

The Reliability of the GDP and GDI Estimates

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THE NATIONAL income and product accounts (NIPAs) provide a timely, comprehensive, and reliable description of the condition of the U.S. economy. The two featured measures—gross domestic product (GDP) and gross domestic income (GDI)—are equally valid summary measures of economic activity. GDP measures activity as the sum of all final expenditures in the economy plus change in private inventories. It is detailed on the product side of the domestic income and product account. GDI measures the sum of all incomes generated in production, and 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 with different source data.

This study analyzes the reliability of the successive estimates of GDP and GDI and their components for 1983–2006. “Reliability” refers to the magnitudes of the revisions to the successive estimates of these mea-

asures and their major components.¹ The revisions are measured as the changes from an earlier vintage of the estimates to a later vintage, for example, from the advance estimate to the final estimate (see the box “Vintages and Timing of Revisions”). The latest available estimates are assumed to be the best estimates and are used as the standards for reliability.

This study concludes that Bureau of Economic Analysis (BEA) statistics are generally reliable and present useful pictures of the nation’s economic activity. In particular, the early quarterly estimates provide an accurate picture of the economy, indicating whether economic growth was positive or negative, whether it was accelerating or decelerating, whether it was high or low relative to trend, and where the economy was in relation to the business cycle.

1. This definition of reliability differs from that used in statistics to analyze survey results and quality control. Reliability is used as a guide to “accuracy” of the total measurement error, which in the NIPAs is never observed.

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, preliminary, and final estimates. The advance estimates for a quarter are released about a month after the quarter ends. The preliminary estimates for the quarter are released 2 months after the quarter. And the final estimates are released 3 months after the quarter. In addition, as part of the annual NIPA revision release in 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 preliminary estimates of GDP for the succeeding quarter. These revised estimates are available beginning with the estimates for the first quarter of 2002.

BEA prepares four vintages of current annual estimates for a year—the sum of finals and the first, second, and third annual estimates. The sum of finals is an aver-

age of the final estimates for each quarter of the previous year; this estimate is prepared and released in March with the final estimate for the fourth quarter of the year. (In years with annual revisions, the quarterly estimate of the first quarter of the previous year is from the first current annual estimate released the previous summer.) The current annual estimates for 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 benchmark NIPA revision.

Annual NIPA revisions are superseded by comprehensive NIPA revisions, which occur about every 5 years. These revisions incorporate changes in definitions and classifications as well as methodological changes. The most recent comprehensive benchmark revision was released in December 2003; it featured revised annual estimates for 1929–2002 and revised quarterly estimates for 1947–2003. The latest available quarterly estimates are the comprehensive benchmark estimates for 1947–99, third annual estimates for 2000–2004, second annual estimates for 2005, and first annual estimates for 2006.

There are three vintages of “current quarterly” estimates for the NIPAs: the advance, preliminary, and final estimates. Each vintage is produced using a wide mix of source data—preliminary survey results, such as the Census Bureau’s surveys of retail sales and manufacturers’ shipments, various indicators, trade industry data, and more—that are later revised to reflect more complete information.

The early quarterly estimates are replaced successively by three vintages of “current annual” estimates that are primarily based on increasingly comprehensive annual source data. For a description of source data and the revision process through the first annual revision estimates, see Grimm and Weadock (2006).

After the third current annual estimates, the estimates of GDP are typically not revised again until a comprehensive benchmark revision. Comprehensive benchmark revisions occur about every 5 years and incorporate even more detailed source data from various economic censuses. Comprehensive benchmark revisions also include changes in definitions that keep the NIPAs abreast of a changing economy. In addition, they include improvements in statistical methodologies.

The construction of confidence intervals for the estimates is not possible, because the data come from a wide range of sources, including random and nonrandom surveys, administrative records, and extrapolated and interpolated estimates. As a result, the only way to evaluate the reliability of early estimates is to compare them with later estimates.

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 much earlier estimates. For example, a 1.0-percentage-point revision to current-dollar personal consumption expenditures (PCE) for 2006 would be worth about four times as many dollars as a 1.0-percentage-point revision to PCE for 1983.

The mean absolute revisions (MARs) to the annual rates of change—without regard to sign—from the current quarterly estimates in 1983–2006 to the latest available estimates of current-dollar and real GDP have averaged slightly more than 1 percentage point. That represents a decline from about 3 percentage points from pre-1960 levels. It seems unlikely that the MARs will fall much more—for reasons that have to do with source data, seasonal adjustments, and comprehensive revisions (discussed below)—and that further reductions would not necessarily indicate increased reliability.

The MARs within the current quarterly estimates are smaller. The MAR from the advance estimates of

real GDP to the preliminary estimates is 0.5 percentage point and to the final estimates is 0.6 percentage point. The MAR from the preliminary estimates to the final estimates is 0.3 percentage point.

Mean revisions (MRs) indicate whether the revisions in bulk are positive or negative. Because revisions may be offsetting, the MRs are much smaller. The MRs from the advance to both the preliminary and final estimates are both 0.1 percentage point. The MR from the advance to the latest available estimates is 0.3 percentage point. Much of this MR reflects revisions that stem from comprehensive revisions of the NIPAs. The MRs from both the preliminary and final estimates to the latest available estimates are both 0.2 percentage point.

For 1983–2006, the mean growth rate of real GDP was 3.4 percent. The growth rates ranged from –3.0 to 9.3 percent with a standard deviation of 2.3 percentage points.

The three vintages of current quarterly estimates of real GDP successfully indicated the following:

- The direction of change 98 percent of the time
- The acceleration or deceleration of growth 76 percent of the time (75 percent for the advance estimates)
- The relative magnitude of growth—whether it was above, near, or below trend (one standard deviation from the mean)—more than four-fifths of the time
- The cyclical peaks in five of the six recessions in 1969–2006
- The cyclical troughs in four of the six recessions²

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

Revisions to Quarterly Estimates of GDP

The measures of reliability featured in much of this evaluation are MRs and MARs from the earlier estimates to the latest available estimates (see the box “Mean Revisions and Mean Absolute Revisions”). This section presents the MRs and MARs from the three current quarterly estimates to the latest available estimates.

In the 1983–2006 period, the MARs for both current-dollar and real GDP range from 1.0 to 1.2 percentage points for all three current quarterly vintages. For current-dollar GDP, the MAR from the advance to

2. The cyclical peaks and troughs as measured by GDP and GDI do not always coincide with the National Bureau of Economic Research’s determinations of monthly peaks and troughs. See Grimm (2005).

preliminary estimates decreases slightly and then increases even more slightly to the final estimates (table 1). The MARs decrease for most GDP components other than equipment and software investment and federal nondefense expenditures. These decreases occur as many of the trend-based projections and most preliminary monthly or quarterly estimates are replaced with revised source data (see Grimm and Weadock 2006). The MARs for GDP and about half of its components increase very slightly from the preliminary to the final estimates. These increases occur even though some additional revised source data are incorporated and some projections are replaced with source data.

For real GDP, the MAR from the advance to the preliminary estimates is unchanged. The MARs decrease for about half of the components, are unchanged for two components, and increase for the remaining components. From the preliminary to the final estimates, the MAR for GDP increases slightly. The MARs increase for about two-thirds of the components and decrease for the others.

The MARs for current-dollar and real GDP are smaller than those for any of their components and subcomponents. This reflects the effects of small or negative correlations between the revisions of the components. Table 2 shows the correlations between real GDP and its major components and the correlations between the major components.

Table 2. Correlation Coefficients of Revisions From Final to Latest Quarterly Estimates of Real GDP and Its Major Components in 1983–2006

	GDP	Personal consumption expenditures	Gross private domestic investment	Fixed investment	Exports	Imports	Federal government
Personal consumption expenditures	0.51	.....	.....	.....	.....	.....	.....
Gross private domestic investment	0.49	-0.05	.....	.....	.....	.....	.....
Fixed investment	0.40	0.21	0.31	.....	.....	.....	.....
Exports	0.24	-0.07	0.15	0.11	.....	.....	.....
Imports	-0.28	-0.03	0.29	0.29	0.13	.....	.....
Federal government	-0.14	-0.10	-0.53	-0.03	-0.21	-0.01	.....
State and local government	0.32	0.13	0.00	0.00	-0.15	-0.15	-0.02

It is not possible to calculate MRs and MARs for the estimates of change in private inventories (CIPI)

Table 1. Average Revisions to Quarterly Estimates of GDP and Its Major Components in 1983–2006

[Percentage points]

