annual and third annual vintages of estimates, the mean percent changes for GDP and all the major components increase.

The absolute values are small: except for the early annual estimates of government expenditures, all of the values are 0.12 or smaller. This is consistent with other findings that mean revisions are small.

Revisions to Quarterly Estimates of GDI

Advance estimates of GDI are not prepared, and since 1995, second quarterly estimates of GDI for the fourth quarter have not been prepared. The naming convention used for the current quarterly vintages of GDI and its components are the same as those used for GDP. Thus, for example, although no advance estimates are

Chart 6. Ratios of Selected Components to Gross Domestic Product, 1983–2009



prepared for GDI and some of its components, the estimates of GDI and components that are published the month after the advance estimates of GDP are called the second estimates. When advance and second vintages of the quarterly estimates of components of GDI have been published, revisions statistics for these are shown (table 10). The MARs for GDI and its components show little or no tendency to decline with successive vintages of estimates.

Beginning with the first quarter of 2001, a fourth vintage of the current quarterly estimate of compensation of employees—and thus of GDI and net national factor income—has been prepared. This estimate uses source data from the Quarterly Census of Employment

and Wages (QCEW), and it is published at the same time as the second estimate of the following quarter (see the box “Vintages and Timing of Revisions”). These fourth estimates are discussed separately; because there are only 32 observations in the sample period, the findings are much less robust than those for the other current quarterly vintages.

The MAR for the third estimate of GDI is almost 0.2 percentage point larger than the MAR for the third estimate of current-dollar GDP.¹³ Similarly, the standard deviation for the third estimate of GDI is about 0.3 percentage point larger than the standard deviation for the third estimate of current-dollar GDP. The MR for GDI, however, is just above 0.02 percentage point, compared with the MR for GDP of 0.1 percentage point. In sum, the revisions statistics for GDI are reasonably similar to those for GDP.

The MARs for all of the components of GDI are larger than MARs for GDP, and some are much larger. The calculation of MARs for some components—including business current transfer payments, current surplus of government enterprises, and rental income of persons—is not feasible, either because of definitional changes during the sample period or because of negative values in some quarters that make the calculation of percent changes impossible.

The MARs for net national factor income are slightly more than 1½ times the size of those for GDP.¹⁴ Among the components of net national factor income, only compensation of employees has MARs similar to those for net national factor income. The MARs for corporate profits and for net interest are roughly 10 times the size of those for GDP.

MRs for GDI and its components are smaller than the MARs, and none are statistically significant.

The MAR for the fourth quarterly estimates of compensation of employees is nearly a fifth smaller than that for the third estimates. This is an indication that the introduction of QCEW source data, which are more comprehensive and broader than the survey-based estimates of nonsupervisory wages used in the third estimates, adds to the reliability of the compensation estimates. The fourth estimate also has a MR of 0.02 percentage point, one-tenth the size of the MRs for the earlier vintages of estimates.

The MAR for the fourth estimate of GDI, however, is noticeably larger than that for the third estimate

Table 10. Average Revisions to Quarterly Estimates of Gross Domestic Income and Selected Components in 1983–2009
[Percentage points]

	Mean revision	Standard deviation	Mean absolute revision
Gross domestic income			
Advance			
Second ¹	-0.01	1.71	1.28
Third	0.02	1.70	1.24
Fourth ²	-0.16	1.83	1.43
Private consumption of fixed capital			
Advance	-0.03	18.53	7.65
Second	-0.19	18.67	7.59
Third	-0.68	22.34	7.98
Taxes on production and imports			
Advance	0.08	3.86	2.88
Second	-0.02	3.84	2.85
Third	0.10	3.93	2.91
Net national factor income ³			
Advance			
Second ¹	0.18	2.42	1.91
Third	-0.07	2.78	2.01
Fourth ²	-0.48	4.07	2.87
Compensation of employees			
Advance	0.38	2.68	2.13
Second	0.14	2.65	2.09
Third	0.21	2.93	1.90
Fourth ²	0.02	2.00	1.54
Proprietors' income			
Advance	-1.17	13.68	9.88
Second	-0.80	13.46	9.72
Third	-0.63	12.85	9.24
Nonfarm proprietors' income			
Advance	-0.99	7.88	5.34
Second	-0.62	6.47	4.83
Third	-0.49	6.57	4.93
Rental income of persons with IVA and CCAadj ⁴			
Corporate profits with IVA and CCAadj			
Advance			
Second ¹	-2.06	18.01	14.35
Third	-3.46	23.41	16.82
Net interest and miscellaneous payments			
Advance ⁵	2.16	24.27	14.77
Second	1.53	15.90	9.96
Third	1.20	15.36	10.44

IVA Inventory valuation adjustment

CCAadj Capital consumption adjustment

1. Beginning in 1995, there are no fourth-quarter estimates.

2. Estimates begin in the first quarter of 2002.

3. Equals national income plus subsidies less taxes on production and imports, business current transfer payments (net), and current surplus of government enterprises.

4. Percentage changes cannot be calculated because of negative values in some quarters.

5. Estimates begin in the second quarter of 2002.

NOTE: None of the mean revisions are statistically significant at the 5 percent level.

13. Second estimates are not compared because there are no fourth-quarter estimates for 1995 and thereafter. Fixler and Grimm (2002) found differences in the MARs for GDP estimates for the different quarters of the year, and the lack of second estimates of GDI for the fourth quarter would make the comparisons of dubious value.

