

Revisions to Gross Domestic Product, Gross Domestic Income, and Their Major Components

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During all periods of the business cycle, including crises such as the COVID–19 pandemic, the private sector and public policymakers rely on the National Income and Product Accounts (NIPAs) of the U.S. Bureau of Economic Analysis (BEA) to provide a timely, comprehensive, and accurate picture of the condition of the U.S. economy and inform their economic decisions.

The main measures the public relies on to grasp the pulse of the economy are gross domestic product (GDP), gross domestic income (GDI), and their major components. This article presents a study that focuses on both measures from 1999 to 2022. Throughout the study, we systematically analyze quarterly and annual GDP and GDI data releases in search of ways to improve the process by which BEA aggregates and reports data.

Additionally, we show how the acceleration of U.S. Census Bureau (Census) data that BEA started receiving in 2015 has changed the patterns of the revisions of the early estimates of GDP. The study also shows revisions of quarterly personal income and two of the most broadly used price consumer indexes: personal consumption expenditures (PCE) and PCE excluding food and energy (PCEX).

The study examines the revisions, also called updates, to GDP, GDI, and their components for 1999 to 2022 and thus covers BEA estimates during the COVID–19 crisis, when measuring the sudden abrupt stop of economic activity and its slow and patchy recovery, both in its geographical and sectoral variation, became extremely difficult and added much more volatility to BEA estimates and thus revisions, than in previous periods. This variation is especially noticeable in all the statistics aiming to measure federal nondefense expenditures in 2020 and 2021, where the variation was the greatest, as the federal government stepped in to ameliorate the human, social, and economic costs of the crisis.

Vintages and Timing of Revisions

BEA prepares quarterly and annual estimates of GDP and GDI. For GDP, BEA prepares three current quarterly vintages of GDP estimates—advance, second, and third estimates. The advance estimates for a quarter are released about 1 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.

For GDI, the timing of its quarterly releases differs from GDP due to data availability. GDI incorporates information from the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW). Three current quarterly vintages are prepared—second, third, and fourth estimates, but the second estimate is only prepared for the first three quarters of the year, due to lack of data for fourth quarters. The vintages are named as such to match the GDP vintage timing. The first release of GDI estimates (second estimates) comes out at the same time as the second estimates of GDP for any given quarter. The next release of GDI estimates (third estimates) comes out when the third estimates of GDP become available. The last current quarterly GDI estimates (fourth estimates) come out about 5 months after the quarter ends.

BEA also regularly prepares four vintages of annual estimates—early annual, first annual, second annual, and third annual estimates. For GDP and GDI. The early annual estimates consist of the sum (or more accurately, the average, since BEA quarters are annualized) of the third current quarterly estimates for all four quarters of the year. The early annual estimates of GDP are released at the end of March along with the third estimates for the fourth quarter of that year, and the early annual estimates of GDI are released with the release of the fourth estimates for the fourth quarter of the year in late May.

These early annual estimates are locked away until the annual update of the NIPAs. Before 2018, the annual update of the NIPAs was released in late July of each year, and included the first, second, and third annual revisions of the quarterly estimates for the 3 preceding years. After 2018, the annual update of the NIPAs takes place in September and can be expanded to span up to 5 years, potentially expanding the number of vintages of annual revisions of quarterly estimates. After these annual revisions, these estimates are generally not revised or released again until the next comprehensive update. Annual NIPA revision estimates are superseded by comprehensive NIPA revisions, which occur about every 5 years. These revisions incorporate changes in definitions, in classifications, and in statistical methodology, and extend further back in time.

The changes that took place in households' habits and in the production and delivery of goods and services affected GDP most profoundly during 2020 and 2021 but continue to affect GDP and its measurement well beyond that. However, BEA's core mission remains the same: to measure GDP as the market value of all the final goods and services produced by the factors of production within a country. In practice, we measure GDP as the sum of all final expenditures in the economy, and GDI as the sum of all the income generated in production of these goods and services. By design, the flows of final expenditures and income should be equal, but in practice, they are not, because each is estimated from largely different source data. This difference is known as the statistical discrepancy.

By convention, the statistical discrepancy is allocated to the income side, and defined as GDP less GDI, reflecting the fact that the source data underlying GDP estimates are generally more reliable and timelier than those corresponding to GDI estimates. Even after comprehensive benchmark revisions, the estimates of GDP and GDI continue to be slightly different, inherent in the fact that some of measurement errors in the components of GDP and GDI do not disappear with time.

Measuring the accuracy of NIPA estimates is challenging because the economy is constantly evolving, and it is impossible to know the true values of the estimates. This measurement challenge derives from three principal facts about the compilation of the estimates. First, the earliest GDP and GDI estimates are based on partial and preliminary data and on trend projections when data are not available. Second, the source data for the early estimates in the NIPAs come from a mixture of survey, tax, and other business and administrative data as well as various indicators, and these data are subject to a mix of sampling and nonsampling errors and biases that cannot be assessed. And third, the NIPAs are regularly revised to reflect changes in the economic concepts and methods necessary for the accounts to provide an accurate picture of the evolving U.S. economy.¹ For example, in the 2018 comprehensive revision of the Industry Economic Accounts, BEA started providing more detailed annual data on value added, gross output, and intermediate inputs consistent with the 2012 North American Industry Classification System (NAICS) at a four-digit level of detail. However, updates in estimates of narrower categories are more dependent on source data. Even so, in the 2023 comprehensive update, BEA started releasing industry and state statistics within the same time frame than its benchmark updates of GDP.

Given the measurement challenges, accuracy cannot be assessed by conventional statistical measures, such as standard errors. Instead, BEA focuses on the reliability of the estimates, which can be assessed by examining the sizes and patterns of revisions to estimates.² Because revisions are repeated estimations of the economic activity in a period, their pattern and magnitude provide a measure of the reliability of the estimates. Some revisions are due to the replacements of early imputations for missing source data or preliminary survey data or the replacement of indirect indicators with revised and more complete data, such as annual or quinquennial Economic Census data. However, other the revisions are the result of updates to the concepts and methods on which the accounts are based, as in the comprehensive revisions mentioned above.

Mean Revisions, Mean Absolute Revisions, and Standard Deviations

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

$$R_t = L_t - E_t$$

where L_t is the growth rate of the economy at period t implied by the later vintage estimates, and E_t is corresponding growth rate implied by the earlier vintage estimates, where these growth rates are annualized for comparison purposes.

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

$$MR = \sum_t R_t / n, \text{ for } t = 1, \dots, n$$

Since these revisions can be positive or negative and tend to offset each other, it is also useful to look at the mean absolute revision (MAR), which is the average of the absolute value of the revisions in the sample period.

$$MAR = \sum_t |R_t| / n, \text{ for } t = 1, \dots, n$$

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.

$$SD(MR) = \text{Var}(MR)^{1/2}$$

All in all, the mean absolute revisions and the standard deviations are complementary measures that help us analyze the statistical distribution of the revisions in growth rates implied by different vintages of estimates.

BEA's principal standard of reliability is based on the revisions from its early estimates to its "latest" estimates, most of which have been through at least one comprehensive revision.³ Because the latest vintage incorporates the most recent comprehensive revision, it incorporates all the available source data that are believed to be the most reliable.

BEA judges the qualitative reliability of its early estimates by whether they present the same general picture of economic activity as the latest estimates in terms of the following: (1) long-term growth rates; (2) trends in saving, investment, government spending, corporate profits, and other key components of GDP and GDI; (3) 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; and (4) the patterns of quarterly growth, including whether growth in any period is high or low relative to trend, is accelerating or decelerating, or is positive or negative.

As we will show in the following sections, both the pattern and the magnitude of the revisions indicate that the early estimates are reliable. That is, the revisions are numerically small and do not significantly change BEA's measures of long-term growth, the picture of business cycles, and the trends in major components of GDP or GDI, allowing policymakers to rely on these estimates as accurate measures of economic activity to inform their decisions. Quantitatively, revisions are measured as the changes from an earlier vintage of a given estimate to a later vintage of that estimate, for example from the advance estimate to the latest estimate. There are three early vintages of “current quarterly” estimates of GDP—the advance estimate, released 1 month after the quarter ends; the second estimate, released 2 months after the quarter ends; and the third estimate, released 3 months after the quarter ends. Each estimate is produced using a wide mix of source data—preliminary survey results from Census, manufacturers' shipments, indicators, trade industry data and more—that are later revised to reflect more complete information or to replace trend projections.

In addition to the current quarterly, BEA regularly prepares four vintages of annual estimates—early annual, first annual, second annual, and third annual estimates. The early annual estimates are the sum (or average, since BEA quarters are annualized) of the third current quarterly estimates for all four quarters of the year, and the first, second, and third annual estimates for the 3 preceding years are released later as part of the annual NIPA update. Once the third annual revision of the estimates for a year is released, these estimates are generally not revised again until the next comprehensive revision, which occurs about every 5 years. These comprehensive revisions incorporate changes in definitions, in classifications, and in statistical methodology.

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

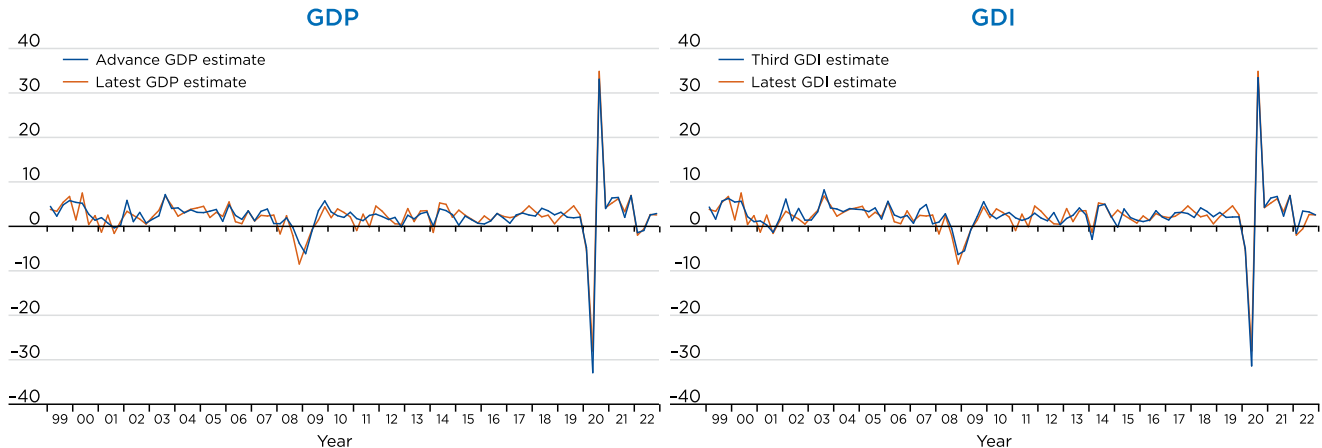
- Does the sign (+/-) of the current quarterly vintages of estimates of growth match that of the latest estimate for our sample period? This is a measure of directional reliability. For GDP, the signs between the advance and the latest estimate match 97 percent of the time, and for GDI, the signs between the third current and the latest estimate match 93 percent of the time.
- Do the magnitudes of the current quarterly estimates fall above, within, or below one standard deviation of the mean growth of the latest estimate over the period? This is a measure of reliability relative to trend. For 1999–2022, the latest estimates of GDP had a mean of 4.62 percent and a standard deviation of 5.92, and the advance quarterly vintages fell within one standard deviation of the mean; this is between -1.30 and 10.54, about 92 percent of the time. For GDI, the corresponding mean and standard deviation were 4.58 percent and 6.03, and the third quarterly vintages fell between one standard deviation of the mean of the latest estimate 88 percent of the time.

As a preview of the analysis, the left panel of chart 1 provides an illustration of this point by plotting advance versus latest estimates of GDP growth over 23 years, from 1999 to 2022.⁴

As one can see, with few exceptions such as the quick recovery of the high-tech bust at the beginning of the sample, and the early quarters of the Great Recession and the COVID-19 pandemic, the initial pulse of GDP provided by BEA's advance estimates is little changed by revisions, and a similar picture emerges when one compares the third estimate of GDI versus the latest estimates in the right panel of chart 1.