	Mean absolute revisions		Mean revisions			Mean absolute revisions		Mean revisions	
	Current-dollar GDP	Real GDP	Current-dollar GDP	Real GDP		Current-dollar GDP	Real GDP	Current-dollar GDP	Real GDP
Gross domestic product									
Advance	1.08	1.18	0.38	0.29	Preliminary	4.28	4.69	-1.51	-1.87
Preliminary	1.00	1.18	0.20	0.16	Final	4.33	5.04	-1.91	-2.54
Final	1.03	1.21	0.19	0.17	Residential				
Personal consumption expenditures					Advance	4.61	4.33	0.56	-0.09
Advance	1.18	1.15	0.39	0.31	Preliminary	4.27	4.63	0.45	0.23
Preliminary	1.12	1.07	0.27	0.19	Final	4.13	4.51	0.29	0.11
Final	1.11	1.14	0.28	0.18	Change in private inventories ¹ .....	.....	.....	.....	.....
Durable goods					Net exports of goods and services¹				
Advance	4.42	4.42	0.46	0.38	Exports				
Preliminary	4.40	4.42	0.41	0.30	Advance	5.13	4.27	2.13	1.73
Final	4.38	4.37	0.35	0.23	Preliminary	4.48	3.51	0.89	0.87
Nondurable goods					Final	4.51	3.53	0.54	0.32
Advance	1.76	2.04	0.48	0.63	Imports				
Preliminary	1.47	1.82	0.15	0.32	Advance	6.09	6.63	0.81	0.10
Final	1.48	1.83	0.18	0.32	Preliminary	4.73	5.60	0.10	-0.91
Services					Final	4.74	5.53	-0.24	-1.19
Advance	1.27	0.98	0.28	0.14	Government consumption expenditures and gross investment				
Preliminary	1.22	0.95	0.26	0.09	Advance	2.46	2.69	0.48	0.51
Final	1.14	0.98	0.28	0.16	Preliminary	2.41	2.64	0.22	0.25
Gross private domestic investment					Final	2.44	2.69	0.30	0.46
Advance	6.99	6.88	-0.52	-0.89	Federal				
Preliminary	7.10	7.03	-0.65	-0.95	Advance	5.20	5.83	0.30	0.06
Final	7.15	6.90	-0.90	-1.27	Preliminary	5.33	5.89	-0.05	-0.21
Fixed investment					Final	5.35	5.91	0.21	0.16
Advance	2.81	3.03	0.00	-0.66	Defense				
Preliminary	2.58	2.89	-0.50	-1.00	Advance	3.87	3.88	0.24	-0.03
Final	2.56	3.14	-0.73	-1.35	Preliminary	3.59	3.25	0.17	0.01
Nonresidential					Final	3.62	3.34	0.20	0.10
Advance	3.39	3.74	-0.28	-0.88	Nondefense²				
Preliminary	3.44	3.71	-0.99	-1.48	Advance	16.90	19.46	-3.08	-4.64
Final	3.32	3.94	-1.22	-1.93	Preliminary	17.49	19.82	-4.37	-5.97
Structures					Final	17.12	19.41	-3.25	-4.65
Advance	5.95	5.45	1.28	0.61	State and local				
Preliminary	5.77	5.45	0.45	0.13	Advance	1.76	1.68	0.54	0.67
Final	5.76	5.27	0.47	0.42	Preliminary	1.63	1.69	0.32	0.49
Equipment and software					Final	1.66	1.70	0.34	0.53
Advance	4.06	4.58	-0.68	-1.07					

1. Negative values in some quarters make the calculation of percentage changes impossible.

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.

because there are a number of quarters when the values are negative. Because the revisions to inventories are large, the MARs for gross private domestic investment are larger than those for any of its fixed investment components.

The MARs for current-dollar and real federal government nondefense expenditures are very large because of a 1991 change in the accounting treatment of the Commodity Credit Corporation's commodity loan program; after this change, the MARs for these expenditures have been about an eighth of the size of the MARs in previous periods. Because this change also produced matching, but opposite, sign revisions to change in private farm inventories, there was no effect on revisions to GDP.

The MRs are much smaller, 0.4 percentage point for the advance estimates of current-dollar GDP and 0.3 percentage point for the advance estimate of real GDP. The MRs for both the preliminary and final estimates of both current-dollar and real GDP are about 0.2 percentage point, with the MRs for real GDP being slightly smaller. The MRs for most components are positive for both current-dollar measures and real measures. The principal exceptions are gross private domestic investment and fixed investment, which reflect the effects of negative MRs for their largest sub-component, equipment and software investment.

An earlier BEA study found that the MRs for current-dollar and real GDP were not statistically significant (Fixler and Grimm 2005). It also reported that only the MRs for both current-dollar and real equipment and software investment were significant. This significance was the result of the recognition of soft-

ware as investment in 1999, which greatly increased the sizes and rates of growth in investment because business expenditures for software were previously counted as intermediate consumption. All other significant revisions were significant in current dollars or in real terms, but not both.

The MRs for GDP are not indications of bias. Most of these revisions reflect definitional and statistical changes that are part of comprehensive revisions that were made to improve the estimates (Fixler 2004). In particular, the definitional revisions were made to adapt the NIPAs to a changing economy. These definitional revisions have generally, but not universally, raised both the levels and rates of change of GDP.

Have revisions gotten smaller?

There has been ample evidence that over time the MARs of GDP have declined. BEA research supports this view. However, MARs may not significantly decline further in the future for three reasons discussed in this section: source data, seasonal adjustments, and comprehensive revisions.

In an earlier article, BEA reported that the MARs estimates of GDP and gross national product (GNP) had declined from about 3 percentage points in the years before 1960 to about 1 percentage point beginning in the early 1980s (Young 1993). This finding was based on five successive BEA studies that were published between 1965 and 1993. More recent BEA studies have also found that revisions from the current quarterly estimates to the latest available estimates have been about 1 percentage point in periods beginning in 1983.

The results of the studies are summarized in table 3.

Mean Revisions and Mean Absolute Revisions

The mean revision is calculated as the average of the revisions in the sample period:

$$MR = \Sigma(L - E)/n$$

Where E is the percent change in the earlier quarterly or annual estimate, L is the percent change in the later estimate, and n is the number of observations in the sample period. Percent changes in quarterly estimates are at annual rates, which corresponds to the convention generally used for the estimates.

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:

$$MAR = \Sigma |L - E|/n$$

The mean absolute revision is the average of the absolute values of the revisions.

Table 3. Absolute Revisions to Quarterly Estimates of Current-Dollar GDP

Study	Period	Mean absolute revisions (percentage points)
Jaszi (1965)	1947-52	3.3
	1953-56	2.1
	1957-61	1.2
Young (1974)	1947-63	3.1
	1964-71	1.0
Parker (1984)	1968-72	1.1
	1978-83	1.5
Young (1987)	1968-77	1.8
	1978-86	1.5
Young (1993)	1978-82	1.8
	1983-91	1.1
Grimm and Parker (1988)	1983-89	1.2
	1990-97	0.8
Fixler and Grimm (2002)	1983-92	1.1
	1993-00	0.9
Fixler and Grimm (2005)	1983-92	1.0
	1993-02	1.2
Fixler and Grimm (2008)	1983-92	1.0
	1993-06	1.0

The first four studies are for GNP; the others are for GDP. (The growth rates of the two measures rarely differ by more than 0.1 percentage point). The revisions are for the preliminary estimates to the latest available estimates at the time. These are shown because only estimates corresponding to the timing of the preliminary estimates were made in the earliest years. All the revisions are for percent changes in current dollars; publication of real current quarterly estimates of GNP began in 1957.

The first study found MARs for GNP ranging from 3.3 percentage points in 1947–52 to 1.2 percentage points in 1957–61 (Jaszi 1965). (See the box “The Reli-

ability of the First Estimates of GNP.”) Later studies found similar MARs for similar time periods. (Because of annual revisions and comprehensive revisions, the latest available estimates have changed over time.) Studies looking at revisions to GDP for periods beginning in 1983 or later have all found MARs of 0.8 percentage point to 1.2 percentage points, depending on the period examined. Although not shown in the table, the MARs for real GDP typically have been 0.1 to 0.2 percentage point larger than the current-dollar GDP MARs; by implication, revisions to prices have had little effect on the MARs of real estimates.

Earlier commentaries by BEA in its revisions studies

The Reliability of the First Estimates of GNP

Early in 1942, the first estimates of current-dollar gross national product (GNP) were published for 1929–41.¹ These estimates provided the first comprehensive report of the workings of the U.S. economy and facilitated war-time planning.

The first complete set of interrelated and consistent national income and product estimates was published in 1947.² The estimates contained improved concepts and definitions and clarified terminology and provided the first full system of national economic accounts that described each major sector of the economy.

Even by today’s standards, those estimates have proven to be generally reliable. The GNP estimates published in 1942 and the estimates published in 1947 both show essentially the same patterns of increases and decreases and of the sizes of the increases and decreases in what is a very volatile period for the economy (see the chart). And the estimates are not very different from the latest available estimates for the period.