14. Net national factor income is the measure in the present accounts that is most similar to the concept used for national income in the accounts before the 2003 comprehensive NIPA revision.

because a substantial negative correlation between revisions to employee compensation and revisions to GDI less compensation in the third estimate is supplanted by a near-zero correlation between the two revisions in the fourth estimates. This occurs as judgmental trends incorporated in the third estimates are replaced by source-data-based inputs from the QCEW. The MARs of net national factor income also increase from the third estimate to the fourth estimate. Fourth estimates of all the other GDI components are unchanged from the third estimates.

Composition of GDI

The relative importance of the major components of GDI has not changed from the earliest estimates to the latest estimates. In 1983–2009, compensation of employees is 55 to 58 percent of GDI, with somewhat higher values in the 1980s and somewhat lower values in the 2000s. In this period, taxes on production and imports are 7 to 8 percent of GDI, and consumption of fixed capital is 7 to 8 percent. Subsidies are roughly 0.5 percent of GDI. The remainder, about one-quarter of GDI, is operating surplus.

The main components of operating surplus are corporate profits, net interest, proprietors’ income, and

rental income of persons.¹⁵ The ratios of corporate profits for the third current quarterly estimates, the July 2009 estimates before the 2009 comprehensive revision, and the estimates after the comprehensive revision to GDI range from about 7 percent to 12 percent of GDI (chart 7).¹⁶ The pattern of all three vintages of estimates are similar: declines in the recessions of 2001 and 2007–2009 and gradually rising values in 2002–2006. The third current quarterly estimates are more volatile than the other two vintages, but the pattern of these estimates is the same.

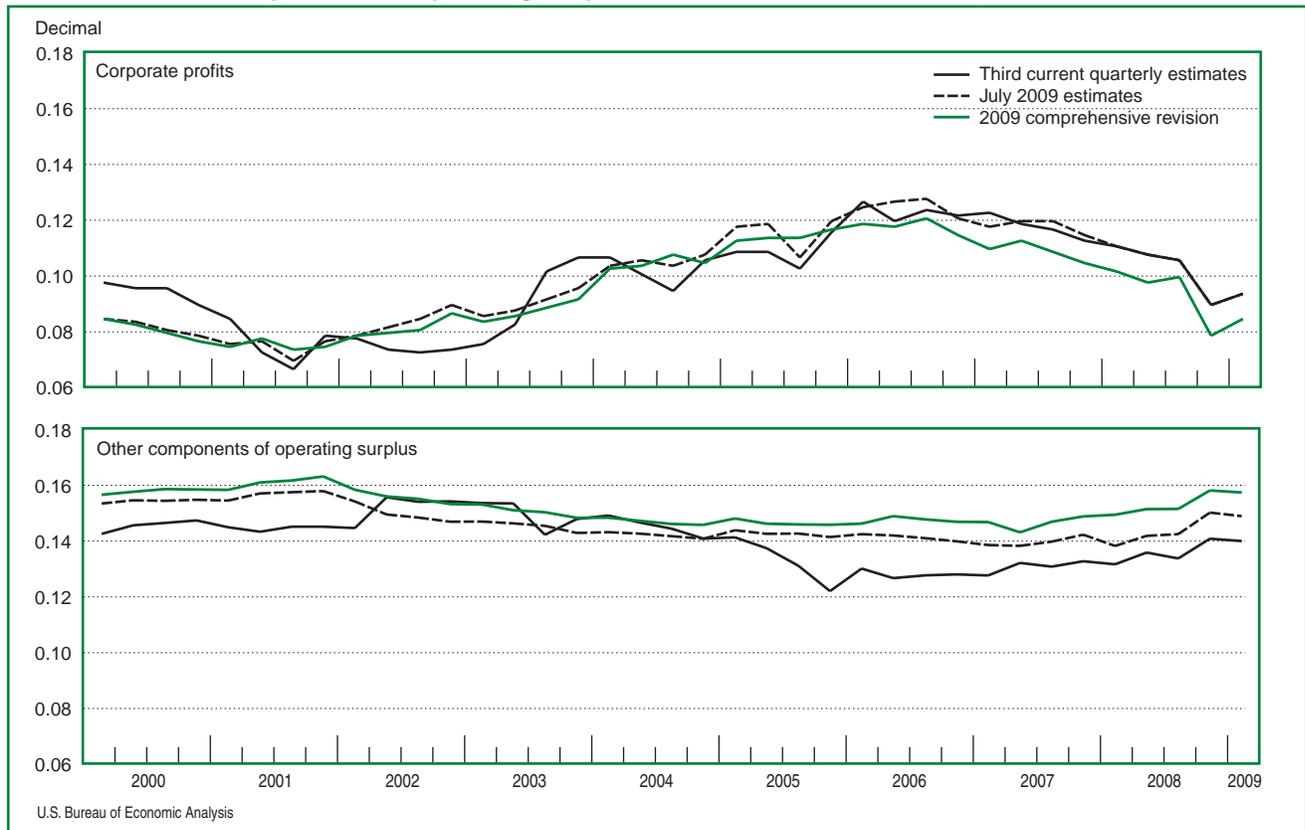
The sum of the other components of operating surplus show little trend over time. The ratios of the third current quarterly estimates are generally somewhat lower than the ratios of the other two vintages and are

15. The other components are business transfer payments, which are 1 percent or less of GDI, and current surplus of government enterprises, which has ranged from –0.1 to 0.2 percent of GDI.

16. The first quarter of 2009 is the last quarter that third current quarterly estimates were published before the comprehensive revision; the first quarter of 2000 was selected as the starting point in order to simplify this examination. Advance and second current quarterly estimates of GDI are not available for all quarters.