Chart 1. Earliest Versus Latest Estimates of GDP and GDI Growth, 1999–2022

(Annualized quarterly growth rate)



GDI Gross domestic income
 GDP Gross domestic product
 U.S. Bureau of Economic Analysis

The remainder of this article is organized as follows:

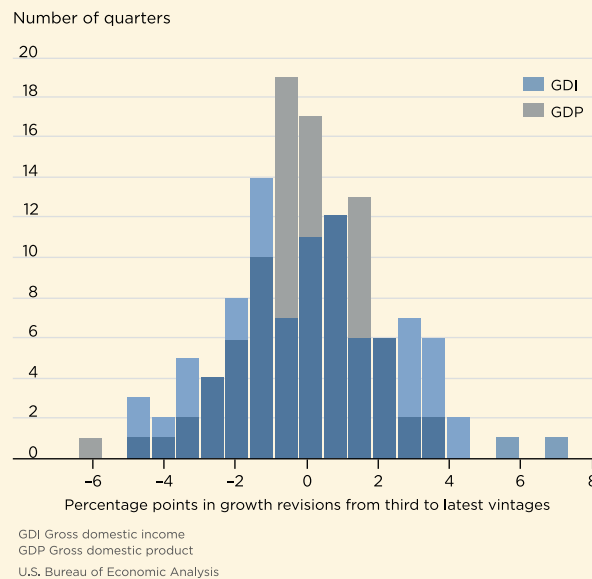
- Discussions of the revisions to [quarterly estimates of GDP and its components](#) and [GDI and its components](#);
- A look at the positive impact of [source data acceleration](#);
- A section that shows the [average quarterly and annual revisions for the main components of personal income](#);
- Discussions of revisions to [annual estimates of GDP and its major components](#) and of [GDI and its major components](#);
- A look at the [relationship of weighted averages quarterly estimates of GDP and GDI](#);
- A look at the [monthly personal consumption expenditures price indexes](#); and
- The [conclusions of this analysis](#).

Statistical Distribution of Revisions

Though we could reasonably assume, by the law of large numbers, that the revisions have a normal distribution, we test for the normality of the revisions of GDP and GDI between their third current and their latest estimates, using the Kolmogorov-Smirnov test, we cannot reject the hypotheses that the revisions to real and nominal GDP, as well as GDI, are normally distributed. Thus, using the p values associated to their normal distributions, we find that the nominal quarterly GDP revisions between the third current and latest estimates will be between -2 percent and $+2$ percent about 77 percent of the time, while quarterly the GDI revisions between the third current and latest estimates will be between -2 percent and $+2$ percent about 60 percent of the time.

To make this point visually, chart I shows a histogram of the revisions between the third and latest estimates of GDP and GDI around their mean, illustrating that nominal GDP revisions are more concentrated around zero than the corresponding ones shown for GDI.¹

Chart I. Distribution of Revisions of Nominal GDP and GDI



1. The mean revision of the third current versus the latest estimate of nominal GDP is -0.10 , and its standard deviation is 1.67 , both shown in table 1, and the corresponding measures for GDI are 0.09 and 2.40 , shown in table 5.

Accuracy, Reliability, and Uncertainty

The GDP estimates that BEA releases are used not just by policymakers in setting public policy, but also by the private sector and households when making economic decisions. Given the important role GDP estimates play in the economy, the obvious question that arises is, “How accurate are GDP estimates?” From a statistical perspective, when one speaks of the accuracy of an estimate, one is usually referring to the difference between the estimate and some “true” value.

For survey-based data, various statistical methods can be used to assess their difference as sample size grows, constructing confidence intervals around the sample mean, for example. However, because GDP is constructed from survey, nonsurvey, and administrative data, with a limited sample size and in a short period of time, its “true” value can never be observed, and so its accuracy cannot be assessed, so we use the concept of reliability instead.

Reliability concerns the repeated estimation of an event. Over time, BEA acquires more and better information about GDP and is therefore able to revise its estimate of GDP, with each revision believed to be a better estimate of its true value. The subsequent revised estimates can be viewed as repeated estimates of the aggregate economic activity for that quarter. That way, by assessing the performance of these revised estimates, BEA can assess its reliability.

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

The fact that BEA provides a sequence over time of estimates for a given quarter—what are referred to as vintage estimates—implies that users of the data should understand that there is some uncertainty surrounding an estimate at a point in time. Moreover, given that GDP and GDI are normally distributed (see previous box), one can use the means and standard deviations of revisions that we provide throughout the study to construct confidence intervals.

For example, using the standard deviation of the revisions between the advance and second quarterly estimates of real GDP of 0.59 provided by appendix table C, one can construct a 90 percent confidence interval for the mean difference of 0.10 between the advance and second quarterly estimate found in appendix table B as:

$$\bar{x} \pm z_{\alpha/2} \sigma = 0.10 \pm 1.645 \times 0.59 = 0.10 \pm 0.97$$

where $z_{\alpha/2}$ is 1.645, the critical value for a 90 percent confidence interval of a normal distribution, and \bar{x} and σ are the corresponding mean and standard deviation of the normal distribution.

This means that, on average, the revision between the advance and second estimates of real GDP is in the interval $(-0.87, 1.07)$. This is an expression of uncertainty regarding the advance estimates, and with this information, one can estimate a range for where the second estimate will likely be, given the advance estimate.

Revisions to Quarterly Estimates of GDP

Table 1 presents revisions for real and nominal annualized quarterly growth for GDP and its components. For all three current quarterly vintages for 1999–2022, the MARs for both real and nominal GDP are somewhat larger than 1.20 percentage points, ranging from 1.18 percentage points to 1.29 percentage points.

Table 1. Revisions and Standard Deviation of Revisions, Early Vintages to the Latest Estimates, and Changes in GDP and Its Major Components, 1999–2022

[Percentage points]

Vintage	Mean absolute revisions		Mean revisions		Standard deviations	
	Nominal	Real	Nominal	Real	Nominal	Real
GDP						
Advance	1.29	1.21	0.18	0.00	1.65	1.56
Second	1.22	1.18	0.06	-0.08	1.57	1.50
Third	1.26	1.19	-0.10	-0.17	1.67	1.50
Personal consumption expenditures						
Advance	1.10	1.08	-0.06	-0.17	1.42	1.37
Second	1.02	1.00	-0.08	-0.17	1.32	1.27
Third	1.02	0.99	-0.19	-0.24	1.38	1.25
Durable goods						
Advance	3.79	4.08	-0.32	-0.21	4.98	5.34
Second	3.95	4.16	-0.53	-0.38	5.22	5.51
Third	3.98	4.21	-0.70	-0.57	5.32	5.61
Nondurable goods						
Advance	2.17	1.82	-0.25	-0.22	2.83	2.43
Second	2.03	1.71	-0.36	-0.28	2.53	2.27
Third	2.04	1.73	-0.38	-0.29	2.62	2.34
Services						
Advance	1.11	1.04	0.02	-0.16	1.49	1.37
Second	1.06	0.94	0.09	-0.14	1.45	1.31
Third	1.05	0.93	-0.05	-0.20	1.51	1.30
Gross private domestic investment						
Advance	4.51	4.69	1.08	0.87	5.89	6.43
Second	4.79	4.92	0.43	0.41	6.26	6.58
Third	4.60	4.71	0.24	0.32	5.98	6.34
Fixed investment						
Advance	2.78	2.77	1.02	0.96	3.47	3.48
Second	2.58	2.58	0.44	0.44	3.35	3.37
Third	2.61	2.61	0.20	0.26	3.38	3.40
Nonresidential						
Advance	3.34	3.30	0.82	1.00	4.15	4.14
Second	3.26	3.17	0.12	0.34	4.10	4.09
Third	3.20	3.15	-0.03	0.22	4.18	4.15
Structures						
Advance	9.03	8.31	3.82	3.04	11.00	10.30
Second	8.23	7.54	2.36	1.83	10.81	9.96
Third	7.97	6.94	1.42	1.05	10.51	9.18
Equipment and intellectual property products						
Advance	3.23	4.72	0.04	0.03	4.12	6.21
Second	3.16	4.42	-0.48	-0.42	4.17	5.71
Third	3.13	4.61	-0.43	-0.25	4.29	6.61
Residential						
Advance	4.31	4.09	1.30	0.42	5.06	5.05
Second	3.92	3.78	1.04	0.31	4.69	4.71
Third	3.63	3.55	0.59	0.01	4.41	4.48

Vintage	Mean absolute revisions		Mean revisions		Standard deviations	
	Nominal	Real	Nominal	Real	Nominal	Real
Exports						
Advance	3.30	3.13	0.68	0.76	4.34	4.05
Second	2.91	2.71	0.23	0.34	3.73	3.45
Third	2.91	2.72	0.00	0.12	4.07	3.77
Imports						
Advance	3.51	3.07	0.40	0.69	4.62	4.07
Second	2.86	2.58	0.02	0.33	3.93	3.48
Third	2.79	2.53	0.03	0.35	3.74	3.43
Government consumption expenditures and gross investment						
Advance	1.70	1.64	0.36	0.03	2.19	2.21
Second	1.71	1.67	0.25	0.02	2.17	2.24
Third	1.83	1.72	0.09	-0.06	2.57	2.33
Federal						
Advance	3.36	3.28	0.11	0.02	4.44	4.37
Second	3.24	3.26	0.03	0.05	4.28	4.32
Third	3.31	3.45	-0.06	-0.11	4.49	4.69
Defense						
Advance	4.06	4.07	-0.43	-0.64	5.53	5.50
Second	4.04	4.04	-0.52	-0.59	5.43	5.48
Third	3.99	4.01	-0.44	-0.56	5.43	5.46
Nondefense						
Advance	4.85	4.47	1.08	1.13	7.70	7.33
Second	5.03	4.64	0.99	1.11	7.84	7.52
Third	5.31	5.11	0.66	0.69	8.70	8.74
State and local						
Advance	1.78	1.60	0.48	0.02	2.20	2.01
Second	1.68	1.54	0.36	-0.01	2.16	1.98
Third	1.74	1.42	0.18	-0.05	2.50	1.85

GDP Gross domestic product

U.S. Bureau of Economic Analysis

Additionally, for most components in table 1, the revisions between the earliest quarterly estimate and the latest estimate are larger than the subsequent revisions computed with later quarterly estimates that incorporate more source data with every vintage. However, something to notice in this study compared to our previous two most recent revisions studies is that the MARs of the third quarterly estimates for nominal and real GDP are slightly larger than the MARs of the second quarterly estimates. In the two aforementioned studies, this pattern was only present for durable goods, but in this study, there are also slight MARs increases between the second and third estimates in nondurable goods, fixed investment, and more dramatically in all types of government expenditures excluding defense, due to the government intervention during the COVID-pandemic.

The MARs for nominal PCE, which is about 70 percent of GDP, are about 0.20 percentage point smaller than those for the corresponding vintages of nominal GDP; the MARs are 1.10 percentage point for the advance estimates, 1.02 percentage point for the second estimate and 1.02 percentage points for the third estimate. Those for real PCE are slightly smaller—1.08 percentage points, 1.00 percentage point, and 0.99 percentage point for the advance, second, and third vintages, respectively. MARs for both nominal and real measures tend to decline slightly with successive vintages.

Within PCE, the MARs for durable goods are noticeably larger, about 3.98 percentage points for nominals durable goods and 4.21 percentage points for real durable goods. Also notable is that durable goods is the only category within PCE in which the MARs are larger for the real measure than for the nominal measure.

The MARs for nondurable goods are larger than those for all PCE and tend to decline with the second vintage and hold steady with the third vintage. The MAR for the advance estimate is 2.17 percentage points, followed by 2.03 percentage points and 2.04 percentage points for the second and third estimates. The MARs for the real estimates range from 0.31 to 0.35 percentage point smaller than nominal estimates.

The MARs for services are the smallest of all PCE components shown. The MARs for nominal services are 1.11 percentage points for the advance, 1.06 for the second estimates and 1.05 percentage points for the third estimate. The MARs for the corresponding real estimates are slightly smaller, but the differences are 0.12 percentages or less. Moreover, the MARs for services decline with successive vintages.