The reliability of both sets of estimates may be examined more closely by looking at the mean revision (MR) and mean absolute revision (MAR) statistics used to judge the reliability of more recent estimates. The values of the MRs from the 1942 estimates to both the 1947 and the latest available estimates—published in 2003—are less than 0.1 percentage point, and the MR from the 1947 estimates to the latest available estimates is 0.1 percentage point (see the table). Those compare favorably to the MRs for the three vintages of current annual estimates, in the 1983–2006 period, of somewhat more than 0.1 percentage point.

1. A more complete report on these estimates may be found in Marcuss and Kane (2007). The publications providing the earliest estimates may be found in Gilbert (1942) and Gilbert and Bangs (1942).

2. The estimates for the period 1929–46 may be found in Gilbert (1947). This and other early publications about GNP and related estimates may be found at BEA’s Digital Library, available on BEA’s Web site at <www.bea.gov>.

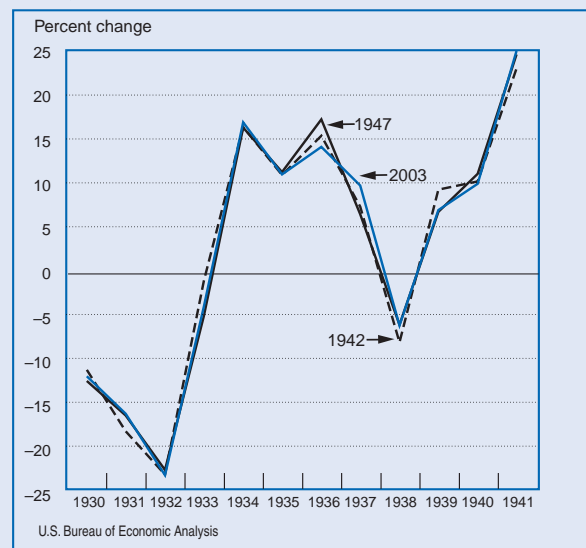
The MARs for the 1942 estimates are about 1.5 percentage points compared with the 1947 estimates and 1.0 percentage point compared with the latest available estimates. The MAR for the 1947 estimates compared to the latest available estimates is 1.4 percentage points. Although these are larger than the 0.3 to 0.4 percentage point MARs for the current annual estimates in the 1983–2006 period, they are smaller when compared with the volatility of GNP in the two periods.

MARs and MRs of Current-Dollar GNP Estimates, 1942–2003

[Percentage points]

Date of earlier estimate	Date of later estimate	MR	MAR
1942	1947	0.04	1.49
1947	2003	0.10	1.38
1942	2003	0.07	0.96

Estimates of GNP Change Published in 1942, 1947, and 2003



suggested that reductions in MARs in later periods were at least a result of the estimates having been through fewer successive revisions. Later work, however, has not supported this suggestion, except for estimates for the most recent few years. As indicated in table 4, the MARs in 1983–2006 for the three current quarterly vintages of GDP peak with the third annual revision estimates and decrease slightly to the latest available estimates. Likewise, the MARs for the five major components of GDP also decrease or increase only slightly from the third current annual estimates to the latest available estimates because as discussed below, the MARs from the current quarterly estimates to the latest estimates show little tendency to increase with successive comprehensive revisions.

There are three reasons why the MARs of GDP may not decline substantially in the near future:

Source data. BEA has increasingly incorporated more timely and higher quality source data earlier in the estimation process. The use of higher quality source data is preferred because such data ultimately leads to more accurate estimates. However, the incorporation of better survey data, because they replace relatively smooth projections, also tends to raise MARs.

Currently, more than half of the source data used

for the advance quarterly estimates are based at least in part on projections (Grimm and Weadock 2006). As better data become available, projection-based data are replaced. In fact, for the preliminary and final estimates, more than two-thirds of the estimates are based on revised monthly or quarterly data. Only a bit more than one-twentieth of the first current annual estimates are trend based; other sources are split evenly between revised monthly or quarterly data and annual data.

BEA continues to incorporate improved source data as those data become available. For example, BEA now incorporates the Census Bureau's Quarterly Services Survey (QSS) to improve BEA estimates of service sector production, though it may raise MARs.

Beyond the QSS, the likelihood of major new surveys becoming available for the early quarterly estimates appears limited. However, the available surveys may lead to improved data through new methods and more suitable records among other things. Again, such improved source data can lead to higher MARs.

Seasonal adjustment factors. These adjustments derive from new or revised source data that reflect changing seasonal patterns even if there are no substantial revisions to the underlying seasonally unadjusted data. These revisions, which continue to be made from the first through the third annual revision, incorporate unpredictable changes in seasonal patterns.

It has been shown that revisions to seasonal adjustment factors will result in revisions to the estimates. One report was that “the average absolute revision in quarterly changes in the seasonal factors in the period 1983 to 1988 . . . is about one-half the size of the total revision (seasonally adjusted) from the current estimates to the latest available estimates of GDP” (Young 1996). A more recent BEA study found that the MARs from seasonal factors from the first to the third current quarterly estimates in 1987–97 were about the same sizes as the corresponding revisions to seasonally adjusted estimates of GDP and seven major components (Fixler and Grimm 2002).

Fixler and Grimm (2002) found that the MAR to GDP estimates that are accounted for by revisions to seasonal factors was 1.0 percentage point.³ This MAR is about the same size as the overall MARs for periods beginning in 1983. This reflects the fact that GDP revisions resulting from revisions to seasonal adjustment factors tend to be of the opposite sign to the revisions

Table 4. Mean Absolute Revisions to Quarterly Estimates of Current-Dollar GDP and Its Major Components in 1983–2006

[Percentage points]

Vintage of estimate	Vintage of revision					
	Preliminary	Final	First annual	Second annual	Third annual	Latest
Gross domestic product						
Advance.....	0.54	0.67	1.01	1.12	1.19	1.08
Preliminary.....	0.27	0.80	0.98	1.07	1.07	1.00
Final.....		0.79	0.97	1.07	1.07	1.03
Personal consumption expenditures						
Advance.....	0.38	0.44	0.80	1.04	1.15	1.18
Preliminary.....		0.27	0.78	0.97	1.04	1.12
Final.....			0.75	0.96	1.03	1.11
Durable goods						
Advance.....	1.41	1.67	2.57	2.97	2.96	2.81
Preliminary.....		0.75	1.99	2.69	2.63	2.58
Final.....			1.88	2.70	2.58	2.56
Nondurable goods						
Advance.....	3.07	3.47	3.99	4.28	5.42	5.13
Preliminary.....		1.63	2.84	3.07	4.37	4.48
Final.....			2.86	3.33	4.60	4.51
Services						
Advance.....	3.80	4.07	5.71	5.95	6.18	6.09
Preliminary.....		1.25	4.15	4.49	4.73	4.73
Final.....			4.02	4.53	4.48	4.74
Government consumption expenditures and gross investment¹						
Advance.....	2.01	2.06	3.77	4.22	4.71	5.20
Preliminary.....		0.93	3.62	4.04	4.82	5.33
Final.....			3.39	3.92	4.75	5.35

NOTE: The revised estimate is the standard for comparison in calculating the mean absolute revision. See the box “Mean Revisions and Mean Absolute Revisions.”

1. Reflects a revised accounting treatment for Credit Commodity Corporation purchases and sales that had no effect on GDP.

3. This does not include any seasonal revisions from the current quarterly to the first current annual estimates. BEA does not compute these revisions and lacks the information to do so.

to seasonally unadjusted estimates. Thus, they tend to be offsetting.

Comprehensive revisions. To account for the evolving economy, BEA continues to make major methodological and definition changes via comprehensive revisions. For example, BEA is tentatively scheduled to capitalize research and development spending starting in 2013. Comprehensive revisions also incorporate high-quality Economic Census data. For these reasons, comprehensive revisions tend to raise MARs.

From 1983 to 2006, there have been five comprehensive benchmark revisions. The first, in December 1985, included only 11 quarters in this period and is not discussed here. The others occurred in late fall of 1991, 1999, and 2003, and—after a delay due to a shut-down of the federal government—in the beginning of 1996. Summary statistics for revisions of current-dollar GDP from the latest available estimates prior to the comprehensive revisions to the comprehensive revision estimates are shown in table 5.