The third current quarterly estimates for 2000 are 2003 benchmark estimates, third annual revision estimates for 2001–2005, second annual estimates for 2006, first annual estimates for 2007, and third current quarterly estimates for 2008 and the first quarter of 2009.

Chart 7. Ratio of Components of Operating Surplus to Gross Domestic Income, 2000–2009



somewhat more volatile. Upward revisions to the comprehensive revision estimates reflect upward revisions to rental income of persons. As a result, the ratios of the third current quarterly estimates range from about 12 to 15 percent of GDI and the ratios of the other two vintage estimates range from about 13 to 16 percent of GDI, with the ratios of the comprehensive revision estimates ranging from 0.4 to 1.3 percentage points higher than the ratios of the prerevision estimates to GDI.

The general picture of the ratio of national saving to GDI is also consistent across vintages of estimates. It is similar for the ratios of both the third current quarterly estimates and the 2009 comprehensive revision estimates. From early 2000 to the middle of 2009, the ratios for both vintages of estimates fall by nearly half (chart 8). In 2004–2007, the third current quarterly estimates roughly level off, but the 2009 comprehensive benchmark revision estimates of the ratio were higher than in the immediately preceding period. This reflects higher ratios of personal saving to GDI that are mostly

due to upward revisions to personal income that are greater than upward revisions to personal outlays; personal current taxes are little revised.

In summary, over time, the shares of GDI and the patterns of growth of the major components of GDI have been maintained over the course of all the vintages of estimates.

Revisions to Annual Estimates of GDI

The MAR for the early annual estimate of GDI is about half the size of the MAR for the fourth quarterly estimate (tables 10 and 11). MARs decline sharply in the first and second annual revision estimates and are about unchanged in the third annual revision estimate. The MARs for the early annual estimates of private consumption of fixed capital and for taxes on production and imports are both less than a third the size of those for the third quarterly estimates, and the MARs for subsequent vintages of the annual estimates decrease steadily.

The MARs for the early annual estimates of net

Chart 8. Ratio of National Saving to Gross Domestic Income, 2000–2009

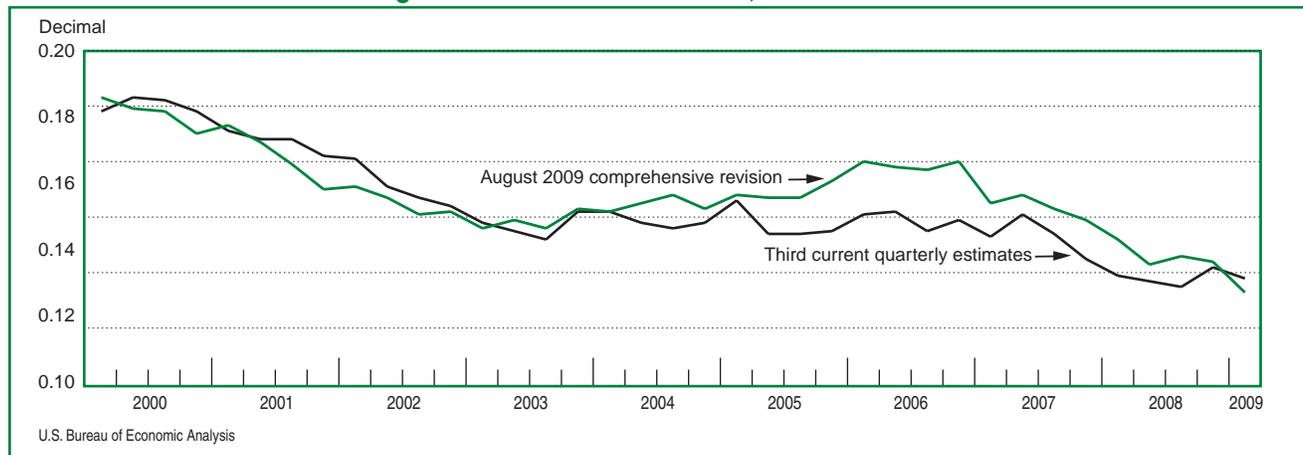


Table 11. Average Revisions to Annual Estimates of Gross Domestic Income and Selected Components in 1983–2009¹

[Percentage points]

	Mean revision				Mean absolute revision			
	Early annual	First annual	Second annual	Third annual	Early annual	First annual	Second annual	Third annual
Gross domestic income	0.23	0.13	0.13	0.18	0.74	0.48	0.29	0.30
Private consumption of fixed capital.....	0.66	0.53	0.66	-0.26	2.20	1.94	1.67	1.59
Taxes on production and imports	0.46	0.39	0.27	0.09	1.14	0.75	0.73	0.67
Net national factor income²	0.22	0.17	0.16	0.21	0.82	0.60	0.42	0.41
Compensation of employees.....	0.10	0.11	0.11	0.13	0.88	0.37	0.22	0.24
Proprietors' income with inventory valuation and capital consumption adjustments.....	0.71	0.67	0.38	0.74	3.79	2.98	2.32	2.51
Nonfarm	0.37	0.51	0.37	0.68	3.81	3.34	2.42	2.79
Rental income of persons with inventory valuation and capital consumption adjustments³								
Corporate profits with inventory valuation and capital consumption adjustments.....	-0.73	-0.32	-0.45	-0.74	7.20	6.52	4.19	3.19
Net interest and miscellaneous payments	1.73	0.95	-0.03	-0.54	6.76	5.77	3.43	2.25

1. Periods ending in 2008 for first annual, 2007 for second annual, 2005 for third annual.

2. Equals national income plus subsidies less taxes on production and imports, business current

transfer payments (net), and current surplus of government enterprises.