The MARs for gross private domestic investment are relatively large; they range from 4.51 percentage points to 4.92 percentage points for both nominal and real investment. Both increase by approximately a quarter of a percentage point between the advance and second estimate and then decrease by around 0.20 percentage point in the third estimate. The MARs for fixed investment are smaller; for current dollars and real estimates, the second and third estimates have the same MAR, while those of the advance estimate only differ by 0.01 percentage points. The MARs of the advance estimates are 2.78 and 2.77 percentage points respectively. The second estimate MAR declines by approximately 0.20 percentage points and then increases by 0.03 percentage points for the third estimate. The smaller sizes are the result of excluding inventory investment, which in a previous study was found, using an alternative methodology, to have larger revisions; see Fixler, Greenaway-McGreevey, and Grimm (2011).

Within fixed investment, MARs for nominal nonresidential range from 3.20 percentage points to 3.34 percentage points, while real nonresidential MARs range from 3.15 percentage points to 3.30 percentage points. Additionally, MARs for nominal structures decrease from 9.03 percentage points for the advance estimates to 8.23 percentage points for the second estimates and 7.97 percent for the third estimates. MARs for real structures are slightly lower—decreasing from 8.31 percentage points for the advance to 7.54 percentage points for the second estimates and 6.94 percentage points for the third estimate.

In the category “equipment and intellectual property products,” MARs for the nominal revisions range from 3.13 percentage points to 3.23 percentage points over the three vintages and decrease from the advance estimate to the third estimate. MARs for the real estimates are slightly higher and range from 4.42 percentage points to 4.72 percentage points, decreasing from the advance estimate to the second estimate before increasing in the third estimate.

The MARs for residential investment are in general approximately within the same range as those for equipment and intellectual property products investment and tend to decline across successive vintages for both nominal and real estimates.

The MARs for nominal and real estimates of exports and imports for the three current quarterly vintages are relatively similar and range from 2.53 to 3.51 percentage points.

The MARs for government consumption expenditures and gross investment range from around 1.64 to 1.83 percentage points for all vintages. For federal expenditures, MARs for nominal and real estimates are higher, ranging from 3.24 to 3.45 percentage points. And finally, the MARs for state and local government expenditures for the nominal advance estimate is 1.78 percentage points, 1.68 percentage points for the second estimate, and 1.74 for the third estimate. Meanwhile, the MARs for the real estimates decrease across vintages, from 1.60 percentage points for the advance estimate to 1.42 percentage points for the third estimate.

Table 2 expands the information presented in table 1 for nominal annualized quarterly growth for GDP and their components, comparing the MARs of all possible pairs of vintages, not only among the current quarterly and the latest estimates, and is interesting for two reasons. First, for every row, we can see that MARs tend to increase with later vintages. Specifically, the jumps in MARs are usually largest from earlier current quarterly estimates to the first annual estimate, and even though MARs remain high, further increases in MARs taper off after that. This pattern can be explained because successive annual revision estimates increasingly reflect the incorporation of data that become available with 1- to 3-year lags and because of the timing of the comprehensive revisions of the NIPAs, made in 5-year intervals. As a result, the first annual revision estimates contain the redefinitions and reclassifications about one-fifth of the time; the second annual revision estimates, about two-fifths of the time; and the third annual revision estimates, about three-fifths of the time.

Second, the numbers in the diagonals of table 2 isolate the revisions from one vintage to the immediate next and can be viewed as the impact of additional source data that BEA has to produce different vintages. The advance estimate is of special importance, as it gives a quick pulse of the economic activity of the previous quarter just 1 month after the reference quarter, and it is broadly used to make informed economic decisions by all sectors of the economy. Thus, revisions to the second and the third quarterly estimates, released only within 1 month from each other, are key to analyzing how reliable our advance estimates are. By looking closely, we can see that the numbers in the diagonal tell a consistent story; this is, after the quick release of the advance estimate just 1 month after a quarter ends, the MARs between the advance and second, and second and third estimates is usually decreasing, reflecting the effort BEA makes to incorporate as much information as possible in the earliest vintages. For example, table 2 shows that the MAR from the advance to the second estimates of nominal GDP is 0.47 percentage point, but the MAR from the second to the third estimates is 0.34 percentage point. Then, for all components and with the luxury of time and more extensive data, the MAR between the third and first annual estimates inevitably jumps up, and then starts decreasing again between the first and second annual, and the second and third annual estimates.

Table 2. Mean Absolute Revisions in Changes in Nominal GDP and Its Components, 1999–2022
[Percentage points]

Vintage	Vintage of the revision used as standard					Latest
	Current quarterly		Annual			
	Second	Third	First	Second	Third	
GDP						
Advance	0.47	0.65	0.94	1.05	1.25	1.29
Second		0.34	0.81	0.96	1.19	1.22
Third			0.75	0.95	1.16	1.26
First annual				0.73	0.90	1.03
Second annual					0.55	0.72
Third annual						0.64
Personal consumption expenditures						
Advance	0.30	0.51	0.85	0.94	1.05	1.10
Second		0.35	0.73	0.84	0.96	1.02
Third			0.64	0.80	0.95	1.02
First annual				0.62	0.81	0.88
Second annual					0.58	0.65
Third annual						0.60
Durable goods						
Advance	1.13	1.22	2.96	3.58	3.49	3.79
Second		0.44	2.67	3.40	3.54	3.95
Third			2.81	3.39	3.46	3.98
First annual				2.50	2.40	3.12
Second annual					1.85	2.17
Third annual						1.23

Vintage	Vintage of the revision used as standard					
	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Nondurable goods						
Advance	0.62	0.66	1.48	1.74	2.00	2.17
Second		0.29	1.28	1.58	1.85	2.03
Third			1.26	1.60	1.88	2.04
First annual				1.32	1.48	1.94
Second annual					0.95	1.29
Third annual						1.09
Services						
Advance	0.26	0.61	0.87	1.05	1.12	1.11
Second		0.51	0.84	0.97	1.05	1.06
Third			0.68	0.82	0.89	1.05
First annual				0.58	0.76	0.90
Second annual					0.57	0.82
Third annual						0.69
Gross private domestic investment						
Advance	2.36	2.73	4.05	4.42	4.76	4.51
Second		1.03	3.76	4.51	5.03	4.79
Third			3.73	4.18	4.81	4.60
First annual				3.13	4.15	4.10
Second annual					2.58	2.92
Third annual						2.28
Fixed investment						
Advance	1.13	1.49	2.28	2.48	3.07	2.78
Second		0.70	2.15	2.35	2.91	2.58
Third			2.05	2.28	2.76	2.61
First annual				1.85	2.36	2.20
Second annual					1.39	1.64
Third annual						1.52
Nonresidential						
Advance	1.42	1.80	2.72	3.14	3.80	3.34
Second		0.82	2.61	3.06	3.66	3.26
Third			2.53	2.90	3.42	3.20
First annual				2.25	2.87	2.46
Second annual					1.65	2.01
Third annual						1.86
Structures						
Advance	3.64	4.68	7.59	8.63	9.03	9.03
Second		2.24	7.29	7.78	8.36	8.23
Third			6.77	7.38	8.23	7.97
First annual				5.21	5.83	6.26
Second annual					2.96	3.47
Third annual						2.95
Equipment and intellectual property products						
Advance	1.54	1.79	2.70	2.93	3.50	3.23
Second		0.86	2.47	3.10	3.60	3.16
Third			2.40	2.90	3.56	3.13
First annual				2.52	3.20	2.87
Second annual					2.09	2.39
Third annual						2.08
Residential						
Advance	1.29	1.73	3.40	3.80	4.20	4.31
Second		0.82	3.09	3.47	3.80	3.92
Third			2.70	3.15	3.35	3.63
First annual				2.34	2.83	3.39
Second annual					1.63	2.26
Third annual						1.56

Vintage	Vintage of the revision used as standard					
	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Exports						
Advance	1.52	2.04	2.69	3.06	3.21	3.30
Second		1.09	2.15	2.45	2.70	2.91
Third			2.29	2.47	2.67	2.91
First annual				1.71	2.15	2.38
Second annual					1.17	1.49
Third annual						1.21
Imports						
Advance	1.63	1.91	2.68	3.44	3.61	3.51
Second		0.84	2.24	2.74	2.80	2.86
Third			2.10	2.68	2.69	2.79
First annual				1.83	1.99	1.91
Second annual					1.14	1.30
Third annual						0.95
Government consumption expenditures and gross investment						
Advance	0.50	0.71	1.11	1.27	1.67	1.70
Second		0.35	1.00	1.16	1.57	1.71
Third			1.13	1.17	1.56	1.83
First annual				0.82	1.33	1.51
Second annual					0.98	1.25
Third annual						1.19
Federal						
Advance	0.39	0.52	2.17	2.47	3.01	3.36
Second		0.30	2.07	2.34	2.93	3.24
Third			2.25	2.38	2.97	3.31
First annual				1.55	2.26	2.85
Second annual					1.32	2.33
Third annual						2.13
Defense						
Advance	0.47	0.52	2.22	2.70	3.58	4.06
Second		0.18	2.20	2.63	3.53	4.04
Third			2.23	2.62	3.48	3.99
First annual				1.57	2.51	3.55
Second annual					1.58	3.34
Third annual						2.95
Nondefense						
Advance	0.52	0.86	3.81	4.50	4.73	4.85
Second		0.63	3.95	4.67	4.72	5.03
Third			4.26	4.60	4.74	5.31
First annual				2.50	3.15	3.66
Second annual					1.75	2.51
Third annual						2.86
State and local						
Advance	0.76	1.01	1.25	1.41	1.79	1.78
Second		0.45	1.02	1.29	1.60	1.68
Third			1.10	1.21	1.59	1.74
First annual				0.85	1.42	1.50
Second annual					1.27	1.27
Third annual						1.24

GDP Gross domestic product

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The MARs for PCE tend to be modestly lower than those for GDP. The MARs for durables PCE are the largest among the subcomponents of total PCE. In fact, they are several times larger than the MARs for total PCE. MARs for nondurables PCE are almost twice the MARs of PCE but smaller than the MARs for durable goods. The MARs for services PCE are comparable to those of total PCE.

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

For exports and imports, the patterns of MARs are roughly the same and similar to the patterns for the other components of GDP, with the MARs of the advance estimate to later vintages of imports estimates just being slightly larger than those for exports.

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

In summary, there are several characteristics of the pattern of revisions that hold true generally but not universally. The difference in revisions from the second to the third vintages of estimates are typically the smallest for most adjacent pairs of vintages. For any given vintage, the MARs tend to increase as later and later vintages include more comprehensive revisions. For any vintage of later estimates, the MARs tend to decrease as later and later vintages of estimates are used and as earlier estimates have already incorporated a lot of information. That is, for any row (vintage of earlier estimates) in table 2, moving across columns of later and later estimates results in increasingly large MARs. Also, for any given column (vintage of later estimates), going down rows generally results in decreasing MARs.

Appendix table A replicates table 2 for real GDP and its components, and the magnitude of most pair-to-pair MARs are very similar to those in table 2 but slightly smaller.⁵

Source data acceleration

Historically, due to the scarce data for the third month of every quarter by the time of the release of the advance estimate of that quarter, BEA prepared projections for the third month of the quarter, including among others, exports and imports of goods, wholesale and retail inventories, nondurable goods manufacturing inventories, and construction statistics. However, between 2015 and 2016, BEA started to receive advance monthly foreign trade statistics and wholesale and retail inventories from Census, allowing the incorporation of more timely information into the advance quarterly estimate.

Additionally, since the beginning of the first quarter of 2017, BEA also receives the “advance” Quarterly Services Survey (QSS) from Census early enough to incorporate this information in the second quarterly GDP estimate as opposed to the third estimate, which had been the common practice. This advance report is a preliminary cut that includes only a subset of the data that we ultimately get in the full QSS on time for our third estimate.

Table 3 shows the MARs between the advance and second quarterly estimates, and the second and third quarterly estimates of the subcomponents of GDP most affected by the data source acceleration, immediately before (2010–2014) and immediately after (2015–2019) the changes mentioned above took place. As expected, the acceleration of source data has significantly reduced the MARs between the advance and second quarterly estimates of nondurable goods, nonresidential investment, and structures, by more than double in the case of exports and imports, decreasing from 1.69 to 0.42 and from 1.58 to 0.64 respectively. Also note the large reduction in the revisions in the pre and post third estimates columns of table 3.