Table 5. Average Revisions to Quarterly Estimates of Current-Dollar GDP in the Comprehensive Revisions
[Percentage points]

Year of comprehensive revision	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
Average.....	.....	0.05	0.63

The MARs are large in comparison with the MRs, as one would expect. The MARs range from 0.54 percentage point to 0.76 percentage point and average 0.63 percentage point. Although there are no comprehensive statistics, earlier and incomplete reviews of the MARs for the various revisions have suggested that the larger contributors to them are the definition changes rather than the statistical revisions. For example, an earlier BEA study reported that definition changes accounted for somewhat more than three-fifths of the average upward revision to current-dollar GDP in the 1999 comprehensive benchmark revision (Fixler and Grimm 2002).⁴

It does not appear that a zero MAR for GDP is an achievable goal for three reasons: (1) by the time of the first current annual estimates, the availability of source data to replace trend data, the availability of revised source data to replace preliminary data, and the availability of some annual data together result in MARs

approaching 1 percentage point; (2) by the time of the third annual revision estimates, the availability of source data for periods in the future to the period being seasonally adjusted also results in MARs of about 1.0 percentage point; and (3) the changes made in the accounts to adapt them to a changing economy, combined with improved statistical methodologies, result in MARs of more than 0.5 percentage point. Thus, three of these factors combined suggest that there is an asymptote of roughly 0.5 to 1.0 percentage point that is a limiting factor to the lowest possible average of revisions. This asymptote is consistent with the MARs of the estimates of GDP from the studies shown in table 3, which are rarely much below 1.0 percentage point after 1983.

Revisions to various vintages of estimates

In addition to the statistics for revisions to the latest available estimates, it is useful to look at the statistics for intermediate vintage estimates (for example, the revisions from the final current quarterly estimates to the first current annual estimates). Intermediate vintage MARs for current-dollar GDP and selected components are shown in table 4. MARs for the current quarterly estimates of GDP increase steadily, reaching their largest values when calculated using the third current annual estimates. The MARs decline slightly from the third annual to the latest estimates. The MAR from the advance estimates to the first annual estimates is about 0.2 percentage point larger than the MARs of the preliminary and final estimates to the first annual estimates and about 0.1 percentage point larger than the MAR from the preliminary and final estimates to all later estimates.

The MARs for PCE also increase steadily but remain somewhat below the corresponding MARs for GDP until the latest estimates, which are about 0.1 percentage point larger. The MARs for all of the other selected components are larger than those for GDP and PCE. They also increase as successively later vintages are used to measure revisions; somewhat fewer than half reach peak values with the third current annual estimates, and the rest reach peak values with the latest available estimates. As mentioned above, changes in the accounting for the Commodity Credit Corporation's loan program sharply increased the MARs for federal government expenditures; if the sample period is truncated to 1992 and later, these MARs are roughly halved.

The MRs for current-dollar GDP and the selected components are shown in table 6. They are small in comparison with the MARs and show little tendency to

4. Calculated from table 12.

increase when measured using successive later vintage estimates. As discussed above, the MRs to the latest available estimates for GDP include the effects of definitional revisions that have tended to raise the rates of growth. These definition changes also affect the MRs to the current annual vintage estimates; definition changes also tend to increase the rates of growth in MRs relative to the current quarterly vintage estimates until the new definitions were incorporated into the current quarterly estimates. As an example, about one-fifth of the first current annual estimates have definition changes that are not in the current quarterly estimates for the same periods. Two-fifths of the second current annual estimates and three-fifths of the third current annual estimates have such changes. These revisions are not errors, but represent the effects of changing definitions in the NIPAs.

The MRs for PCE from the three current quarterly vintages of estimates to the various subsequent vintages are similar in size to those for GDP. Through the second current annual estimates, the revisions are slightly smaller; for the third current annual estimate and the latest available estimate, they are somewhat

less than 0.1 percentage point larger. All the MRs are positive except the MR from the preliminary to the final current quarterly estimates.

The MRs both for fixed investment and for equipment and software investment are nearly all positive through the revisions to the first current annual estimates and are negative for revisions to subsequent vintages. These patterns reflect the patterns for equipment and software investment, which declined 2.0 percentage points to negative values from the first to the second current annual estimates. MRs to subsequent vintages are also negative.

MRs for the advance estimates of exports are positive. They are the largest for all components, peaking with the third current annual estimates and then declining slightly. MRs for the preliminary estimates follow pretty much the same pattern, but at lower values. MRs for the final estimates start at a small negative value and become increasingly positive through the third current annual estimates before declining.

MRs for the advance estimates of imports fluctuate from vintage to vintage, mostly at values just below 1.0 percentage point. MRs for the preliminary estimates fluctuate, primarily at small positive values. MRs for the final estimates fluctuate between -0.2 percentage point and -0.4 percentage point.

The MRs for the current quarterly estimates of federal government consumption expenditures and gross investment range from -0.3 to 0.5 percentage point, with no particular patterns, and most are positive. The MRs for state and local government are generally positive, with peak values of 0.4 to 0.6 percentage point with the third current annual estimates, and decline about 0.1 percentage point with the latest available estimates.

Relationships among various vintages

Some observers have found that revisions are sometimes related to other vintages of revisions. However, others—including Grimm and Parker (1998)—have found much less of a correlation. At least two sorts of revisions might be related: the relationship between revisions in adjacent periods and the relationship between revisions in adjacent vintages of estimates for the same periods.

Relationships between revisions in adjacent periods may be analyzed by regressions based on

$$Rev_t = a_0 + a_1 Rev_{t-1}$$

The upper panel of table 7 shows the results of these regressions for GDP and five of its six major components. Summary results are shown for each of the six

Table 6. Mean Revisions to Quarterly Estimates of Current-Dollar GDP and Its Major Components in 1983–2006
[Percentage points]

Vintage of estimate	Vintage of revision					
	Preliminary	Final	First annual	Second annual	Third annual	Latest
Gross domestic product						
Advance	0.18	0.19	0.25	0.26	0.30	0.38
Preliminary .....	.....	0.01	0.07	0.07	0.13	0.20
Final .....	.....	.....	0.06	0.06	0.12	0.19
Personal consumption expenditures						
Advance	0.11	0.11	0.13	0.23	0.31	0.39
Preliminary .....	.....	-0.01	0.02	0.11	0.18	0.27
Final .....	.....	.....	0.02	0.11	0.18	0.28
Gross private domestic investment						
Fixed investment						
Advance	0.51	0.73	0.88	-0.16	-0.20	0.00
Preliminary .....	.....	0.23	0.38	-0.70	-0.70	-0.50
Final .....	.....	.....	0.15	-0.94	-0.95	-0.73
Equipment and software						
Advance	0.82	1.23	1.11	-0.73	-0.86	-0.68
Preliminary .....	.....	0.40	0.28	-1.62	-1.77	-1.51
Final .....	.....	.....	-0.12	-2.03	-2.20	-1.91
Change in private inventories¹						
Net exports of goods and services¹						
Exports						
Advance	1.24	1.59	1.57	1.95	2.43	2.13
Preliminary .....	.....	0.35	0.34	0.70	1.16	0.89
Final .....	.....	.....	-0.01	0.35	0.81	0.54
Imports						
Advance	0.71	1.05	0.88	0.92	0.94	0.81
Preliminary .....	.....	0.34	-0.03	0.17	0.18	0.10
Final .....	.....	.....	-0.37	-0.20	-0.21	-0.24
Government consumption expenditures and gross investment						
Federal						
Advance	0.36	0.09	0.51	0.47	-0.01	0.30
Preliminary .....	.....	-0.26	0.16	0.09	-0.34	-0.05
Final .....	.....	.....	0.42	0.36	-0.05	0.21
State and local						
Advance	0.21	0.20	0.34	0.33	0.63	0.54
Preliminary .....	.....	-0.02	0.13	0.15	0.44	0.32
Final .....	.....	.....	0.14	0.18	0.46	0.34

1. Negative values in some quarters make the calculation of percentage changes impossible.

vintages and components; the estimated coefficients a_1 , the p-value of the estimated a_1 coefficients, and the R-bar square for the estimated equation. No a_1 coefficients for the vintages of GDP or PCE estimates are significant at a value of $p \leq 0.05$. Fourteen of the coefficients of the other 24 components and vintages are significant, ranging from 2 for fixed investment to 5 for imports. The explanatory power of the equations, however, is very slight; 11 of the 14 equations with significant coefficients have R-bar squares of less than 0.10, and only 1 has an R-bar square of more than 0.40.

Relationships between revisions in adjacent vintages of estimates for the same periods may be analyzed by

regressions based on

$$Rev_v = b_0 + b_1 Rev_{v-1}$$

The lower panel of table 7 shows the results of the regressions. Two of the vintages of revisions of GDP are statistically significant. The R-bar squares of the two equations are small, however, at less than 0.10. None of the vintages of revisions of PCE or fixed investment have statistically significant b_1 coefficients. Five of the ten equations for exports and imports have significant b_1 coefficients, and three of the five have R-bar squares of more than 0.10. Two of the equations for government have significant coefficients, but their R-bar squares are well below 0.10.

Regression results for both equations suggest that revisions do have modest momentum across both sequential time periods and sequential vintages. The relatively large numbers of significant coefficients for exports and imports suggest that a closer examination of them at a finer level of detail might find some patterns that could be adjusted to yield improved estimates. However, the rather low R-bar squares of the equations with significant coefficients suggest that any improvements are likely to be modest.