3. Percentage changes cannot be calculated because of negative values in some quarters.

national factor income are less than half the size of the MARs for the third quarterly estimates (table 11), and they also decline steadily with subsequent vintages. The MARs for the annual estimates of the other components of GDI are also less than the MARs for the current quarterly estimates of these components, and they decline from the early annual estimates through the second annual revision. The MARs for the third annual revision estimates increase slightly for compensation of employees and proprietors' income.

The MRs for all the components of GDI except corporate profits and the second and third annual revision estimates of net interest are generally positive. Like the quarterly estimates, the MRs for the annual estimates are much smaller than the MARs for GDI and for its components.

GDP and GDI

GDP and GDI are both measures of the same concept of activity in the U.S. economy (Fixler and Nalewaik 2004). They are constructed using different source data, but they are, in theory, estimates of the economic output of the economy. The true state of the economy is never known, but it is reasonable to assume that in any period, both GDP and GDI present a more or less unbiased estimate of output.

The relative merits of GDP and GDI as measures of economic activity have been discussed extensively. For a recent discussion, see Nalewaik (2010) and the accompanying comments by Landefeld (2010). Nalewaik finds some explanatory power for revisions of GDP from the early estimates of GDI; the paper argues that GDI has some superior statistical properties and finds some significant relationships between GDI and some other cyclical measures, especially the unemployment rate.¹⁷ Landefeld points out that missing source data prevents preparing advance estimates of GDI for all quarters and second estimates of GDI for the fourth quarter. He also suggests that the quality of source data for the other current quarterly estimates of GDP is superior to that of GDI. Depending on which vintage of estimates is examined, the strength of the underlying source data is key to perceptions of accuracy. For example, the second annual revision estimates of GDI, which are the first vintage to incorporate tax data into estimates of the income components, have a slightly lower MAR than that for the second annual revision estimates of GDP, while the first annual MAR for GDI is much larger than that for GDP.

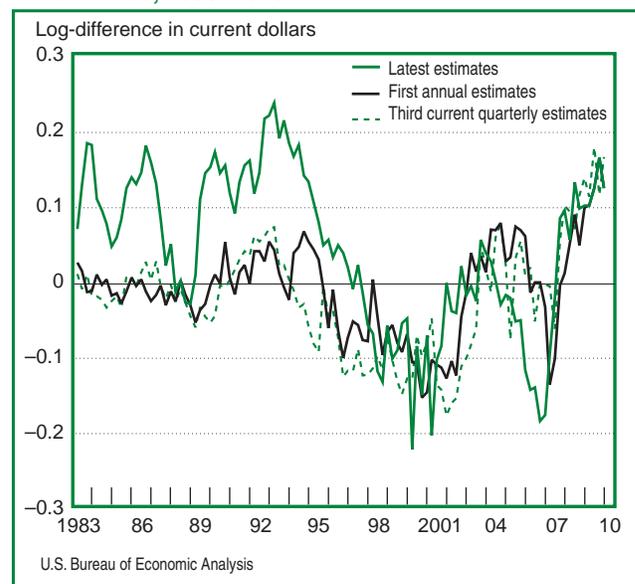
17. As part of the preparation for this article, the authors reexamined the statistical relationship between the unemployment rate and the statistical discrepancy (noted by Nalewaik) and found that the apparent contemporaneous correlation was vitiated when lags and serial correlation corrections were included in the regression equations.

The difference between GDP and GDI is known as the statistical discrepancy. There are several different vintages of both GDP and GDI, and for each vintage pair of GDP and GDI estimates, there is an associated statistical discrepancy. Chart 9 depicts the statistical discrepancy for three vintages of GDP and GDI. Each vintage is expressed in logged form in order to convert the exponential trend in GDP and GDI to a linear trend before taking the difference.

It seems likely that a weighted average of GDP and GDI might have smaller revisions because the measurement errors in the early vintages are unlikely to be perfectly correlated. In table 12, the variances of different weighted sums of GDP and GDI for the third quarterly estimate and for the latest estimate for 1983–2009, for 1983–1992, and for 1993–2009 are shown. The largest MARs are for GDI in all three periods. The weighted averages are constructed by assigning weights (that sum to one) to the levels of GDP and GDI. The percent changes underlying the table are those of the weighted-together levels.

The weighted averages have smaller MARs than either GDP or GDI alone. This is consistent with GDP and GDI being independent measures of the same variable—unknown true economic activity. For both the third estimates and the latest estimates, GDP has a smaller variance than GDI. The differences, however, are small. For 1983–2009, the MAR of GDP is about 0.2 percentage point smaller than the MAR of GDI and about 0.1 percentage point larger than the smallest MAR for weighted averages of GDP and GDI. These MARs may be compared with an average rate of

Chart 9. The Statistical Discrepancy by Vintage of Estimates, 1983–2010



growth of current-dollar GDP of 5.6 percent.

Based on the quality of source data, the earlier estimates of GDP should be more accurate than the earlier estimates of GDI. Nearly four-sevenths of the source data for the third current quarterly estimates of GDP—and thus the early annual vintage—are based on monthly or revised monthly data (Grimm and Weadock 2006). In contrast, only about one-sixth of the source data for the third current-quarterly estimates of GDI is based on comprehensive or direct indicator data (Holdren and Grimm 2008).