Table 3. Mean Absolute Revisions of Annualized Growth in Nominal GDP and Some Key Components, 2010–2014 Versus 2015–2019

[Percentage points]

Vintage	Preacceleration (2010–2014)		Postacceleration (2015–2019)	
	Second	Third	Second	Third
GDP				
Advance	0.45	0.70	0.31	0.39
Second		0.37		0.20
Nondurable goods				
Advance	0.63	0.70	0.44	0.59
Second		0.33		0.32
Services				
Advance	0.24	0.75	0.20	0.48
Second		0.64		0.35
Nonresidential				
Advance	1.58	2.22	1.10	1.42
Second		1.17		0.71
Structures				
Advance	4.51	6.33	2.43	3.35
Second		2.75		2.18
Exports				
Advance	1.69	2.05	0.42	0.74
Second		1.17		0.53
Imports				
Advance	1.58	1.79	0.64	0.83
Second		0.92		0.29

GDP Gross domestic product

Note. Impact of data acceleration on early revisions to GDP and some of its components.

U.S. Bureau of Economic Analysis

For services, the acceleration of source data for the second quarterly GDP estimate has reduced the MARs between the second and third quarterly estimates notably from 0.64 to 0.35, but more interestingly, we can also observe a widespread reduction of MARs between these vintages for all the other components of table 3, showing that incorporating reliable data early on has some ripple effects that help us estimate even further away estimates more accurately.

Mean revisions and standard deviations of revisions

In addition to MARs, table 1 also presents MRs for real and nominal GDP. The reported MRs are generally much smaller than the MARs because positive and negative revisions tend to offset each other, and generally, there is little or no tendency for MRs to become smaller with successive vintages of estimates. For example, the MR for the advance estimates of nominal GDP is 0.18 percentage point, and the MR for real GDP is 0.00 percentage point. The MRs for the second and third nominal estimates of GDP are 0.06 percentage point and -0.10 percentage point, respectively, and the corresponding MRs for real GDP are -0.08 percentage point and -0.17 percentage point, respectively. The signs of the MRs vary across components and with successive vintages, but the MRs for most of the components of real and nominal GDP are generally small, except for the MRs of nominal structures investment, which are substantially larger.

As mentioned in the Statistical Distribution of Revisions box, the revisions of GDP are normally distributed, and thus the standard deviations of the revisions presented in table 1 can be used to test whether the MRs are statistically significant and different from zero. We find that for both nominal and real GDP, the MRs are not statistically different from zero for any of its components.

Because the size of the MARs are related to the standard deviations of the MRs, the MARs patterns discussed previously in this study tend to hold true in general for the standard deviations as well. For example, within PCE, durables have the largest standard deviations, while services have the smallest, and the largest standard deviations are observed for gross private domestic investment.

Table 4 provides additional information about the volatility of the revisions from earlier vintages to the latest estimates.

The first two columns show the standard deviations of the latest estimates of real and nominal GDP and its components at the same level of detail as in tables 1 and 2. The growth of some components is much more volatile than others. They range from 2.76 percentage points for real state and local to 18.48 percentage points for nominal imports. Columns 3 and 4 of table 4 expand upon table 1 by presenting standard deviations of the three annual revision vintages of estimates, again showing wide variation in size.

And lastly, to facilitate comparisons among components, columns 5 and 6 of table 4 show the scaled standard deviations of revisions, which are standard deviations of the earlier revisions divided by the standard deviations of the latest estimates. These are used instead of coefficients of variation, which are the standard deviations divided by their means, because the mean revisions in the denominator are so small that coefficients of variation are uninterpretable.

When we do this, the resulting scaled standard deviations for each component have relatively small ranges: from 0.07 to 0.25 percentage point (for nominal imports), from 0.59 to 0.77 percentage point (for nominal defense), or from 0.19 to 1.22 percentage points (for real residential investment).

Table 4. Standard Deviations of Revisions, Early to the Latest Estimates for Changes in GDP and Its Components, 1999–2022

[Percentage points]

Vintage	Standard deviation of estimates		Standard deviation of revisions		Scaled standard deviation of revisions ¹	
	Nominal	Real	Nominal	Real	Nominal	Real
GDP	5.92	5.20				
Advance			1.65	1.56	0.28	0.30
Second			1.57	1.50	0.27	0.29
Third			1.67	1.50	0.28	0.29
First annual			1.40	5.32	0.24	1.02
Second annual			0.98	1.03	0.17	0.20
Third annual			0.87	4.25	0.15	0.82
Personal consumption expenditures	6.55	5.69				
Advance			1.42	1.37	0.22	0.24
Second			1.32	1.27	0.20	0.22
Third			1.38	1.25	0.21	0.22
First annual			1.19	4.11	0.18	0.72
Second annual			0.84	0.76	0.13	0.13
Third annual			0.79	2.99	0.12	0.53
Durable goods	14.32	13.47				
Advance			4.98	5.34	0.35	0.40
Second			5.22	5.51	0.36	0.41
Third			5.32	5.61	0.37	0.42
First annual			4.20	10.31	0.29	0.77
Second annual			3.09	3.14	0.22	0.23
Third annual			1.82	3.73	0.13	0.28
Nondurable goods	7.14	4.44				
Advance			2.83	2.43	0.40	0.55
Second			2.53	2.27	0.35	0.51
Third			2.62	2.34	0.37	0.53
First annual			2.88	1.91	0.40	0.43
Second annual			1.70	1.42	0.24	0.32
Third annual			1.51	1.25	0.21	0.28
Services	6.39	5.84				
Advance			1.49	1.37	0.23	0.23
Second			1.45	1.31	0.23	0.22
Third			1.51	1.30	0.24	0.22
First annual			1.24	7.84	0.19	1.34
Second annual			1.00	0.92	0.16	0.16
Third annual			0.93	5.79	0.15	0.99
Gross private domestic investment	16.94	16.25				
Advance			5.89	6.43	0.35	0.40
Second			6.26	6.58	0.37	0.40
Third			5.98	6.34	0.35	0.39
First annual			5.69	7.58	0.34	0.47
Second annual			3.92	4.18	0.23	0.26
Third annual			2.94	5.08	0.17	0.31
Fixed investment	8.92	8.24				
Advance			3.47	3.48	0.39	0.42
Second			3.35	3.37	0.38	0.41
Third			3.38	3.40	0.38	0.41
First annual			3.11	6.26	0.35	0.76
Second annual			1.99	1.94	0.22	0.24
Third annual			2.15	4.78	0.24	0.58

Vintage	Standard deviation of estimates		Standard deviation of revisions		Scaled standard deviation of revisions ¹	
	Nominal	Real	Nominal	Real	Nominal	Real
Nonresidential	8.71	8.16				
Advance			4.15	4.14	0.48	0.51
Second			4.10	4.09	0.47	0.50
Third			4.18	4.15	0.48	0.51
First annual			3.63	4.79	0.42	0.59
Second annual			2.49	2.33	0.29	0.29
Third annual			2.49	3.22	0.29	0.39
Structures	15.75	13.57				
Advance			11.00	10.30	0.70	0.76
Second			10.81	9.96	0.69	0.73
Third			10.51	9.18	0.67	0.68
First annual			8.49	14.77	0.54	1.09
Second annual			4.31	3.96	0.27	0.29
Third annual			4.29	7.83	0.27	0.58
Equipment and intellectual property products	8.55	13.03				
Advance			4.12	6.21	0.48	0.48
Second			4.17	5.71	0.49	0.44
Third			4.29	6.61	0.50	0.51
First annual			4.00	5.44	0.47	0.42
Second annual			2.90	4.90	0.34	0.38
Third annual			2.84	3.54	0.33	0.27
Residential	17.19	15.32				
Advance			5.06	5.05	0.29	0.33
Second			4.69	4.71	0.27	0.31
Third			4.41	4.48	0.26	0.29
First annual			4.31	15.73	0.25	1.03
Second annual			2.97	2.90	0.17	0.19
Third annual			2.19	18.65	0.13	1.22
Exports	16.59	12.61				
Advance			4.34	4.05	0.26	0.32
Second			3.73	3.45	0.22	0.27
Third			4.07	3.77	0.25	0.30
First annual			3.06	3.53	0.18	0.28
Second annual			2.04	1.99	0.12	0.16
Third annual			1.57	2.06	0.09	0.16
Imports	18.48	13.65				
Advance			4.62	4.07	0.25	0.30
Second			3.93	3.48	0.21	0.25
Third			3.74	3.43	0.20	0.25
First annual			2.99	8.47	0.16	0.62
Second annual			1.81	2.13	0.10	0.16
Third annual			1.35	3.81	0.07	0.28

Vintage	Standard deviation of estimates		Standard deviation of revisions		Scaled standard deviation of revisions ¹	
	Nominal	Real	Nominal	Real	Nominal	Real
Government consumption expenditures and gross investment	3.43	3.08				
Advance			2.19	2.21	0.64	0.72
Second			2.17	2.24	0.63	0.73
Third			2.57	2.33	0.75	0.76
First annual			1.86	4.75	0.54	1.54
Second annual			1.63	1.56	0.48	0.51
Third annual			1.60	4.61	0.47	1.50
Federal	6.77	6.46				
Advance			4.44	4.37	0.66	0.68
Second			4.28	4.32	0.63	0.67
Third			4.49	4.69	0.66	0.73
First annual			3.81	4.67	0.56	0.72
Second annual			3.25	3.25	0.48	0.50
Third annual			3.14	4.31	0.46	0.67
Defense	7.22	6.52				
Advance			5.53	5.50	0.77	0.84
Second			5.43	5.48	0.75	0.84
Third			5.43	5.46	0.75	0.84
First annual			4.74	5.62	0.66	0.86
Second annual			4.61	5.52	0.64	0.85
Third annual			4.28	5.02	0.59	0.77
Nondefense	13.06	12.97				
Advance			7.70	7.33	0.59	0.57
Second			7.84	7.52	0.60	0.58
Third			8.70	8.74	0.67	0.67
First annual			6.17	6.49	0.47	0.50
Second annual			3.87	3.27	0.30	0.25
Third annual			4.53	5.68	0.35	0.44
State and local	3.52	2.76				
Advance			2.20	2.01	0.62	0.73
Second			2.16	1.98	0.61	0.72
Third			2.50	1.85	0.71	0.67
First annual			1.85	6.45	0.53	2.34
Second annual			1.61	1.39	0.46	0.50
Third annual			1.70	5.45	0.48	1.97

GDP Gross domestic product

1. Scaled standard deviations are standard deviations of the revisions divided by the standard deviations of the latest estimates.

Note. There are different ways to scale standard deviations to get a deeper understanding about the amount of variability forecasting or estimating statistics. One common way to do this is to calculate the coefficient of variation, which is the ratio of the standard deviation to the mean. However, in our case, the coefficients of variation are very large because of near-zero means and thereby uninterpretable. Accordingly, in this table, we measure the variability in the early vintages of a series by a scale that divides the standard deviations of a vintage by the standard deviation of its latest estimate.

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Revisions to Quarterly Estimates of GDI

Table 5 presents the MARs, MRs, and the standard deviations of the MRs to quarterly estimates of GDI and its components. Note that some components of GDI are revised less than others, like national income and corporate profits, whose first estimates are released at the same time as the third revisions of other components of GDI. Consequently, advance estimates of GDI are not prepared, and since 1995, second current quarterly estimates of GDI in the fourth quarter of each year have not been prepared either. The reason these estimates of GDI are not produced is mainly that there is a lack of reliable source data for estimating corporate profits, which affects several other components of GDI. Advance and second estimates are prepared for the other major components of GDI, such as compensation of employees and proprietors' income, and are shown in table 5.