Table 7. Regression Equations Explaining Revisions to the Various Vintages of GDP and Its Major Components in 1983–2006

[Coefficients and summary statistics]

Estimation period	Advance to preliminary	Preliminary to final	Final to first annual	First to second annual	Second to third annual	Third annual to latest
	1983:I–2006:IV			1983:I–2005:IV	1983:I–2004:IV	1983:I–1999:IV
Using the previous quarter's revision to the same vintage as explanatory variables						
Gross domestic product	0.030	0.100	-0.014	-0.056	0.029	-0.148
P-value	0.778	0.334	0.895	0.598	0.788	0.223
R-bar square	-0.010	-0.001	-0.011	-0.008	-0.011	0.008
Personal consumption expenditures						
P-value	-0.014	-0.077	0.138	-0.078	-0.048	-0.192
P-value	0.891	0.456	0.182	0.458	0.659	0.113
R-bar square	-0.011	-0.005	0.009	-0.005	-0.009	0.023
Fixed investment						
P-value	0.008	-0.346	-0.211	0.025	-0.172	-0.123
P-value	0.939	0.001	0.038	0.780	0.111	0.310
R-bar square	-0.011	0.110	0.035	-0.010	0.018	0.001
Exports						
P-value	0.281	-0.081	-0.221	-0.171	-0.250	-0.581
P-value	0.006	0.435	0.032	0.105	0.019	0.000
R-bar square	0.069	-0.004	0.038	0.018	0.052	0.332
Imports						
P-value	0.581	0.063	-0.822	-0.275	-0.321	-0.313
P-value	0.000	0.542	0.000	0.009	0.002	0.010
R-bar square	0.029	-0.007	0.671	0.064	0.101	0.084
Government consumption expenditures and gross investment						
P-value	-0.009	0.076	-0.249	-0.224	-0.303	-0.068
P-value	0.933	0.464	0.015	0.033	0.004	0.566
R-bar square	-0.011	-0.005	0.052	0.040	0.081	-0.010
Using the previous vintages of revisions as explanatory variables						
Gross domestic product		0.115	0.089	0.903	-0.034	-0.282
P-value		0.036	0.781	0.000	0.546	0.160
R-bar square		0.036	-0.010	0.065	-0.007	0.015
Personal consumption expenditures						
P-value		-0.104	-0.277	-0.053	-0.032	-0.103
P-value		0.208	0.306	0.571	0.687	0.644
R-bar square		0.006	0.001	-0.007	-0.010	-0.012
Fixed investment						
P-value		-0.070	-0.442	-0.123	-0.057	-0.299
P-value		0.237	0.080	0.241	0.508	0.079
R-bar square		0.004	0.022	0.004	-0.006	0.032
Exports						
P-value		-0.015	-0.806	-0.161	0.290	-0.802
P-value		0.789	0.000	0.016	0.277	0.000
R-bar square		-0.010	0.191	0.052	0.002	0.424
Imports						
P-value		0.004	-0.262	-0.117	-0.373	-0.111
P-value		0.922	0.571	0.005	0.001	0.127
R-bar square		-0.011	-0.007	0.074	0.131	0.016
Government consumption expenditures and gross investment						
P-value		-0.125	0.172	-0.119	0.400	-0.267
P-value		0.024	0.563	0.070	0.013	0.130
R-bar square		0.043	-0.007	0.025	0.059	0.020

Another way of measuring revisions

Studies of revisions to the NIPAs have typically featured revisions to percent changes to GDP and its components. Percent changes are used because the size of the economy has grown greatly over time. For example, GDP in 2006 is about four 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 2006.

The use of percent changes has some disadvantages. First, percent changes cannot be used to measure changes in variables 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 one in the succeeding period. Second, the effects of percent changes in two components cannot be directly compared. A 1 percent revision in PCE, which accounts for roughly 66 percent of GDP, means much more to the overall economy than a 1 percent revision in fixed investment, which accounts for roughly 14 percent of GDP. Third, there is a well-known phenomenon that the revisions to larger aggregates, measured in percent-change terms, are typically smaller than those to their components because subcomponents' revisions tend to offset one another. With a percent-change formulation, however, the offsets cannot be examined directly.

An alternative approach is to use a trended series 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. Differences in the scaled measures can be used in the same way as percent changes are used.

The scaling is done by dividing the values of the revisions by trend GDP. A trend GDP series is constructed using a Hodrick-Prescott filter.⁵ This trend GDP is used as the denominator, and the GDP components are used as numerators, in calculating de-trended measures of revisions to the components.⁶ More specifically, the de-trended measure for the i^{th} component of GDP in period t is simply $DGDP_i(t) = GDP_i(t) / TGDP(t)$, where $TGDP$ is trend GDP. The results of the de-trending are scaled dimensionless units because both numerators and denominators are in dollars. (For ease of exposition, the de-trended measures also are multiplied by 100; this has no effect on the discussion of results.)

To illustrate how the scaling by trend GDP permits the calculation of revisions when estimates for successive periods are of the opposite sign, consider the final current quarterly estimates of change in private inventories, which were \$49.8 billion in the fourth quarter of 2000 and -\$26.1 billion in the first quarter of 2001 (table 8). Calculation of a percent change is impossible in this case. Similarly, a percent change cannot be calculated for the latest estimates of \$41.4 billion and -\$9 billion. Changes and revision in change, however, may be calculated for these values when divided by trend GDP.

Table 8. Change in Private Inventories

	Billions of dollars			De-trended units		
	Final	Latest	Revision	Final	Latest	Revision
2000:IV.....	49.8	41.4	-8.4	0.507	0.421	-0.086
2001:I.....	-26.1	-0.9	25.2	-26.3	-.01	-0.04
Change.....	-75.9	-42.3	33.6	-0.77	-0.521	0.249

The value in the lowest cell in the right column is the revision in change; note that it is the sum of the absolute value of the revisions across vintages (summing down the column “Revision”), and equivalently, the difference between the change in the latest and the change in the final over time (going across the bottom

5. The trend estimates here use a penalty (lambda) parameter of 1,600 and are not unique; a different lambda—or an alternative, such as a logarithmic trend—will yield somewhat different estimates of trend GDP. Also, the de-trending methodology is not ideal, because the longer term shares of the components in GDP change over time; in particular, the share of imports increases from about 10 percent in 1983 to more than 16 percent in 2006.

6. The values of trend GDP in the sample period vary between 98 percent and 102 percent of the latest estimates of GDP.

row of the right-hand vintage columns). Thus the revision in change can be viewed as either the revision in vintages for a point in time or the movement in the vintage estimates over time. The time series of the revision-in-change units may be used to calculate the MRs and MARs of the estimates from the final to the latest vintage. More specifically, using the right “Revision” column, the MR would be 0.038, and the MAR would be 0.124. The same methodology may be used for other combinations of vintages, for GDP, and for its components.

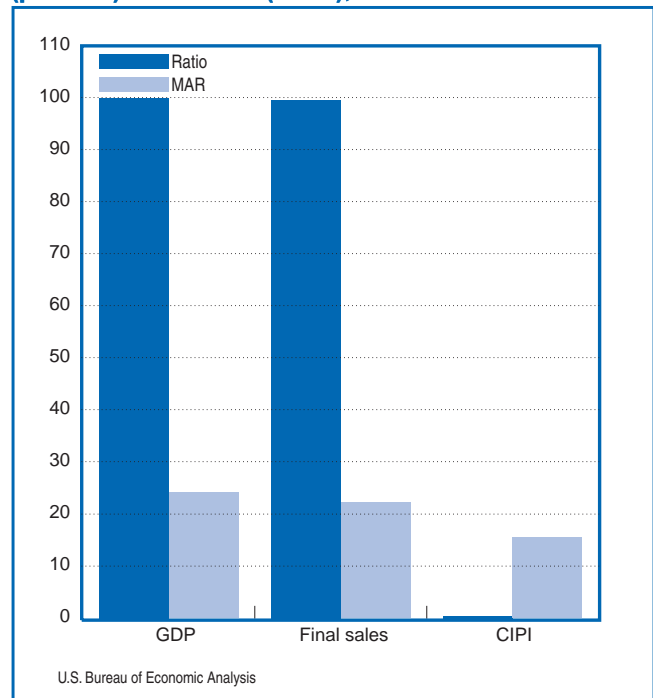
The results of this de-trending methodology are directly comparable among components as well as for aggregates like GDP.⁷ A 1 unit MAR in a component will, *ceteris paribus*, yield a 1 unit MAR in GDP. Similarly, a 1 unit revision in one component means the same as a 1 unit revision in another component.⁸

The scaling methodology both allows the calculation of revisions to estimates of change in private inventories (CIPI) and a direct evaluation of their impact on revisions to GDP. Chart 1 and table 9 show the MARs from the final current quarterly estimates to the

7. This methodology can only be used for current-dollar GDP. BEA estimates real GDP by chaining together its components. As a result, real GDP does not equal the sum of its components.