Note that the variances of the weighted average are not linear with respect to the weights because GDP and GDI are not perfectly correlated (table 12). In fact, for the latest estimates, the correlation between the two series is sufficiently low so that a weighted average of GDP and GDI has a lower variance than GDP itself. If both GDP and GDI are each interpreted as the sums of true, unobserved, economic activity and measurement errors, it is possible to infer that a weighted average of GDP and GDI is a more accurate measure of output than either GDP or GDI alone because some of the measurement error is averaged out, and this is reflected in the reduced magnitude in subsequent revisions to the weighted average.

In table 12, the largest MARs for GDP, GDI, and selected weighted averages of the two for each of the three periods are denoted by boldface numbers, and the smallest by shaded cells. In all the samples, the MARs for GDI are greater than those for GDP. However, the MAR for a weighted average of the two series is below the MARs for GDP and for GDI. In each sample, the smallest MARs are provided by different weighted sums that are at least 50 percent GDP.

The MAR is a measure of both the mean and the spread of the time series of revisions; that is, even if the revisions have a mean of zero, the revisions would not be expected to have an MAR of zero, because the revision series exhibits variance around the mean.

As table 12 demonstrates, GDP and GDI vintage pairs are not perfectly correlated series, meaning that some weighted average of GDP and GDI offers a more accurate measure of output. More advanced statistical techniques also find that a combination of GDP and GDI is preferred to either alone (see the box “Is GDP or GDI Responsible for the Statistical Discrepancy?”).

Another way of comparing GDP and GDI is their performance around turning points. Grimm (2005) found that neither measure captured all of the turning-point quarters as determined by the Business Cycle Dating Committee of the National Bureau of Economic Research (NBER). Around the peak quarters, weighted sums of one-third to two-thirds of GDP have the smallest MARs (table 13). GDP alone has the largest MARs, but it is tied with GDI for the quarter after the peak. Around the trough, GDP also has the largest MARs. Around the trough, GDI has the smallest MARs, but at the trough quarter, it has the largest MAR, and a weighted sum favoring GDP has the smallest. However, because of the small sample size, these results must be viewed with some caution.

Thus, tables 12 and 13 suggest that weighted sums of GDP and GDI do better than either alone for large periods of time, and around cyclical peaks. Around cyclical troughs, the results are less clear,

GDP Price Indexes

Average revisions to the price indexes for GDP and its major components have much smaller MARs than either real or current-dollar GDP and its components. For example, the MAR for the third estimates of the GDP price index is 0.3 percentage point; in comparison, for the third estimate, the MAR of real GDP is 1.1 percentage points, and the MAR for the current-dollar GDP is 1.3 percentage points.

The MARs for the three current quarterly vintages of estimates—advance, second, and third estimates—are shown in table 14, page 28. The sample period is 1997 to 2009; current quarterly estimates of

Table 12. Mean Absolute Revisions and Variances of the Third to Latest Estimates of Current-Dollar GDP and GDI

[Percentage points]

	Variances, 1983–2009						GDI
	GDP	.75P+.25I	.67P+.33I	.5P+.5I	.33P+.67I	.25P+.75I	
Third.....	7.93	7.94	7.97	8.07	8.23	8.33	8.72
Latest.....	9.20	8.90	8.91	9.10	9.51	9.80	11.00
Mean absolute revisions							
	GDP	.75P+.25I	.67P+.33I	.5P+.5I	.33P+.67I	.25P+.75I	GDI
1983–2009.....	1.12	1.01	0.99	1.00	1.07	1.13	1.33
1983–1992.....	1.07	1.04	1.06	1.13	1.21	1.26	1.43
1993–2009.....	1.15	0.98	0.95	0.93	0.99	1.05	1.27

NOTES: Bold indicates highest value in the row, and shade indicates lowest value in the row. A weighted sum of the levels of GDP and GDI are calculated as $x \cdot \text{GDP} + (1-x) \cdot \text{GDI}$, where x is in the range of zero to one. The percent changes are then calculated using the weighted values.

Table 13. Mean Absolute Revisions Around Cyclical Turning Points of the Third to Latest Quarterly Estimates of Current-Dollar GDP and GDI

[Percentage points]

	GDP	.75P+.25I	.67P+.33I	.5P+.5I	.33P+.67I	.25P+.75I	GDI
Prior quarter.....	3.24	1.57	1.54	1.48	1.46	1.51	1.79
Peak quarter.....	2.68	0.66	0.64	0.77	1.20	1.41	2.06
After quarter.....	1.21	0.74	0.59	0.41	0.57	0.73	1.21
Prior quarter.....	2.86	2.55	2.44	2.32	2.71	2.15	1.99
Trough quarter.....	2.89	2.79	2.88	3.07	3.26	3.35	3.72
After quarter.....	2.43	1.83	1.70	1.52	1.34	1.28	1.11

NOTES: Recessions: 1969–70, 1973–75, 1980, 1981–82, 1990–91, and 2001. Bold indicates highest value in the row, and shade indicates lowest value in the row. A weighted sum of the levels of GDP and GDI are calculated as $x \cdot \text{GDP} + (1-x) \cdot \text{GDI}$, where x is in the range of zero to one. The percent changes are then calculated using the weighted values.

chain prices began during 1996.¹⁸ The largest MARs are for the price index for imports, followed by those for the price index for federal nondefense expenditures.

The MRs for the price indexes for GDP and its major components are generally not smaller than those for real GDP and current-dollar GDP and its major components. The standard deviations for the price indexes, however, are smaller. As a result, the MRs for GDP and some of its major components are statistically significant.