Table 5. Revisions and Standard Deviation of Revisions, Early to the Latest Estimates for Changes in GDI and Its Components, 1999–2022

[Percentage points]

Vintage	Mean absolute revisions	Mean revisions	Standard deviations
GDI¹			
Third	1.91	0.09	2.40
First annual	1.60	0.06	2.01
Second annual	1.17	0.14	1.72
Third annual	0.93	0.20	1.25
Private consumption of fixed capital			
Advance	5.67	-0.22	18.00
Second	5.65	-0.29	18.11
Third	6.11	-0.84	22.27
First annual	5.83	-1.32	22.22
Second annual	5.25	-1.23	22.29
Third annual	5.63	-1.31	22.96
Taxes on production and imports			
Advance	2.30	0.62	3.24
Second	2.41	0.60	3.40
Third	2.02	0.70	2.73
First annual	2.00	0.66	2.77
Second annual	1.33	0.42	1.84
Third annual	1.08	0.24	1.60
National income¹			
Third	2.69	0.08	3.70
First annual	2.13	0.04	2.90
Second annual	1.76	0.12	2.72
Third annual	1.61	0.09	2.51
Compensation of employees			
Advance	2.57	0.15	3.29
Second	3.15	0.04	4.06
Third	3.09	0.14	4.05
First annual	1.58	0.06	2.26
Second annual	1.13	0.02	1.67
Third annual	0.83	0.00	1.36
Proprietors' income			
Advance	5.48	0.02	7.21
Second	5.45	-0.03	7.21
Third	5.33	0.18	7.23
First annual	5.51	-0.01	7.34
Second annual	4.83	0.17	6.47
Third annual	4.33	0.77	6.40

Vintage	Mean absolute revisions	Mean revisions	Standard deviations
Nonfarm proprietors' income			
Advance	4.95	-0.15	6.88
Second	4.88	-0.27	6.82
Third	4.90	-0.15	6.86
First annual	4.97	0.00	6.71
Second annual	4.71	0.16	6.32
Third annual	4.33	0.78	6.44
Corporate profits¹			
Third	16.60	-0.08	23.91
First annual	12.43	-0.39	18.48
Second annual	9.40	0.21	17.50
Third annual	6.48	-0.61	11.31
Net interest payments			
Advance	19.65	2.63	27.60
Second	18.58	1.37	26.46
Third	18.28	1.09	26.37
First annual	17.49	1.41	24.69
Second annual	14.96	1.15	22.16
Third annual	15.41	0.08	22.18

GDI Gross domestic income

1. Advance and second estimates are not produced for GDI, national income, and corporate profits.

U.S. Bureau of Economic Analysis

Beginning with the first quarter of 2002, a “fourth” vintage of the estimates for the previous quarter has been prepared using data from the BLS Quarterly Census of Employment and Wages (QCEW). These data are used to revise the estimates of compensation of employees, national income, and GDI. The fourth vintage is released at the time of the second quarterly estimate of the following quarter. However, the fourth vintage MR and MAR numbers are not shown in table 5.

The MAR for the first annual estimates of GDI to the latest estimate is 1.60 percentage points and then declines slowly for the other annual estimates.

The MARs for most of the components of GDI tend to decline with successive vintages of estimates after the third current quarter estimate has been published, with a few exceptions: private consumption of fixed capital, nonfarm proprietors' income, and net interest payments. This is somehow comparable to the MARs patterns shown for nominal GDP, shown in table 2, but the magnitude of the revisions of GDI and its components, as well as the volatility of its revisions, is much higher than those of GDP and its components. Another notable observation from table 5 is that the MARs for GDI components can be significantly larger than the MAR for total GDI. For example, depending on the vintages chosen, the MARs for corporate profits can be about 10 times larger than those for GDI, and the MARs for private consumption of fixed capital about 5 times larger than those for GDI.

Similar to GDP shown in table 1, the MRs for GDI and its major components are much smaller than the corresponding MARs and do not tend to decline with successive vintages, since the MRs for any given component can have a mixture of positive and negative signs for different vintages, and most of them do. Private consumption of fixed capital seems to be the outlier with negative MRs for almost all vintages shown.

Table 6 presents additional information on the standard deviation measures of GDI estimates. The scaled standard deviations provide a sense of how volatile the revisions can be, taking into account the variability of the estimates themselves.

Table 6. Standard Deviation of Revisions, From Early to the Latest Estimates for Changes in GDI and Its Components, 1999–2022¹

[Percentage points]

Vintage	Standard deviation of latest estimates	Standard deviation of revisions	Scaled standard deviation of revisions
GDI²	6.03		
Third		2.40	0.40
First annual		2.01	0.33
Second annual		1.72	0.29
Third annual		1.25	0.21
Private consumption of fixed capital	2.95		
Advance		18.00	6.10
Second		18.11	6.14
Third		22.27	7.55
First annual		22.22	7.53
Second annual		22.29	7.56
Third annual		22.96	7.78
Taxes on production and imports	6.49		
Advance		3.24	0.50
Second		3.40	0.52
Third		2.73	0.42
First annual		2.77	0.43
Second annual		1.84	0.28
Third annual		1.60	0.25
National income²	6.22		
Third		3.70	0.59
First annual		2.90	0.47
Second annual		2.72	0.44
Third annual		2.51	0.40
Compensation of employees	5.05		
Advance		3.29	0.65
Second		4.06	0.80
Third		4.05	0.80
First annual		2.26	0.45
Second annual		1.67	0.33
Third annual		1.36	0.27
Proprietors' income	13.91		
Advance		7.21	0.52
Second		7.21	0.52
Third		7.23	0.52
First annual		7.34	0.53
Second annual		6.47	0.47
Third annual		6.40	0.46
Nonfarm proprietors' income	13.04		
Advance		6.88	0.53
Second		6.82	0.52
Third		6.86	0.53
First annual		6.71	0.51
Second annual		6.32	0.48
Third annual		6.44	0.49
Corporate profits²	30.82		
Third		23.91	0.78
First annual		18.48	0.60
Second annual		17.50	0.57
Third annual		11.31	0.37
Net interest payments	22.57		
Advance		27.60	1.22
Second		26.46	1.17
Third		26.37	1.17
First annual		24.69	1.09
Second annual		22.16	0.98
Third annual		22.18	0.98

GDI Gross domestic income

1. Scaled standard deviations are standard deviations of the revisions divided by the standard deviation of the latest estimates.
2. Advance and second estimates are not produced for GDI, national income, and corporate profits.

Note. There are different ways to scale standard deviations to get a deeper understanding about the amount of variability forecasting or estimating statistics. One common way to do this is to calculate the coefficient of variation, which is the ratio of the standard deviation to the mean. However, in our case, the coefficients of variation are very large because of near-zero means and thereby uninterpretable. Accordingly, in this table, we measure the variability in the early vintages of a series by a scale that divides the standard deviations of a vintage by the standard deviation of its latest estimate.

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For GDI and most of its components, the scaled standard deviations are larger than those of GDP and its components shown in table 4, but still rather small, usually less than 1 percentage point for all vintages. However, in stark contrast to all of the other components, the scaled standard deviations of private consumption of fixed capital almost reach 8 percentage points for some vintages, and the standard deviations don't get smaller with successive vintages.

Table 7 shows the MARs for successive vintages of estimates for GDI and its components. The observed patterns among the annual estimates are similar to those for GDP for the most part. For example, the MARs for the majority of GDI components decline from the first to the third annual estimates, but there are some cases where this doesn't happen, mostly due to the different timing, and, in general, the MARs for most of the GDI components and vintages tend to be larger than those of the GDP components.

Table 7. Mean Absolute Revisions for Changes in GDI and Its Components, 1999–2022¹
[Percentage points]

Vintage	Current quarterly			Annual			Latest
	Second	Third	Fourth	First	Second	Third	
GDI							
Third			1.60	1.46	1.61	1.70	1.91
Fourth				0.91	1.32	1.59	1.70
First annual					1.07	1.44	1.60
Second annual						0.84	1.17
Third annual							0.93
Private consumption of fixed capital							
Advance	0.37	1.16	...	2.85	2.55	2.91	5.67
Second		0.89	...	2.82	2.53	2.85	5.65
Third			...	2.42	2.08	2.33	6.11
First annual					1.79	2.15	5.83
Second annual						0.91	5.25
Third annual							5.63
Taxes on production and imports							
Advance	0.54	1.32	...	1.80	1.91	2.03	2.30
Second		1.22	...	1.81	2.01	2.10	2.41
Third			...	1.50	1.61	1.76	2.02
First annual					1.30	1.58	2.00
Second annual						0.98	1.33
Third annual							1.08
National income							
Third			2.12	1.93	2.06	2.04	2.69
Fourth				1.52	1.99	2.44	2.71
First annual					1.31	1.92	2.13
Second annual						1.20	1.76
Third annual							1.61

Vintage	Current quarterly			Annual			Latest
	Second	Third	Fourth	First	Second	Third	
Compensation of employees							
Advance	1.16	1.34	2.38	2.29	2.25	2.41	2.57
Second		0.25	2.99	2.85	2.74	2.90	3.15
Third			2.92	2.76	2.75	2.89	3.09
First annual				1.00	1.35	1.53	1.63
Second annual					1.18	1.47	1.58
Third annual						0.66	1.13
Third annual							0.83
Proprietors' income							
Advance	0.83	1.29	...	3.59	4.61	4.81	5.48
Second		0.85	...	3.56	4.57	4.76	5.45
Third			...	3.21	4.44	4.76	5.33
First annual					3.95	4.83	5.51
Second annual						3.19	4.83
Third annual							4.33
Nonfarm proprietors' income							
Advance	0.63	0.91	...	2.70	3.83	4.40	4.95
Second		0.55	...	2.57	3.76	4.35	4.88
Third			...	2.51	3.76	4.35	4.90
First annual					3.24	4.70	4.97
Second annual						3.41	4.71
Third annual							4.33
Corporate profits							
Third			...	8.67	12.44	14.47	16.60
First annual					7.33	11.33	12.43
Second annual						8.26	9.40
Third annual							6.48
Net interest payments							
Advance	2.01	4.12	...	10.73	13.10	15.18	19.65
Second		3.08	...	9.52	12.70	13.81	18.58
Third			...	9.34	12.73	13.44	18.28
First annual					9.08	13.06	17.49
Second annual						8.51	14.96
Third annual							15.41

GDI Gross domestic income

1. Vintage of the revisions is used as the standard.

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Revisions in Personal Income

Personal income is the income that people receive as wages or salaries, assets in the form of dividends and interest income, Social Security and other government transfers, business ownership, and some other minor sources. Looking at the sources of personal income is important in assessing the financial health of American households and estimating future consumer spending. In particular, compensation of employees is the main component of personal income, constituting 67 percent of personal income at the beginning of the sample and 62 percent at the end, falling to a minimum of 54 percent during the COVID-19 pandemic. The other major two components of personal income were government transfers, averaging to 17 percent through our sample but reaching 27 percent of personal income during the pandemic, and asset income, consistently staying around 15 percent.

Table 8 presents the MARs for the different quarterly vintages of personal income and its major components. In principle, personal income statistics suffer the same shortcomings of GDI statistics, and our MARs are similar in magnitude, and larger than those for GDP and its components, but the overall pattern that MARs tend to decrease between consecutive vintages as time passes and more information is incorporated into our statistics remains. For example, the MAR between the third and first annual vintage for compensation of employees was 3.49, but between the first and second annual it decreased to 1.06 and between the second and third annual, it decreased even more to 0.45.