8. 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 in this section.

Chart 1. GDP and Components: Ratios to GDP (percent) and MARs (units), 1993–2006



latest estimates for GDP, CIPI, and final sales for the fourth quarter of 1993 to the fourth quarter of 2006, expressed as revisions to scaled first differences in their ratios to trend GDP (units).⁹ The MAR for final sales is nine-tenths the size of the MAR for GDP, but the MAR for CIPI is two-thirds the size of the MAR for GDP.¹⁰ The effects on GDP are not the sum of the two MARs, because the revisions to final sales and CIPI are negatively correlated, with a correlation coefficient of -0.17 , and the revisions partly offset one another. As a result, although MARs to CIPI are large relative to those to GDP and far more than in proportion to the share of CIPI in GDP, their effects are partly offset by revisions to final sales.

The methodology may be used to compare the revisions in all of the components of GDP. MARs and average ratios of all current quarterly estimates of components to trend GDP are shown in table 9. The ratio of PCE to trend GDP is slightly more than two-thirds. The ratios of the other components of final sales to trend GDP are very roughly similar to one another, ranging from about 10 percent to 20 percent.¹¹ The MAR for PCE is second only to the MAR for CIPI.

9. This period was chosen to avoid the large revisions in historical estimates of CIPI that were introduced in the December 1991 comprehensive NIPA revision. These revisions resulted from the reclassification of the highly volatile purchases and sales of the Commodity Credit Corporation from the government sector to the business sector, which had no effect on GDP. The period also incorporates the improvements in estimates of international trade in goods that were introduced in the December 1985 comprehensive NIPA revision.

10. The choice of trend methodology appears to make little qualitative difference. If a logarithmic trend fitted to GDP in the first quarter of 1983 and the fourth quarter of 2006 is used as the scaling variable, the MARs for GDP and its major components are modestly higher, but the same relative patterns are observable.

11. Because imports are subtracted and the other components are added to calculate GDP, the ratios for all components (including CIPI) sum to about 124 percent of GDP.

Table 9. Ratios to Trend GDP and Average Revisions to the Latest Estimates in 1993–2006

	Ratio	Mean absolute revisions			Mean revisions ¹		
		Advance	Preliminary	Final	Advance	Preliminary	Final
	(Percent)	(Units) ²					
Gross domestic product.....	100.0	26.3	23.6	24.1	5.9	1.7	-0.5
Personal consumption expenditures.....	67.2	15.5	13.3	13.7	1.0	0.5	-0.3
Fixed investment.....	15.6	9.6	9.3	9.2	4.2	1.9	-0.4
Change in private inventories.....	0.4	17.2	15.7	15.5	-0.7	-0.5	-0.2
Exports.....	9.7	12.7	10.5	10.7	3.8	1.0	0.9
Imports.....	12.3	14.4	8.3	7.9	3.7	0.5	1.1
Government consumption expenditures and gross investment.....	19.3	6.2	6.8	6.1	2.4	0.6	1.3
Final sales.....	99.6	25.7	23.6	22.3	7.0	-0.8	-0.8

NOTE: Final sales equals GDP less the change in private inventories.

1. Mean revision components do not sum to total because of approximation methodologies.

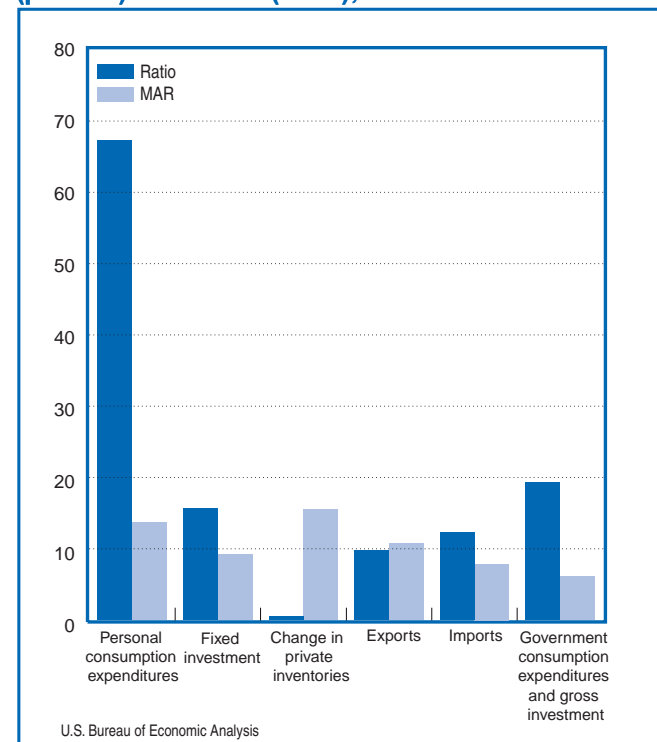
2. Units are current-dollar values divided by trend GDP.

But the ratio of PCE to trend GDP is smaller than that for the other components. The sum of the MARs for the final current quarterly estimates of the components of final demand is 47.6 units, somewhat more than twice the MAR for final demand because revisions in the components tend to offset one another.

The results are similar for the advance and final estimates (they are not shown in this study). The MARs for GDP, final sales, and all other components except government consumption expenditures and gross investment decline from the advance to the final estimates. The MARs for GDP, PCE, and exports increase modestly from the preliminary to the final estimates. The MARs for the other components decline.

Chart 2 shows the ratios of the latest estimates of the six major components of GDP to GDP. The ratio of PCE to GDP is by far the largest, and the ratio of CIPI to GDP is by far the smallest. The ratios of the other four components to GDP are roughly similar in size. The chart also shows the MARs of the final estimates of the scaled components. The MAR for CIPI is the largest, followed by PCE, exports, fixed investment, imports, and government. The revisions of the components tend to be offsetting, and as a result, the MAR for GDP is only moderately larger than that of final sales. In turn, as the result of offsets, the MAR for final sales is only moderately larger than the MARs for

Chart 2. GDP Components: Ratios to GDP (percent) and MARs (units); 1993–2006



its five components.

As indicated in table 9, the MRs are small in comparison with the MARs. For the advance estimates, the MRs are positive for GDP and all components except CIPI. These MRs reflect the same small positive biases on a percent-change basis that were noted above. For the preliminary estimates, the MR for GDP is much smaller, and the MR for final sales is negative. For the final estimates, the MRs for GDP, final sales, and three of the six GDP components are negative.

Regarding the MARs for GDP, the contribution of CIPI is the largest and is far out of proportion to CIPI's share. The contributions of the revisions to the major components of GDP tend to be offsetting, and the MAR for GDP is about half the size of the sum of the

MARs of its components.

In sum, the methodology shows that the direct impacts on GDP of revisions to CIPI are somewhat larger than those for any of the five major components of final sales and are about two-thirds as large as those for all of final sales. This approximate result cannot be revealed with the use of percent changes.

Revisions to Current Annual Estimates of GDP

MRs and MARs for the "sum of finals" and the three current annual estimates are shown in table 10.¹² The

12. The sum of finals is the average GDP level of the most recently available estimates for the quarters of the year. This average level is then used to calculate growth rates.

Table 10. Average Revisions to Annual Estimates of GDP and Its Major Components in 1983–2006

[Percentage points]