18. The switch to chained price indexes began in 1996, and the 1997 start for the sample period is based on this.

The MRs for all three quarterly vintages of the estimates of the price index for GDP are statistically significant. The MRs for the price indexes for all three vintages of residential fixed investment and government consumption expenditures and gross investment are also statistically significant. Within government expenditures, the MRs for price indexes for the advance estimates of the price index of federal defense expenditures and for all three vintages of state and local government expenditures are significant. Except for the advance estimate of current-dollar GDP, these MRs are all larger than the corresponding MRs for the three vintages of real and current-dollar estimates of GDP.

Is GDP or GDI Responsible for the Statistical Discrepancy?

The difference between the GDP and GDI—the “statistical discrepancy”—can be large and persistent over time. Though GDP and GDI are constructed using different source data, conceptually, they are estimates of the same entity—the economic output of the economy. Therefore, the statistical discrepancy can be thought of as the sum of the measurement error in GDP and the measurement error in GDI. We investigate which measure of output—GDP or GDI—contributes more to the statistical discrepancy.

Let $y_{GDP,t}$ denote the log level of GDP, and let $y_{GDI,t}$ denote the log level of GDI at time t . Then let

$$x_t = y_{GDP,t} - y_{GDI,t}$$

denote the statistical discrepancy (in log levels). If each measure of output is comprised of “true” output ($y_{TRUE,t}$) and a measurement error ($u_{GDP,t}$ for GDP and $u_{GDI,t}$ for GDI), then the statistical discrepancy is the difference between the measurement errors. Algebraically,

$$\begin{aligned} x_t &= y_{GDP,t} - y_{GDI,t} \\ &= y_{TRUE,t} + u_{GDP,t} - y_{TRUE,t} - u_{GDI,t} \\ &= u_{GDP,t} - u_{GDI,t}. \end{aligned}$$

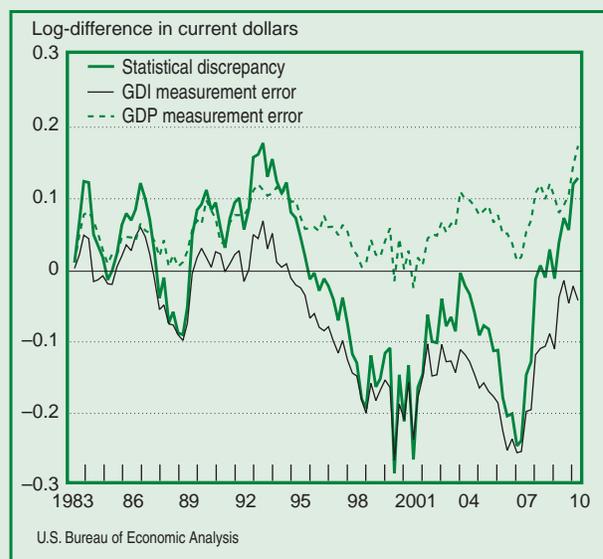
Hence, the statistical discrepancy can be thought of as the sum of the measurement error in GDP less the measurement error in GDI.

The Kalman (1960) filter was used to estimate “true” output that is based on the observable time series of GDP and GDI. The filter works by predicting “true” output growth in the current period through the use of “true” output growth in the previous period. It then constructs the mean square error of observed GDP and GDI output growth in the current period. The filter updates the estimate of “true” growth in the current period by minimizing the mean square error (the sum of variance and squared bias) of GDP and GDI growth. The filter recursively estimates the whole time series of “true” output

growth by recursively updating the estimates until no further reductions in mean square error can be made. This approach is used by Greenaway-McGrevy (forthcoming) to decompose the growth rates in the latest current-dollar estimates of GDP and GDI into “true” growth in output and measurement errors over 1983–2009.

The chart exhibits the statistical discrepancy x_t and the cumulative measurement error in GDP and the cumulative measurement error in GDI.

Note that by construction, at each point and time t , the solid black line (the statistical discrepancy) is equal to the sum of the other two lines (GDP and GDI measurement errors). The measurement error series that more closely tracks the statistical discrepancy indicates which source—GDP or GDI—is more responsible for measurement error. It is clear from the chart that the solid green line more closely tracks the solid black line, particularly since the early 1990s, indicating that GDI measurement error is mostly responsible for the statistical discrepancy.



Another Way of Measuring Revisions

All BEA studies of the revisions to the NIPAs have featured revisions to percent changes in GDP and its components. Percent changes are used because the size of the economy has grown greatly over time. For example, current-dollar GDP in 2009 is about 4 times the size of GDP in 1983, and a 1 dollar revision in 1983 is proportionally a much larger revision than a 1 dollar revision in 2009. Similarly, real GDP in 2009 is somewhat more than twice the size of real GDP in 1983.

The use of percent changes has some disadvantages. First, percent changes cannot be used to measure changes in measures such as change in private inventories that have both positive and negative values; a percent change has no meaning, for example, when going

from a negative value in one period to a positive value in the next period. This limitation means that the importance of revisions to inventories cannot be directly examined. Similarly, because net exports may have both positive and negative values, it may not be possible to calculate percent changes for all periods. Second, the effects of percent changes in two components cannot be directly compared. For example, a 1 percent revision to PCE, which accounts for about 70 percent of GDP, means much more to the overall economy than a 1 percent revision to fixed investment, which accounts for about 16 percent of GDP. Third, there is a well-known phenomenon that the revisions to larger aggregates, measured in percent changes, are typically smaller than those to their components because their subcomponents' revisions tend to offset one another. With a percent change formulation, however, the offsets cannot be examined directly.