Table 8. Mean Absolute Revisions of Annualized Growth in Personal Income and Its Components, 2013–2022
[Percentage points]

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Personal income						
Advance	1.12	1.44	1.71	1.62	1.94	1.70
Second		0.74	2.39	2.09	2.41	2.27
Third			2.16	1.88	2.23	2.05
First annual				0.99	1.80	1.33
Second annual					1.12	0.59
Third annual						0.82
Compensation of employees						
Advance	1.96	2.70	2.69	1.99	2.19	2.45
Second		1.56	4.06	3.37	3.25	3.96
Third			3.49	3.14	2.77	3.26
First annual				1.06	1.28	1.19
Second annual					0.45	0.52
Third annual						0.25
Proprietors' income						
Advance	1.04	2.99	3.93	3.52	5.38	4.80
Second		2.66	3.69	3.24	5.00	4.53
Third			2.29	2.66	4.37	3.24
First annual				2.54	4.42	3.39
Second annual					3.80	2.88
Third annual						3.73
Rental income						
Advance	1.14	1.57	5.55	2.80	4.55	4.88
Second		1.38	5.84	3.14	5.07	5.36
Third			5.64	2.46	4.34	4.70
First annual				2.68	5.09	6.31
Second annual					3.84	3.97
Third annual						3.62

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Asset income						
Advance	0.40	3.25	4.54	4.52	6.97	6.80
Second		3.07	4.57	4.45	6.81	6.62
Third			3.51	4.28	6.57	6.41
First annual				3.28	7.07	5.47
Second annual					4.97	3.65
Third annual						3.66
Transfers						
Advance	1.31	1.47	2.11	2.92	3.93	3.80
Second		0.98	2.83	3.69	4.81	4.58
Third			2.42	3.18	4.36	4.09
First annual				1.62	2.70	2.62
Second annual					1.60	1.43
Third annual						0.23
Disposable income						
Advance	1.26	1.78	2.24	1.63	1.83	1.92
Second		0.93	2.65	2.15	2.35	2.37
Third			2.41	2.02	2.25	2.10
First annual				1.07	1.94	1.36
Second annual					1.25	0.64
Third annual						0.93

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Table 9 shows the MARs in the growth rates for different annual vintages of personal income and its major components. Importantly, revisions in growth rates derive from level revisions in personal income and its components, just as the revisions in the annual estimates of the distribution of personal income found [on the BEA website](#). However, it is important to notice that revisions in some of the components of personal income growth may be large and frequent, but revisions in the distribution of personal income tend to be small, as most income is tied to the production of goods and services and to nonspeculative investment decisions, which take time to change. A handy example are the large revisions in rental income growth shown in both tables 8 and 9, which are due mostly to the large swings and subsequent estimates of rental income around the 2008 financial crisis for which tax data were not received until the third annual estimate.

But even around the financial crisis, using the underlying annual estimates behind table 9, the share of rental income as personal income derived from the annual level revisions remained small and relatively stable. In particular, in 2008, using the first annual estimates of personal and rental income, rental income was 1.7 percent of personal income, and this share was later revised to 1.8 percent and 1.9 percent using their second and third annual estimates. After 2008, the latest annual estimates showed that the share of rental income as personal income has been slowly increasing, and its latest estimate was 4.02 percent in 2022.

Table 9. Mean Absolute Revisions of Annual Growth Estimates in Personal Income and Its Components, 2000–2022

[Percentage points]

Vintage	Second annual	Third annual	Latest
Personal income			
First annual	0.28	0.49	0.46
Second annual		0.33	0.32
Third annual			0.38
Compensation of employees			
First annual	5.13	5.39	0.25
Second annual		0.22	5.19
Third annual			5.33
Proprietors' income			
First annual	3.37	4.34	4.59
Second annual		2.14	3.49
Third annual			4.22
Rental income			
First annual	7.99	20.60	12.83
Second annual		15.81	10.18
Third annual			23.68
Asset income			
First annual	1.99	2.69	2.76
Second annual		1.93	1.86
Third annual			1.45
Transfers			
First annual	0.69	0.77	0.74
Second annual		0.21	0.20
Third annual			0.03
Disposable income			
First annual	0.96	1.56	0.85
Second annual		0.83	0.67
Third annual			0.86

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Revisions to Annual Estimates of GDP

Table 10 shows the mean and mean absolute revisions of the different annual estimates to the latest estimates, for both real and nominal GDP, and its major components.

Like the quarterly estimates, the mean revisions for the annual estimates are small in magnitude and vary in direction. The early annual estimates are those that become available in March of the following year and are mostly composed of third current quarterly estimates, excluding the fourth-quarter numbers, and thus their mean revisions are similar to those of previous quarterly estimates.

The MARs are much smaller than the current quarterly estimates for both real and nominal GDP. The main reason is that annual frequency estimates are not subject to revisions to seasonal adjustment factors, and another, is that they aggregate activity during a longer period where misses in one quarter are going to be captured in another quarter, or simply compensated for by opposite misses in another.⁶ The MARs show a tendency to decline over each vintage both in nominal and real-dollar estimates. Moreover, MARs also decline steadily across vintages for the underlying components. As with total GDP, the MARs of components are much smaller than those for quarterly estimates.

Subsequent revisions in definitions about what constitute economic activity and how best to measure it as part of comprehensive NIPA revisions, have generally resulted in increases to the growth rates of GDP over time, explaining the decreasing pattern for GDP and most of its components of MARs revisions from early annual versus third annual estimates when compared to the latest estimates found in table 10.

Table 10. Mean Revisions and Mean Absolute Revisions From Annual to Latest Estimates of Changes in GDP and Its Major Components, 1999–2022
[Percentage points]

Vintage	Mean revision		Mean absolute revision	
	Nominal	Real	Nominal	Real
GDP				
Early annual ¹	0.03	-0.06	0.38	0.37
First annual	-0.07	-0.37	0.37	0.71
Second annual	0.06	-0.23	0.31	0.69
Third annual	0.10	-0.17	0.22	0.62
Personal consumption expenditures				
Early annual ¹	-0.07	-0.11	0.38	0.34
First annual	-0.23	-0.43	0.37	0.63
Second annual	-0.10	-0.31	0.29	0.60
Third annual	0.04	-0.17	0.26	0.56
Gross private domestic investment				
Early annual ¹	0.26	0.29	1.35	1.63
First annual	0.52	0.36	1.52	1.78
Second annual	0.75	0.71	1.33	1.68
Third annual	0.60	0.61	1.09	1.49
Fixed investment				
Early annual ¹	0.31	-0.05	1.00	2.08
First annual	0.32	-0.16	0.99	2.25
Second annual	0.64	0.19	1.04	2.25
Third annual	0.46	0.61	0.88	3.44
Exports				
Early annual ¹	0.14	0.26	0.74	0.66
First annual	0.28	0.61	0.57	0.81
Second annual	0.16	0.46	0.43	0.68
Third annual	0.05	0.32	0.36	0.62
Imports				
Early annual ¹	0.10	0.38	0.47	0.51
First annual	0.14	0.85	0.29	0.92
Second annual	0.06	0.82	0.22	0.89
Third annual	0.05	0.66	0.26	0.84
Federal				
Early annual ¹	0.14	0.00	0.58	0.65
First annual	-0.26	-0.42	0.60	0.75
Second annual	-0.21	-0.30	0.32	0.57
Third annual	-0.20	-0.26	0.32	0.60
State and local				
Early annual ¹	0.34	-0.07	1.14	1.02
First annual	0.14	-0.37	1.06	1.32
Second annual	0.21	-0.24	0.95	1.20
Third annual	0.03	-0.45	0.54	0.83

GDP Gross domestic product

1. Early annual estimates are released in March of the following year and include third current quarterly estimates.

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Revisions to Annual Estimates of GDI

Table 11 presents the mean and mean absolute revisions of annual estimates of GDI growth rates and its major components.

Table 11. Mean Revisions and Mean Absolute Revisions From Annual to Latest Estimates of Changes in GDI and Its Major Components, 1999–2022

[Percentage points]

Vintage	Mean revision	Mean absolute revision
GDI		
Early annual	0.05	0.61
First annual	0.09	0.48
Second annual	0.11	0.28
Third annual	0.12	0.29
Private consumption of fixed capital		
Early annual	0.49	1.39
First annual	0.19	1.12
Second annual	0.40	1.10
Third annual	-0.10	0.87
Taxes on production and imports		
Early annual	0.75	1.19
First annual	0.43	0.83
Second annual	0.30	0.52
Third annual	0.17	0.41
National income		
Early annual	-3.29	3.72
First annual	0.09	0.52
Second annual	0.10	0.43
Third annual	0.12	0.39
Compensation of employees		
Early annual	-0.06	0.74
First annual	0.06	0.21
Second annual	0.07	0.24
Third annual	-0.04	0.20
Proprietors' income		
Early annual	-0.19	3.27
First annual	0.03	3.38
Second annual	0.41	3.07
Third annual	0.84	2.82
Nonfarm proprietors' income		
Early annual	-0.22	3.34
First annual	0.04	3.32
Second annual	0.41	3.09
Third annual	0.84	2.92
Corporate profits		
Early annual	-0.19	4.94
First annual	-0.02	3.54
Second annual	-0.62	2.29
Third annual	0.02	1.95
Net interest payments		
Early annual	0.27	9.77
First annual	0.95	8.73
Second annual	1.02	6.12
Third annual	-0.13	4.94

GDI Gross domestic income

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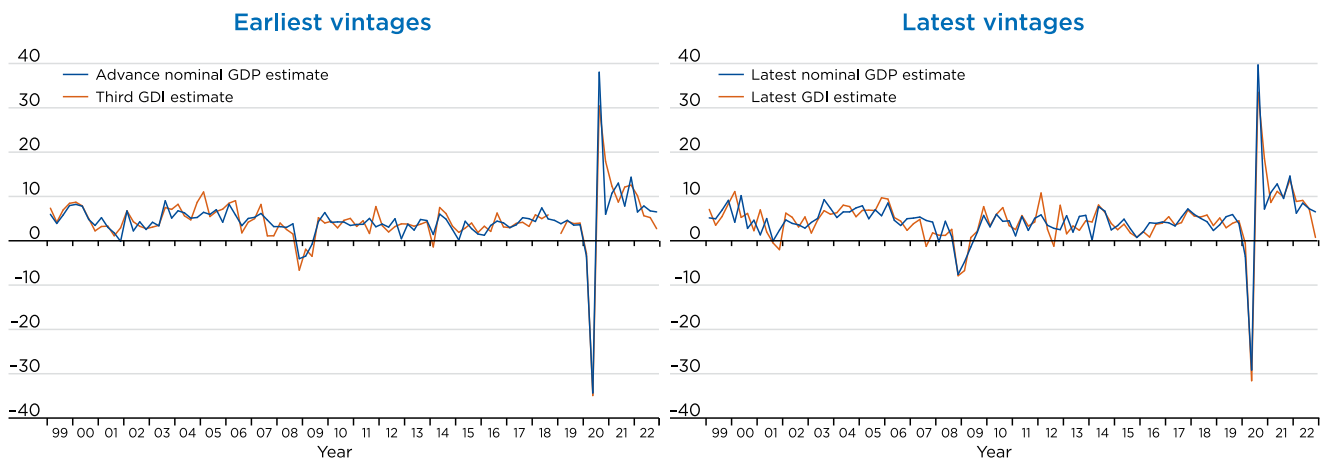
The MARs of the growth rates of the different annual estimates compared to the latest estimates are relatively similar in magnitude to their quarterly counterparts shown previously in table 5. Also, as with the quarterly estimates, the MRs are small in magnitude and vary in sign.

The MARs for GDI tend to decline with each successive estimate. These declines reflect the incorporation of newly received annual source data that is more complete or more accurate than earlier data. In particular, the second annual vintage is the first to incorporate data from the Statistics of Income from the Internal Revenue Service, so the drop in MARs should be most noticeable moving from the first to the second annual estimate for GDI and its components. For example, the MAR for GDI declines 0.20 percentage point from the first annual estimate of 0.48 to second annual estimate of 0.28. Depending on the particular component of GDI, the size of the fall in of an annual MAR to the next is closely related with the arrival of the new incoming source data incorporated between those vintages.

Revisions to Averages of GDP and GDI

In national economic accounting, GDP and GDI are conceptually equal, but practically they are different. GDP measures overall economic activity by final expenditures, while GDI measures economic activity by the incomes generated from producing the goods and services inside GDP.

Chart 2. GDP Versus GDI Growth by Vintage, 1999–2022
(Annualized quarterly growth rate)



GDI Gross domestic income
GDP Gross domestic product
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In practice, GDP and GDI differ because they are constructed using different sources of information, both of them imperfect in different ways. The different source data produce different results for a number of reasons, including sampling errors, coverage differences, and timing differences with respect to when expenditures and incomes are recorded and when we receive them.⁷ However, chart 2 shows that for most of our sample, estimates of real GDP and GDI growth give a similar picture of the economy.