	Mean absolute revisions		Mean revisions			Mean absolute revisions		Mean revisions	
	Current-dollar GDP	Real GDP	Current-dollar GDP	Real GDP		Current-dollar GDP	Real GDP	Current-dollar GDP	Real GDP
Gross domestic product									
Sum of finals	0.42	0.65	0.20	0.21	Second annual	1.58	1.74	0.35	0.15
First annual	0.39	0.56	0.13	0.27	Third annual	1.41	1.51	0.24	0.17
Second annual	0.33	0.48	0.16	0.33	Residential				
Third annual	0.29	0.41	0.12	0.37	Sum of finals	1.43	1.28	0.67	0.29
Personal consumption expenditures									
Sum of finals	0.55	0.56	0.35	0.34	First annual	0.85	1.01	0.09	-0.15
First annual	0.45	0.56	0.23	0.37	Second annual	0.84	0.73	0.17	0.14
Second annual	0.35	0.46	0.20	0.37	Third annual	0.98	0.82	0.26	0.18
Third annual	0.29	0.44	0.19	0.44	Change in private inventories¹				
Durable goods									
Sum of finals	1.24	1.18	0.49	0.43	Net exports of goods and services²				
First annual	1.26	1.11	0.28	0.34	Exports				
Second annual	1.03	0.93	0.30	0.34	Sum of finals	0.82	1.25	0.36	0.32
Third annual	1.03	0.91	0.30	0.44	First annual	0.73	1.10	0.48	0.32
Nondurable goods									
Sum of finals	0.59	0.81	0.08	0.31	Second annual	0.61	0.89	0.22	-0.01
First annual	0.57	0.76	0.02	0.29	Third annual	0.72	0.99	-0.10	-0.27
Second annual	0.27	0.49	0.10	0.35	Imports				
Third annual	0.25	0.51	0.05	0.35	Sum of finals	0.62	1.10	0.31	-0.34
Services									
Sum of finals	0.69	0.60	0.47	0.37	First annual	0.46	0.81	0.22	-0.18
First annual	0.60	0.60	0.32	0.44	Second annual	0.42	0.69	0.13	-0.12
Second annual	0.59	0.54	0.24	0.40	Third annual	0.42	0.69	0.03	-0.14
Third annual	0.48	0.51	0.27	0.51	Government consumption expenditures and gross investment				
Gross private domestic investment									
Sum of finals	2.07	1.97	-0.52	-0.86	Sum of finals	0.61	0.76	0.22	0.48
First annual	1.86	1.81	-0.46	-0.64	First annual	0.54	0.63	0.11	0.34
Second annual	1.38	1.35	0.01	0.01	Second annual	0.57	0.68	0.14	0.28
Third annual	1.23	1.25	-0.04	0.07	Third annual	0.55	0.58	0.01	0.18
Fixed investment									
Sum of finals	1.55	1.48	-0.88	-0.88	Federal				
First annual	1.60	1.33	-0.97	-0.77	Sum of finals	1.00	1.33	0.24	0.27
Second annual	0.99	0.91	0.06	0.19	First annual	0.94	1.33	0.08	0.28
Third annual	0.88	0.82	0.17	0.18	Second annual	0.93	1.31	0.18	0.30
Nonresidential									
Sum of finals	1.83	2.16	-0.97	-1.36	Third annual	1.15	1.41	0.22	0.26
First annual	1.55	1.71	-0.78	-1.05	Defense				
Second annual	1.12	1.52	0.39	0.73	Sum of finals	0.63	1.00	0.09	0.04
Third annual	1.11	2.19	0.27	0.21	First annual	0.54	0.76	-0.04	0.10
Structures									
Sum of finals	2.32	1.91	0.64	0.18	Second annual	0.46	0.50	0.03	0.14
First annual	1.37	0.95	0.39	0.30	Third annual	0.53	0.41	0.09	0.07
Second annual	1.03	1.22	0.60	0.71	Nondefense²				
Third annual	1.09	1.26	0.37	0.49	Sum of finals	3.77	3.48	0.38	0.20
Equipment and software									
Sum of finals	2.29	2.45	-1.54	-1.71	First annual	3.75	2.95	0.19	-0.08
First annual	2.17	2.39	-1.20	-1.42	Second annual	3.54	2.88	0.52	0.45
					Third annual	4.46	3.61	0.45	0.08
					State and local				
					Sum of finals	0.84	0.99	0.27	0.44
					First annual	0.63	0.74	0.17	0.38
					Second annual	0.63	0.69	0.10	0.25
					Third annual	0.50	0.48	-0.12	0.11

1. Negative values in some quarters make the calculation of percentage changes impossible.

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.

estimates are in percent changes of annual estimates of current-dollar and real GDP and its major components.

The MARs for both current-dollar and real GDP are much smaller than the MARs for the three current quarterly vintages. The sizes of the MARs generally decrease as the annual estimates are revised. For current-dollar GDP, the largest decrease is between the first and second annual estimates. For real GDP, the decreases get slightly smaller with each successive vintage.

The results reflect two factors: (1) annual estimates are unaffected by revisions to seasonal adjustments, and (2) revisions, such as the replacements of quarterly extrapolations with interpolations, do not affect annual estimates.

Except for some vintages of estimates of current-dollar and real PCE, the MRs for GDP are smaller than the MRs for its major components. Among the components, PCE has the smallest MARs, and federal non-defense expenditures has the largest. The latter reflects the changes in treatment of the Commodity Credit Corporation's commodity loan program; if the sample period is truncated to 1992–2006, the MARs are one-half to one-tenth those shown in the table.

The MRs for the sum of finals estimates of current-dollar GDP are about the same as the MRs for the current quarterly estimates; the MRs for the annual vintage estimates of real GDP have somewhat larger positive values. These patterns reflect similar patterns of MRs for current-dollar and real PCE. The MRs for current-dollar and real fixed investment are negative, reflecting increasingly negative MRs for equipment and software investment. Although the MRs for current-dollar imports are small positives, the MRs for real imports are negative; these differences reflect upward revisions in the price of imports. The MRs for most other components of GDP are generally small positives.

Revisions to Quarterly Estimates of GDI

Advance estimates of GDI are not prepared, and since 1995, preliminary estimates of fourth-quarter GDI have not been prepared. As a result, this discussion is mainly about revisions to the final estimates for 1983–2006. Net national factor income (similar to what was labeled national income prior to the 2003 comprehensive revision) has the same publication schedule.¹³ When advance and preliminary current

quarterly vintages of the estimates of components of GDI have been published, revisions statistics for these are shown (table 11). Generally, revisions to the components have the same general trend as the revisions to GDP components—including very small tendencies for downward movement in MARs.

Table 11. Average Revisions to Quarterly Estimates of GDI and Selected Components in 1983–2006

[Percentage points]

	Mean absolute revisions			Mean revisions		
	Advance	Preliminary	Final	Advance	Preliminary	Final
Gross domestic income			0.89			0.01
Consumption of fixed capital ¹	3.08	3.07	3.03	1.75	1.70	1.49
Taxes on production and imports	2.82	2.82	3.94	0.28	0.10	0.15
Net national factor income ²			1.47			-0.03
Compensation of employees.....	1.69	1.56	1.53	0.39	0.16	0.15
Proprietors' income with IVA and CCAj						
CCAj.....	10.04	9.80	9.28	-1.25	-0.84	-0.63
Nonfarm.....	5.11	4.61	4.68	-1.04	-0.60	-0.47
Rental income of persons with IVA and CCAj ³	276.83	96.48	81.04	-253.28	-73.51	-57.92
Corporate profits with IVA and CCAj.....			15.39			-2.85
Net interest and miscellaneous payments.....		8.37	8.36		0.73	0.47

IVA inventory valuation adjustment

CCAj capital consumption adjustment

1. Excludes 1985:III because an extremely large value in this quarter distorts the results.

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

The MARs for the final estimates of GDI and net national factor income are similar to those for current-dollar GDP; MARs for GDI are very slightly smaller; and MARs for net national factor income are a bit larger. Among the components of net national factor income, only compensation of employees has MARs similar to those for most of the major components of GDP. For the other components, the MARs are much larger, reflecting the limited availability of quarterly source data. For example, corporate profits are estimated using sources such as corporate financial statements; beginning with the second annual revision estimates, tax return data are used for the estimates. Very large MARs for rental income result from small dollar-denominated revisions when the base period values are near zero; this results in large percentage-point revisions. The large MARs for proprietors' income reflect generally large revisions to farm proprietors' income; the MARs for nonfarm proprietors' income are half the size of those for the totals.

The MR for the final estimates of GDI is quite small and positive. This primarily reflects a positive MR for consumption of fixed capital. The MRs for the components of net national factor income are mostly negative and are largely offset by a positive MR for compensation of employees. Again, the large negative MR for

13. The present measure named "national income" has a somewhat different definition.

rental income translates from quite small dollar-denominated revisions.

Additional revisions to estimates of compensation of employees

Beginning with the first quarter of 2002, BEA has revised certain income-side estimates 2 months after the release of the final estimates of quarterly personal income. This has allowed the incorporation of private-sector data from the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW); these data are tabulations that originate from the state unemployment insurance (UI) system and from the UI program for federal civilian employees. The QCEW data are from quarterly state UI contribution reports—also known as form ES-202—that are filed by employers in the industries that are covered by, and subject to, each state's UI laws and by federal agencies; these data are available 5 months after the end of each quarter. The QCEW data for almost all private industries, for federal government civilian employees, and for state and local government employees account for 95 percent of wages and salaries.

The QCEW data are used to replace the more limited information used in the current quarterly estimates. The advance, preliminary, and final estimates of wages and salaries incorporate data from the BLS monthly current employment statistics payroll survey of nonfarm employment, hours, and earnings. This survey covers hours and earnings only for production workers (or for nonsupervisory workers in service industries) and does not include commissions, tips, bonuses, or gains from exercising nonqualified stock options. Thus, the BLS monthly survey misses a substantial portion of the wage and salary compensation of high-wage workers.