An alternative approach is to scale the revisions to produce dimensionless units so that a 1-unit revision at the end of the period of analysis means about the same thing as a 1-unit revision at the beginning of the period. The scaled measures used here are the ratios of the components to trended activity. First differences in the scaled measures can be used in the same way that percent changes are used to measure revisions in the rest of this study.

More formally, the scaling is done by dividing the values of the components by trend economic activity, which is defined here as a detrended unweighted average of GDP and GDI that is constructed using a Hodrick-Prescott filter.¹⁹ Scaled GDP component C of vintage i is defined as

$$C_{i,t} = \text{Component } i_t / \text{Trendactivity}_t$$

First differences of the scaled measures are then used instead of the percent changes. First differences are from the then-latest-available estimate of the previous quarter (vintage j) to the i^{th} current quarterly vintage of the then-current quarter.

$$\text{The first difference is } \Delta C_{i,t} = C_{i,t} - C_{j,t-1}.$$

For example, the first difference for the advance estimate of the first quarter of 2009 is calculated using the third current quarterly estimate for the fourth quarter of 2008. The $C_{i,t}$ can be used in the same types of revisions calculations that the percent changes in components support. The revision from vintage i to

Table 14. Average Revisions to Quarterly Estimates of Price Indexes of GDP and Its Major Components in 1997–2009
[Percentage points]

	Mean revision	Standard deviation	Mean absolute revision
Gross domestic product			
Advance	* 0.25	0.70	0.38
Second	* 0.24	0.72	0.36
Third	* 0.20	0.69	0.31
Personal consumption expenditures			
Advance	0.07	0.52	0.42
Second	0.11	0.52	0.45
Third	0.12	0.62	0.47
Nonresidential fixed investment			
Advance	0.22	0.84	0.78
Second	0.20	0.83	0.75
Third	0.18	0.83	0.72
Residential fixed investment			
Advance	* 1.38	1.69	1.82
Second	* 1.31	1.68	1.57
Third	* 1.06	1.55	1.48
Change in private inventories ¹			
Net exports of goods and services ¹			
Exports			
Advance	-0.14	0.68	0.54
Second	0.01	0.67	0.61
Third	-0.09	0.62	0.36
Imports			
Advance	0.06	4.36	3.05
Second	0.08	4.33	2.95
Third	0.12	4.33	2.93
Government consumption expenditures and gross investment			
Advance	* 0.55	0.93	0.92
Second	* 0.46	0.92	0.87
Third	* 0.41	0.91	0.82
Federal defense			
Advance	* 0.60	1.70	1.35
Second	0.75	4.06	1.85
Third	0.40	1.64	1.24
Federal nondefense			
Advance	0.09	2.60	1.82
Second	0.70	5.34	2.42
Third	0.05	2.63	1.84
State and local			
Advance	* 0.58	1.16	1.05
Second	* 0.53	1.05	0.94
Third	* 0.47	1.02	0.86

* Significant at $p \leq 0.05$
1. Estimates are not available.

19. The trend estimates here use a penalty (lambda) parameter of 1,600 and are not unique; a different lambda—or an alternative methodology such as a logarithmic trend—will yield somewhat different estimates of trend activity. The detrending is not ideal, because the shares of the components in the total tend to change somewhat over time. In particular, the share of imports increases from less than 10 percent in 1983 to more than 16 percent in 2007, before declining cyclically.

vintage n would be

$$R_{in,t} = \Delta C_{n,t} - \Delta C_{i,t}$$

The results of this methodology are directly comparable among components as well as for aggregates like GDP.²⁰ A 1-unit MAR in a component will, *ceteris paribus*, yield a 1-unit MAR in GDP. Similarly, a 1-unit revision to one component means the same thing as a 1-unit revision to another component.²¹ A caveat of this approach results from the fact that there are many ways to calculate trends; the units of measure are thus internally comparable but cannot be compared with the results of calculations using a different trend computation methodology.

Measures of the revisions of the third estimates to the latest estimates are shown in table 15. The scaling methodology allows both the calculation of revisions to estimates of change in private inventories and a direct evaluation of their impact on revisions to GDP. The ratio of GDP to trend activity is slightly greater than 1.000 because the trend measure is not constrained to equal GDP over the sample period. The ratio of change in private inventories to trend activity is very small, 0.003, reflecting the existence of both positive and negative values in the various quarters. However, the ratio of the absolute value of change in private inventories to trend activity is much larger, 0.306.

The MRs are generally small and, with the exception of fixed nonresidential investment, positive. The MARs

are many times larger than the MRs. The MAR for final sales of domestic product is somewhat larger than that for GDP, as the revisions to final sales are partly offset by revisions to change in private inventories. If the sample period for federal government expenditures is shortened to 1992 in order to eliminate the effects of the revised accounting treatment for Commodity Credit Corporation purchases and sales, the MAR for federal government expenditures is reduced by somewhat more than half. Unlike the percent change calculations, the MARs for all of the components of GDP are smaller than the MAR for GDP. The MAR for change in private inventories is the largest among the components, and the MAR for state and local government is the smallest (chart 10). The ordinal rankings of sizes of the MARs for components is quite different