Even though GDP and GDI are two ways of measuring aggregate economic activity, studies have shown varying information content in GDP and GDI (See for example Fixler and Nalewaik (2010) and Aruoba et. al. (2013). Conceptually, if GDP and GDI are different ways of adding the unobserved true economic activity with their corresponding measurement errors, it is possible to infer that the average of the two is a more reliable measure of activity than either one alone. This will be true of course, almost mechanically, as some of the measurement errors are averaged out, reducing subsequent revisions in the average. In July 2015, BEA began to produce an arithmetic average of GDP and GDI levels and the corresponding growth rates. It should be noted that the better reliability observed using the average of GDP and GDI will not lead to a better understanding of the detailed workings of the economy, because there is no obvious way of distributing the results of the averaging among the major components of GDP and GDI. Thus, the average series can only provide supplemental summary information about the recent course of the aggregate economy.

Table 12 presents the MARs and MRs of GDP and GDI alone, and then their average from the third estimate onwards compared with subsequent annual revisions and the latest estimates available.⁸

The top half of table 12 reports the MARs of the stand-alone series, follow by the average below, and as expected, the revisions increase as later and later vintages are used as the standard. However, the MAR from a vintage to the immediate next, given by the numbers in the diagonal, are highest for the first annual estimate and decrease monotonically after that, reflecting that as time passes revisions get smaller, as most of the information has been incorporated in previous vintages.

The bottom half of table 12 reports the MRs of the series of interest, and as one would expect, these revisions are small and don't always have the same sign, as we sometimes overestimate and other times underestimate growth as we continue to incorporate information to reveal the true state of the economy.

Table 12. Revisions From Quarterly to Later Estimates of Annualized Growth for GDP, GDI, and Their Average, 1999–2022

[Percentage points]

Vintage	Mean absolute revisions				Latest	Mean revisions			Latest
	First annual	Second annual	Third annual	Latest		First annual	Second annual	Third annual	
Nominal GDP									
Third	0.75	0.95	1.16	1.26	-0.09	-0.12	-0.11	-0.10	
First annual		0.73	0.90	1.03		-0.04	-0.07	-0.01	
Second annual			0.55	0.72			0.01	0.09	
Third annual				0.64				0.08	
GDI									
Third	1.46	1.61	1.70	1.91	0.04	-0.07	-0.07	0.09	
First annual		1.07	1.44	1.60		-0.06	-0.12	0.06	
Second annual			0.84	1.17			-0.03	0.14	
Third annual				0.93				0.20	
Average									
Third	1.04	1.16	1.20	1.41	-0.07	-0.14	-0.07	-0.06	
First annual		0.69	0.93	1.20		-0.06	-0.09	0.03	
Second annual			0.55	1.03			0.01	0.13	
Third annual				0.85				0.07	

GDI Gross domestic income

GDP Gross domestic product

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Monthly revisions to the personal consumption expenditures price indexes

The monthly price index for personal consumption expenditures (PCE) and the index for personal consumption expenditures excluding food and energy (PCEX) receive a lot of attention, in part because of their use in setting monetary policy.

The first estimates of PCE and PCEX come out a month after the referenced month, and after that, estimates are revised regularly two more times in the subsequent months. In table 13 we label these vintages first, second, and third monthly, and compare them again against the latest comprehensive estimate available.

Thus, to analyze how reliable our measures of monthly prices are, we calculate the MRs and MARs for the current monthly estimates to the latest vintage estimates available of monthly data between 2013 and 2022, and their implications for the revisions of the annualized percent changes of PCE and PCEX.

As expected, table 13 shows that the revision patterns for PCE and PCEX are similar in magnitude and sign, but the revisions to all vintages of PCEX are smaller than the corresponding revisions to PCE, as food and energy prices are usually more volatile and thus more difficult to estimate than the prices of the rest of goods and services comprised in PCE. For example, the 0.91 MAR from the advance monthly estimate to the latest revision of PCE corresponds to a month-to-month rate MAR shy of 0.05 percent.

The MRs for PCE and PCEX are quite small and not always positive, as opposed to the findings of Fixler, Greenaway-McGreevey, and Grimm (2014) for the 2000–2013 sample period used in their study, where the MRs were comparably small but always positive. The reason for this is that often in the past, for the first monthly prices estimates, BEA had to use trended proxies as the basis for weight estimation until the QSS data from Census were received and the weights were revised. The practice was to be conservative when proxies were being used, so as not to overstate inflation, leading to mostly positive revisions. More recently, BEA has started incorporating more timely high-frequency payment card transactions data and other public and private source data for various estimates. These have made first monthly price estimates more accurate, and thus following revisions have more evenly distributed combinations of positive and negative signs.

Table 13. Revisions to Successive Vintages of Monthly Estimates of Annualized Percent Change in PCE, 2013–2022¹
[Percentage points]

Vintage	Mean revisions			Mean absolute revisions		
	Second monthly	Third monthly	Latest monthly	Second monthly	Third monthly	Latest monthly
PCE						
Advance	-0.20	-0.02	-0.09	0.86	0.84	0.91
Second		0.19	0.13		0.50	0.98
Third			-0.06			1.00
PCE excluding food and energy						
Advance	-0.11	0.00	-0.04	0.67	0.74	0.83
Second		0.11	0.08		0.40	0.88
Third			-0.03			0.88

PCE Personal consumption expenditures

1. Percent change in the personal consumption expenditure (PCE) and PCE excluding food and energy.

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Summary and Conclusions

BEA seeks to provide a timely, comprehensive, and accurate picture of the U.S. economy. However, because of the flow of source data over time, BEA provides vintages of estimates, each incorporating and aggregating information in a regular basis. This study has examined how those vintage estimates vary, focusing on GDP, GDI, and their components, but also briefly analyzing quarterly personal income and monthly price indexes estimates.

More specifically, we have shown that the estimates of GDP and GDI that BEA publishes have relatively small MARs and MRs, consistent with previous similar BEA studies. Moreover, we have also shown that these estimates are reliable and that the differences in vintages' estimates are mostly due to the arrival of new information and not to systematic measurement errors.

The average of GDP and GDI series appears to be a more reliable measure of aggregate economic activity than GDP and GDI taken separately in the sense that the MARs of the average series are smaller or equal than those of GDP and GDI taken individually, but this average comes with a 2-month delay compared to the release of the advance estimate of GDP.

Even so, combining these estimates at times where each alone is pointing in a different direction may be particularly useful to give us a more accurate picture of the economy, and it clearly shows that the data sources we use to compute these two estimates are different and convey information that is not always captured “properly” or “timely” in the other estimate, indicating that the estimates of GDP and GDI complement each other.

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Appendix

Appendix Table A. Mean Absolute Revisions to Changes in Real GDP and Its Components, 1999–2022
[Percentage points]

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
GDP						
Advance	0.45	0.58	1.51	0.96	1.63	1.21
Second		0.28	1.41	0.95	1.63	1.18
Third			1.37	0.95	1.59	1.19
First annual				0.99	1.33	1.63
Second annual					1.03	0.78
Third annual						1.01
Personal consumption expenditures						
Advance	0.29	0.48	1.33	0.92	1.34	1.08
Second		0.32	1.25	0.85	1.24	1.00
Third			1.14	0.79	1.17	0.99
First annual				0.80	1.03	1.29
Second annual					0.83	0.58
Third annual						0.81
Durable goods						
Advance	1.14	1.23	4.08	3.72	3.97	4.08
Second		0.45	3.79	3.54	3.99	4.16
Third			3.93	3.54	3.94	4.21
First annual				3.30	2.86	4.25
Second annual					2.21	2.20
Third annual						1.61
Nondurable goods						
Advance	0.63	0.67	1.11	1.40	1.50	1.82
Second		0.30	0.99	1.31	1.41	1.71
Third			0.95	1.30	1.41	1.73
First annual				0.98	1.19	1.43
Second annual					0.77	1.04
Third annual						0.91
Services						
Advance	0.25	0.59	1.86	1.00	1.67	1.04
Second		0.47	1.82	0.93	1.61	0.94
Third			1.62	0.77	1.47	0.93
First annual				0.91	1.33	1.78
Second annual					1.19	0.72
Third annual						1.24
Gross private domestic investment						
Advance	2.29	2.62	4.77	4.50	5.30	4.69
Second		1.05	4.47	4.55	5.56	4.92
Third			4.49	4.17	5.36	4.71
First annual				3.59	4.66	4.78
Second annual					2.89	3.23
Third annual						2.79
Fixed investment						
Advance	1.10	1.43	2.89	2.52	3.37	2.77
Second		0.71	2.74	2.38	3.26	2.58
Third			2.69	2.31	3.15	2.61
First annual				2.09	2.75	2.76
Second annual					1.71	1.68
Third annual						1.91

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Nonresidential						
Advance	1.43	1.76	3.08	3.14	3.86	3.30
Second		0.85	2.91	3.02	3.77	3.17
Third			2.86	2.87	3.56	3.15
First annual				2.40	3.05	2.85
Second annual					1.79	1.99
Third annual						2.02
Structures						
Advance	3.42	4.53	8.69	7.99	8.90	8.31
Second		2.42	8.47	7.37	8.22	7.54
Third			7.64	6.81	7.81	6.94
First annual				5.33	5.87	7.16
Second annual					3.25	2.96
Third annual						3.37
Equipment and intellectual property products						
Advance	1.65	1.92	3.33	3.67	4.45	4.72
Second		0.90	2.98	3.80	4.30	4.42
Third			3.06	3.69	4.31	4.61
First annual				3.05	3.90	4.04
Second annual					2.98	3.51
Third annual						2.49
Residential						
Advance	1.38	1.72	5.09	3.58	5.69	4.09
Second		0.77	4.73	3.36	5.41	3.78
Third			4.42	3.17	5.12	3.55
First annual				2.91	4.74	5.10
Second annual					3.52	2.28
Third annual						3.41
Exports						
Advance	1.46	2.00	2.95	2.86	3.20	3.13
Second		1.06	2.40	2.31	2.70	2.71
Third			2.54	2.32	2.70	2.72
First annual				1.71	2.17	2.53
Second annual					1.25	1.50
Third annual						1.36
Imports						
Advance	1.55	1.86	3.76	3.05	3.65	3.07
Second		0.79	3.14	2.41	2.95	2.58
Third			3.06	2.37	2.81	2.53
First annual				2.43	2.33	2.96
Second annual					1.71	1.48
Third annual						1.63
Government consumption expenditures and gross investment						
Advance	0.46	0.60	1.60	1.23	2.09	1.64
Second		0.30	1.52	1.16	2.08	1.67
Third			1.39	1.13	2.06	1.72
First annual				1.08	1.73	1.97
Second annual					1.38	1.20
Third annual						1.56
Federal						
Advance	0.45	0.60	2.31	2.30	3.25	3.28
Second		0.36	2.21	2.25	3.22	3.26
Third			2.07	2.26	3.22	3.45
First annual				1.69	2.44	3.13
Second annual					1.67	2.36
Third annual						2.56
Defense						
Advance	0.55	0.57	2.58	3.21	3.58	4.07
Second		0.19	2.51	3.14	3.47	4.04
Third			2.50	3.11	3.41	4.01
First annual				2.66	3.03	4.05
Second annual					2.46	3.83
Third annual						3.34

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Nondefense						
Advance	0.56	0.99	3.86	4.23	4.80	4.47
Second		0.72	4.00	4.47	4.89	4.64
Third			3.87	4.42	4.86	5.11
First annual				2.39	3.17	3.59
Second annual					1.99	2.15
Third annual						2.88
State and local						
Advance	0.67	0.81	2.16	1.32	2.29	1.60
Second		0.35	2.02	1.19	2.19	1.54
Third			1.86	1.07	2.11	1.42
First annual				1.50	2.29	2.41
Second annual					1.69	1.02
Third annual						1.45

GDP Gross domestic product

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Appendix Table B. Mean Revisions to Successive Vintages of Changes in Real GDP and Its Components, 1999–2022
[Percentage points]