In the sample period, there are just 20 quarters of

information on revisions to the QCEW estimates of compensation. First current annual revision estimates are used as the standard of comparison for the revisions in order to allow the longest possible sample period, 2002 to 2006, and to avoid an untidy mixture of revisions to first, second, and third annual estimates.

Table 12 shows the MARs for compensation for the final estimates and the QCEW estimates. The MAR for the 20 quarters preceding the first quarter of 2002 is also shown for comparison. The MAR for the final estimates increases 0.8 percentage point from the earlier to the later period. The MAR for the QCEW-based estimates is slightly lower than the MAR for 1997–2001.

Table 12. MARs for Compensation of Employees
[Percentage points]

	First annual less final	First annual less QCEW
1997–2001	1.19	.....
2002–2005	2.03	1.13

Clearly, the incorporation of the QCEW data has improved the reliability of the estimates of compensation.

Revisions to Annual Estimates of GDI

The MAR for the sum of finals estimate of GDI is similar to the MAR for the “final” current quarterly estimate (table 13). The MARs for the three current annual estimates are half that size or less. The MARs for consumption of fixed capital and taxes on production and imports are generally less than half those for the current quarterly estimates.

The MARs for net national factor income are smaller than the MARs for the final current quarterly estimates. The MARs decline to a low with the second annual estimate and then increase slightly. The MARs for compensation of employees are generally smaller than the corresponding MARs for factor income but

Table 13. Average Revisions to Annual Estimates of GDI and Selected Components in 1983–2006

[Percentage points]

	Mean absolute revision				Mean revision			
	Sum of finals ¹	First annual ²	Second annual ³	Third annual ⁴	Sum of finals ¹	First annual ²	Second annual ³	Third annual ⁴
Gross domestic income	0.80	0.40	0.27	0.36	0.19	0.06	0.04	0.13
Consumption of fixed capital	1.84	1.11	1.14	1.35	0.72	0.56	0.71	0.11
Taxes on production and imports	1.16	0.74	0.73	0.88	0.42	0.34	0.22	0.09
Net national factor income⁵	0.82	0.48	0.34	0.44	0.16	0.08	0.04	0.10
Compensation of employees	0.93	0.34	0.19	0.22	0.13	0.09	0.08	0.12
Proprietors' income with IVA and CCAAdj	3.87	2.61	1.73	2.46	0.68	0.53	-0.04	0.30
Nonfarm	3.79	3.08	2.15	2.91	0.36	0.29	-0.01	0.22
Rental income of persons with IVA and CCAAdj ⁶	7.83	6.63	4.31	3.36	-0.56	-0.19	-0.57	-1.16
Corporate profits with IVA and CCAAdj	5.87	5.25	3.18	2.23	0.68	0.26	-0.30	-0.28
Net interest and miscellaneous payments								

IVA inventory valuation adjustment
CCAAdj capital consumption adjustment
1. Sum of final estimates are for 1983–2006.
2. First annual estimates are for 1983–2005.

3. Second annual estimates are for 1983–2004.
4. Third annual estimates are for 1983–99.
5. Equals the present definition of national income plus subsidies, less taxes on production and imports, business current transfer payments (net), and current surplus of government enterprises.
6. Negative values in some years make the calculation of percent changes impossible.

follow a similar pattern. The pattern of MARs for proprietors' income follows a similar pattern, but they are considerably larger. The MARs for corporate profits and for net interest are very roughly twice the size of the MARs for proprietors' income, but they decline steadily with succeeding vintages of estimates.

The MRs for GDI, net national factor income, and compensation are generally positive and often smaller than most of the current quarterly estimates of the same measures. The MRs for corporate profits and for net interest show tendencies to be increasingly negative with successive vintages.

GDP Versus GDI

GDP measures activity as the sum of all final expenditures in the economy plus changes in private inventories. GDI measures the sum of all incomes generated in production. They differ in practice because all of the transactions underlying them are not recorded and because seasonal adjustments and interpolations and extrapolations are not made by identical methodologies. The difference between them is known as the statistical discrepancy.¹⁴

In the long run, GDP and GDI have similar levels and percent movements. In the 10 year period of 1997 to 2006, a graph of the latest values of the two measures would show two largely overlapping lines. Chart 3 shows percent changes of the final and latest estimates of the two measures. The upper panel shows changes in the final estimates of the two measures. Both measures are quite volatile with peaks and troughs appearing every few quarters and with peaks and troughs generally occurring in the same quarters. The lower panel shows changes in the latest estimates of the two measures. Again, peaks and troughs occur every few quarters, but the peaks and troughs of the two measures are less closely aligned.

A closer look at the distributions of the measures finds that for both vintages and measures, the hypothesis that the changes are normally distributed cannot be rejected even at the 50 percent level of confidence. The variances of the GDI estimates decline from 4.76 percentage points for the final estimates to 4.14 percentage points for the latest estimates. In contrast, the variances of the GDP estimates increase from 4.10 percentage points for the final estimates to 5.80 percentage points for the latest estimates.

14. For a more complete discussion of the statistical discrepancy and its causes, see Grimm (2007).

The correlations of GDP with GDI for the two vintages also show a weakening relationship for the latest vintage. The correlation of the two measures is 0.87 for the final estimates and 0.59 for the latest estimates. The correlation of the final GDP estimates with the latest GDI estimates is 0.70 higher than that of the latest estimates. As reported in Fixler and Grimm (2006), national income is statistically significant in regression equations, explaining GDP revisions from the final estimates to the latest estimates, but GDP is not significant in explaining revisions to either GDI or national income.

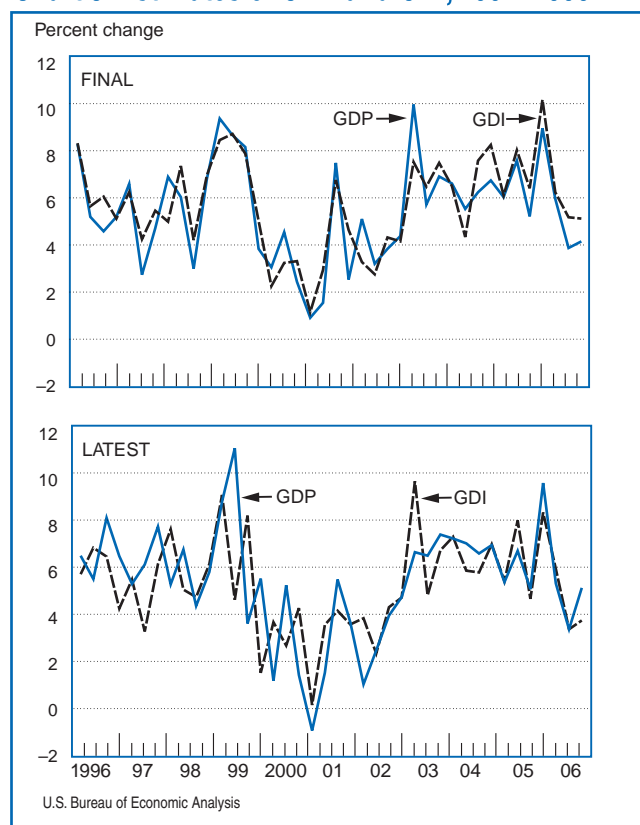
Summary and Conclusions

The results of this review are generally consistent with those of previous BEA studies:¹⁵

- The estimates of GDP and GDI are reliable; the MARs for the quarterly estimates of both measures are slightly more than 1.0 percentage point.

15. Although not included in this review, the reliability of real GDP estimates around the last five turning points is the same as that presented in a previous study (Fixler and Grimm 2005); the relevant estimates are unchanged since that study was made.

Chart 3. Estimates of GDP and GDI, 1997–2006



- The MRs for GDP and GDI are positive, primarily reflecting the improvements of measures of economic activity and expansions of the definition of economic activity that have been introduced in comprehensive NIPA revisions to adapt GDP and GDI to a changing economy.
- The quarterly estimates are reliable indicators of whether the economy is growing at rates above, near, or below the long-term trend.
- MARs for GDP/GNP have declined from somewhat more than 3.0 percentage points prior to the mid-1950s to somewhat more than 1.0 percentage point since the early 1980s. The MARs appear to be near an asymptote that results from several inevitable factors.
- MRs declined largely because of improvements in the source data available over time, improvements in methodologies, and definitional changes made to keep the accounts abreast of a changing economy. They are not due to corrections of errors.
- The MARs for all the annual estimates are less than half the corresponding quarterly estimates. The MARs decline modestly with each succeeding vintage of estimates from the sum of finals to the third current annual revisions.
- The use of an alternative methodology makes clear that revisions to inventories have an importance to GDP revisions that is nearly as large as that of final sales.
- The revisions to GDP and its major components appear to have some modest momentum, but using this information does not appear to be worthwhile.
- The revision of estimates of GDI and compensation of employees 5 months after the end of each quarter appears to have improved the reliability of these measures.

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