Table 15. Revisions to GDP and Its Components in 1983–2009

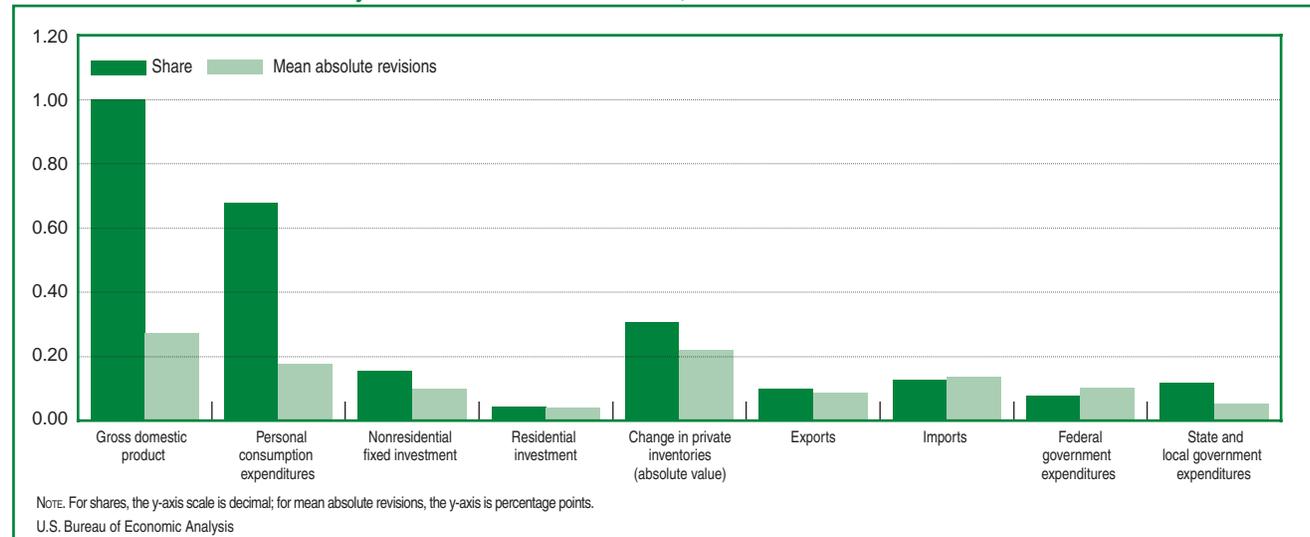
	Ratio to trend activity	Mean revision	Mean absolute revision	Intensity
	Decimal	Scaled units		Units
Gross domestic product	1.002	0.043	0.272	0.272
Personal consumption expenditures.....	0.676	0.024	0.175	0.259
Nonresidential fixed investment.....	0.156	-0.009	0.099	0.634
Residential fixed investment.....	0.044	0.001	0.039	0.865
Change in private inventories.....	0.003	0.005	0.219	0.717
Exports.....	0.099	0.014	0.087	0.883
Imports.....	0.127	0.002	0.137	1.085
Federal government consumption expenditures and gross investment.....	0.077	0.014	0.100	1.299
State and local government consumption expenditures and gross investment.....	0.117	0.017	0.053	0.456
Addenda:				
Final sales of domestic product.....	0.998	0.085	0.324	0.325
Federal government consumption expenditures and gross investment, 1992–2009.....	0.069	-0.001	0.046	0.667

Activity = (GDP + GDI)/2
 Trend activity is HP-filtered activity, with the HP filter curvature penalty set to 1,600.
 Intensity = MAR/Ratio of activity to trend activity
 Absolute value of (Change in private industries)/Trend activity for inventories

20. This methodology cannot be used for real GDP. BEA estimates real GDP by chaining together its components. As a result, real GDP does not equal the sum of its components.

21. Because the constant-share assumption does not quite hold, the results of the scaled revisions for the components are not precisely additive; this has little effect on the qualitative results described here.

Chart 10. Shares of Trend Activity and Mean Absolute Revisions, 1983–2009



from that shown for the percent changes in table 1.

An “intensity” measure may be calculated that scales the MARs by the ratios of the components to trend activity. This scaling allows the direct comparison of revisions to one component of GDP to the revisions to all of the other components, and thus the evaluation of the importance of the revisions of one component compared to those of other components. This is useful because indirect comparisons using percent changes have suggested that revisions to inventories were disproportionately important in revisions to GDP relative to revisions to other components. In the calculations, the intensity of change in private inventories is obtained by dividing the revisions in the scaled estimates by the ratio of the absolute values of change in private inventories to trend activity. (And similarly for the other components of GDP.) Although the intensity for change in private inventories is more than 2 ½ times as large as that for GDP, it is well within the range of the intensities of the other components. Thus, by the intensity measure, the revisions to change in private inventories are not outliers.

Summary and Conclusions

The results of this review are generally consistent with those of previous studies.²²

22. Although not included in this review, the reliability of real GDP estimates around the most recent five recessions—excluding the most recent recession—are the same as that presented in a previous study (Fixler and Grimm 2005). Full revisions are not yet available for the most recent recession.

- The estimates of GDP and GDI are accurate; the MARs for both measures are modestly above 1.0 percentage point.
- The MRs for both GDP and GDI are near zero and reflect the improvements in measures of economic activity and the expansions of the definition of economic activity that have been introduced in comprehensive NIPA revisions that adapt the NIPAs to a changing economy.
- Revisions to the major components of GDP have preserved the trends found in the early estimates.
- The quarterly estimates are accurate indicators of whether the economy is growing at rates above, near, or below the long-term trend.
- The MARs for all of the annual estimates of GDP and GDI are half, or less than half, of those for the current quarterly estimates. The MARs decline modestly with each succeeding vintage of estimates from the early annual estimates to the third annual revision estimates.
- The revised estimates of GDI and compensation of employees that are published 5 months after the end of each quarter reduce the MAR for compensation but not the MR for GDI.
- GDI provides additional and valuable information about the course of true economic activity, which is never observed.
- The MARs for price indexes for GDP and its major components are small in comparison with the MARs for the corresponding real and current-dollar measures.

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