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
GDP						
Advance	0.10	0.17	0.18	-0.16	0.24	0.00
Second		0.08	0.10	-0.24	0.16	-0.08
Third			0.01	-0.29	0.11	-0.17
First annual				0.10	0.19	-0.18
Second annual					0.40	0.16
Third annual						-0.23
Personal consumption expenditures						
Advance	0.02	0.07	0.06	-0.11	0.03	-0.17
Second		0.06	0.05	-0.12	0.03	-0.17
Third			-0.02	-0.13	0.01	-0.24
First annual				0.17	0.05	-0.22
Second annual					0.14	-0.06
Third annual						-0.21
Durable goods						
Advance	0.21	0.36	0.53	-0.16	-0.68	-0.21
Second		0.17	0.37	-0.34	-0.70	-0.38
Third			0.18	-0.40	-0.78	-0.57
First annual				-1.16	-0.74	-0.74
Second annual					-0.55	-0.08
Third annual						0.48
Nondurable goods						
Advance	0.06	0.07	0.17	-0.14	-0.26	-0.22
Second		0.02	0.12	-0.18	-0.31	-0.28
Third			0.10	-0.22	-0.34	-0.29
First annual				-0.27	-0.40	-0.39
Second annual					-0.13	-0.13
Third annual						-0.01
Services						
Advance	-0.01	0.04	0.07	-0.11	0.32	-0.16
Second		0.04	0.09	-0.10	0.32	-0.14
Third			0.03	-0.09	0.31	-0.20
First annual				0.50	0.48	-0.23
Second annual					0.42	-0.03
Third annual						-0.45

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Gross private domestic investment						
Advance	0.52	0.55	0.63	-0.28	0.26	0.87
Second		0.05	0.13	-0.79	-0.26	0.41
Third			0.08	-0.89	-0.28	0.32
First annual				-0.50	-0.23	0.24
Second annual					0.60	1.12
Third annual						0.58
Fixed investment						
Advance	0.55	0.70	0.98	-0.03	0.50	0.96
Second		0.16	0.45	-0.56	-0.03	0.44
Third			0.28	-0.76	-0.24	0.26
First annual				-0.50	-0.36	-0.02
Second annual					0.55	0.95
Third annual						0.46
Nonresidential						
Advance	0.70	0.78	0.97	-0.17	0.18	1.00
Second		0.10	0.29	-0.83	-0.48	0.34
Third			0.18	-1.00	-0.64	0.22
First annual				-0.81	-0.74	0.04
Second annual					0.36	1.12
Third annual						0.83
Structures						
Advance	1.31	1.98	3.25	2.34	3.00	3.04
Second		0.69	2.03	1.26	1.89	1.83
Third			1.27	0.68	1.39	1.05
First annual				0.55	0.62	-0.22
Second annual					0.83	0.46
Third annual						-0.35
Equipment and intellectual property products						
Advance	0.47	0.28	0.54	-0.87	-0.34	0.03
Second		-0.19	0.08	-1.38	-0.94	-0.42
Third			0.27	-1.41	-0.93	-0.25
First annual				-1.52	-0.97	-0.52
Second annual					0.35	0.88
Third annual						0.58
Residential						
Advance	0.16	0.41	1.22	0.09	2.08	0.42
Second		0.27	1.09	-0.08	1.96	0.31
Third			0.82	-0.33	1.65	0.01
First annual				0.30	1.66	-0.80
Second annual					2.05	0.33
Third annual						-1.70
Exports						
Advance	0.42	0.63	0.07	0.55	0.58	0.76
Second		0.22	-0.36	0.11	0.12	0.34
Third			-0.57	-0.01	-0.04	0.12
First annual				0.25	0.45	0.69
Second annual					0.04	0.31
Third annual						0.30
Imports						
Advance	0.36	0.35	0.55	0.45	0.11	0.69
Second		0.00	0.18	0.07	-0.29	0.33
Third			0.20	0.09	-0.23	0.35
First annual				-0.49	-0.11	0.15
Second annual					-0.31	0.23
Third annual						0.55

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Government consumption expenditures and gross investment						
Advance	0.01	0.09	0.24	-0.18	0.49	0.03
Second		0.09	0.24	-0.17	0.50	0.02
Third			0.14	-0.18	0.48	-0.06
First annual				-0.03	0.35	-0.20
Second annual					0.64	0.19
Third annual						-0.44
Federal						
Advance	-0.03	0.13	0.32	0.16	0.34	0.02
Second		0.17	0.36	0.17	0.35	0.05
Third			0.19	0.20	0.36	-0.11
First annual				0.06	0.07	-0.30
Second annual					0.21	-0.14
Third annual						-0.36
Defense						
Advance	-0.05	-0.07	0.08	-0.89	-0.21	-0.64
Second		-0.02	0.15	-0.86	-0.19	-0.59
Third			0.16	-0.82	-0.17	-0.56
First annual				-0.78	-0.34	-0.72
Second annual					0.65	0.24
Third annual						-0.39
Nondefense						
Advance	0.02	0.43	0.87	1.39	1.37	1.13
Second		0.42	0.84	1.37	1.33	1.11
Third			0.44	1.38	1.35	0.69
First annual				0.80	0.74	0.26
Second annual					0.14	-0.26
Third annual						-0.42
State and local						
Advance	0.03	0.07	-0.06	-0.35	0.61	0.02
Second		0.06	-0.08	-0.33	0.63	-0.01
Third			-0.14	-0.37	0.58	-0.05
First annual				0.23	0.85	0.08
Second annual					0.90	0.33
Third annual						-0.54

GDP Gross domestic product

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Appendix Table C. Standard Deviations of Revisions to Successive Vintages of Changes in Real GDP and Its Components, 1999–2022

[Percentage points]

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
GDP						
Advance	0.59	0.84	5.35	1.29	4.43	1.56
Second		0.54	5.32	1.22	4.46	1.50
Third			4.97	1.18	4.42	1.50
First annual				3.13	4.33	5.32
Second annual					4.17	1.03
Third annual						4.25
Personal consumption expenditures						
Advance	0.37	0.78	4.36	1.19	3.31	1.37
Second		0.66	4.35	1.09	3.20	1.27
Third			3.86	1.01	3.16	1.25
First annual				2.55	3.11	4.11
Second annual					2.97	0.76
Third annual						2.99
Durable goods						
Advance	1.58	2.02	10.03	5.06	5.77	5.34
Second		1.20	9.89	5.12	5.92	5.51
Third			10.48	5.15	5.86	5.61
First annual				9.22	4.87	10.31
Second annual					4.62	3.14
Third annual						3.73
Nondurable goods						
Advance	0.81	0.84	1.42	1.79	1.95	2.43
Second		0.44	1.28	1.66	1.91	2.27
Third			1.31	1.68	1.92	2.34
First annual				1.28	1.51	1.91
Second annual					1.10	1.42
Third annual						1.25
Services						
Advance	0.32	0.92	7.97	1.25	6.10	1.37
Second		0.90	8.08	1.19	6.06	1.31
Third			7.39	0.96	5.99	1.30
First annual				4.08	5.98	7.84
Second annual					5.83	0.92
Third annual						5.79
Gross private domestic investment						
Advance	3.07	3.32	7.34	6.15	7.72	6.43
Second		1.51	7.22	5.91	7.99	6.58
Third			7.51	5.54	7.63	6.34
First annual				5.32	6.73	7.58
Second annual					4.89	4.18
Third annual						5.08
Fixed investment						
Advance	1.31	1.73	6.49	3.23	5.70	3.48
Second		0.98	6.48	3.05	5.66	3.37
Third			6.83	2.90	5.44	3.40
First annual				4.08	5.15	6.26
Second annual					4.59	1.94
Third annual						4.78

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Nonresidential						
Advance	1.66	2.17	4.99	3.86	5.15	4.14
Second		1.30	4.95	3.72	5.05	4.09
Third			5.41	3.53	4.79	4.15
First annual				3.56	4.26	4.79
Second annual					3.08	2.33
Third annual						3.22
Structures						
Advance	4.14	5.64	16.29	10.20	12.53	10.30
Second		3.53	16.31	9.82	11.86	9.96
Third			15.03	9.25	11.05	9.18
First annual				8.14	9.23	14.77
Second annual					7.35	3.96
Third annual						7.83
Equipment and intellectual property products						
Advance	2.04	3.28	4.42	4.65	5.97	6.21
Second		2.66	4.04	4.46	5.71	5.71
Third			4.48	4.37	5.72	6.61
First annual				3.60	4.87	5.44
Second annual					4.14	4.90
Third annual						3.54
Residential						
Advance	1.74	2.07	15.87	4.45	18.38	5.05
Second		0.97	15.95	4.15	18.68	4.71
Third			15.71	3.87	18.56	4.48
First annual				6.95	18.27	15.73
Second annual					18.27	2.90
Third annual						18.65
Exports						
Advance	2.02	2.63	4.42	3.89	4.45	4.05
Second		1.71	3.73	3.07	3.80	3.45
Third			4.49	3.00	3.70	3.77
First annual				2.60	2.95	3.53
Second annual					1.98	1.99
Third annual						2.06
Imports						
Advance	2.09	2.56	8.53	4.13	5.47	4.07
Second		1.27	8.28	3.51	4.85	3.48
Third			8.22	3.49	4.72	3.43
First annual				7.48	4.48	8.47
Second annual					4.05	2.13
Third annual						3.81
Government consumption expenditures and gross investment						
Advance	0.61	1.02	4.58	1.68	5.22	2.21
Second		0.80	4.57	1.58	5.22	2.24
Third			3.97	1.53	5.15	2.33
First annual				2.87	4.80	4.75
Second annual					4.67	1.56
Third annual						4.61
Federal						
Advance	0.76	1.81	3.70	3.09	5.19	4.37
Second		1.76	3.67	3.03	5.13	4.32
Third			3.01	3.08	5.16	4.69
First annual				2.89	4.49	4.67
Second annual					3.76	3.25
Third annual						4.31
Defense						
Advance	0.91	0.87	4.22	4.88	5.30	5.50
Second		0.33	4.14	4.74	5.18	5.48
Third			4.10	4.73	5.15	5.46
First annual				4.69	4.87	5.62
Second annual					4.61	5.52
Third annual						5.02

Vintage	Current quarterly		Annual			Latest
	Second	Third	First	Second	Third	
Nondefense						
Advance	1.09	4.33	5.98	6.97	8.65	7.33
Second		4.25	6.06	7.21	8.83	7.52
Third			5.78	7.32	8.89	8.74
First annual				5.04	6.82	6.49
Second annual					4.95	3.27
Third annual						5.68
State and local						
Advance	0.87	1.02	6.49	1.69	6.13	2.01
Second		0.46	6.39	1.52	6.11	1.98
Third			6.21	1.36	6.01	1.85
First annual				4.40	6.29	6.45
Second annual					5.62	1.39
Third annual						5.45

GDP Gross domestic product

U.S. Bureau of Economic Analysis

Footnotes

1. For example, the accounts contain no entry for business investment in computer software before 1959; the amount of software prior to that year was negligible. But by 2012, business investment in software was 1.7 percent of the size of GDP; the level and rates of growth of the economy were raised when software investment was first included in the accounts in the late 1990s.
2. See the box [“Accuracy, Reliability, and Uncertainty.”](#)
3. See the box [“Vintages and Timing of Revisions”](#) for a detailed revision schedule.
4. The most immediate revisions study by Fixler, de Francisco, and Kanal (2021) covered data from 1996 to 2018, and the years 1996–1999 from the last study do not exhibit any trends that affect the current study, so the sample years have been rolled over 3 years toward the present to make comparisons consistent with previous studies.
5. We also include the MRs of all possible pairs of vintages for real annualized quarterly growth for GDP and their components in appendix table B, but as one would expect when taking averages between positive and negative revisions, the MRs are much smaller than the MARs, about one order of magnitude less for most components.
6. Seasonal adjustment is part of the annual revision process. The revised quarterly estimates contain seasonal factors the annual estimates do not. Also, it is not straightforward to decompose revisions to the part due to seasonal adjustment and the part that is not.
7. For a detailed discussion of the timing of GDP and GDI estimates and the source data available for each estimate, see [Fixler, Greenaway-McGreevey, and Grimm \(2014\)](#), and [Holdren \(2014\)](#) or [the NIPA handbook](#)
8. Because GDI is not available when the advance estimates of GDP are released, and it is only available for the first three quarters of the year when it is released with the second estimate of GDP, we prefer to choose the third estimate for both measures as our “earliest” vintage.



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