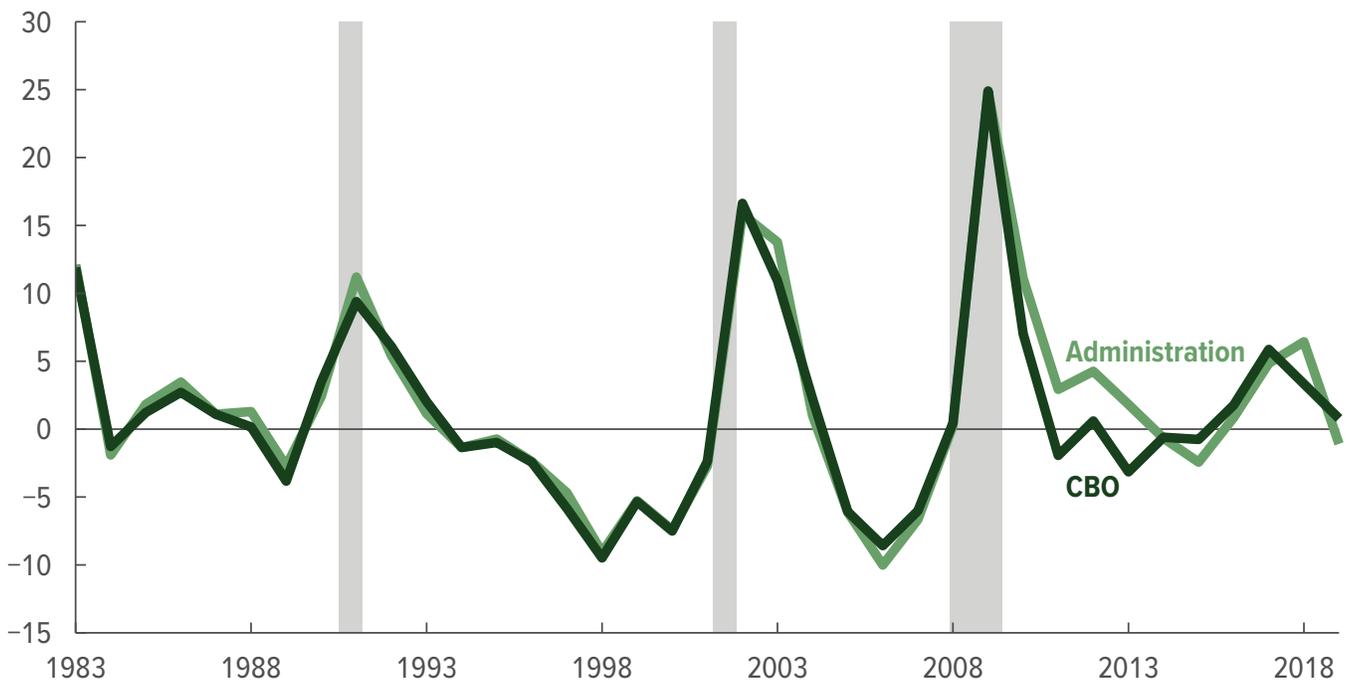


CBO

An Evaluation of CBO's Past Revenue Projections

Differences Between CBO's and the Administration's Budget-Year Projections of Revenues and Actual Amounts

Percentage of Actual Amount



AUGUST 2020

At a Glance

To prepare its baseline projections of the federal budget, the Congressional Budget Office projects what federal revenues would be in the current year and the next 10 years if current laws generally remained unchanged. In this report, CBO analyzes the baseline revenue projections that it has made each winter since 1982 for two years in the projection period in particular—the budget year (typically the year beginning about nine months after the projections were made) and the sixth year (counting the current year as the first).

CBO's analysis resulted in these key findings:

- On average, CBO has slightly overestimated revenues in its budget-year projections; the agency has overestimated revenues in its sixth-year projections by a greater amount.
- Many of CBO's revenue projection errors can be attributed to errors in the agency's economic forecast; other errors in the revenue projections arise from differences in projected and actual income relative to the size of the economy.
- The largest projection errors were the result of specific hard-to-predict events (business cycle downturns, for example) rather than indicators of any general trend in the accuracy of CBO's projections. CBO expects that the economic disruptions associated with the 2020 coronavirus pandemic will result in large projection errors.
- CBO's revenue projections are inherently uncertain, but the degree of uncertainty is not the same for all projections. It increases as the projections extend further into the future.
- Over the past few decades, the Administration's budget-year revenue projections have been about as accurate as CBO's projections, but its sixth-year projections have been slightly less accurate than CBO's, on average.



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Notes

Unless this report indicates otherwise, all years referred to are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end.

Numbers in the text and tables may not add up to totals because of rounding.

Some of the figures in this report use shaded vertical bars to indicate periods of recession. A recession extends from the peak of a business cycle to its trough.

Supplemental data are posted along with this report on CBO's website (www.cbo.gov/publication/56499).



An Evaluation of CBO's Past Revenue Projections

Summary

In the course of producing baseline projections of the federal budget, the Congressional Budget Office regularly projects what federal revenues would be in the current year and in the next 10 years if current laws generally remained unchanged. To refine its methods and improve its projections, the agency routinely assesses the accuracy of its past projections.

In this report, CBO assesses the quality of the revenue projections that it has produced since 1982—the earliest year for which the information necessary to assess the projections is available—by comparing them (after an adjustment to account for the effects of subsequent legislation) with actual revenue collections. Specifically, it looks at the projections of total revenues and of different sources of revenues for the budget year (the next fiscal year after the year in which the projections are made) and for the sixth year of the projection period (including the current year).

The agency has tended to overestimate revenues in its projections—especially those that extend further into the future—largely because it is difficult to predict the timing, depth, and duration of downturns in the business cycle. A disproportionate share of the largest projection errors (which are calculated as the difference between the adjusted projection and actual revenues, expressed as a percentage of actual revenues) are in projections made just before a recession. When the four budget-year projections that were produced at or near business cycle peaks are excluded, the accuracy of the projections, according to key statistical measures, improves significantly.¹

How Do CBO's Revenue Projections Compare With Actual Outcomes?

In evaluating its projections, CBO focused on three characteristics of forecast quality—centeredness, accuracy, and dispersion (see Table 1).

Centeredness. The tendency of a set of projections to not repeatedly err in the same direction is referred to as centeredness. To measure centeredness, CBO uses the average error—the arithmetic mean of the projection errors. A perfectly centered set of projections would have an average error of zero.

The average error for CBO's budget-year projections published since 1982 is 1.2 percent, indicating that, on average, CBO has slightly overestimated total revenues for the budget year. For context, an error of that size in the baseline projections that CBO produced in 2018 would amount to about \$42 billion of the roughly \$3.5 trillion in total revenues that CBO projected for 2019.²

Overestimates and underestimates offset each other in the calculation of the average error, so the measure can obscure the magnitude of the errors. The 1.2 percent average error for CBO's budget-year projections reflects projections in which CBO overestimated revenues by as much as 25 percent (the projection for 2009 published in January 2008) and others, namely those for the late 1990s and the mid-2000s, in which the agency underestimated revenues by nearly 10 percent.

Projection errors are generally larger the further into the future the projection extends. In its projections of revenues for the sixth year of the baseline projection period, CBO has, on average, overestimated revenues by 5.6 percent.

Accuracy. This characteristic refers to how close the projected values are to the actual amounts. CBO uses two standard measures of accuracy: the average absolute error (that is, the average of all errors with the negative signs removed from the underestimates) and the root mean square error (RMSE).

1. The four budget-year projections made near the beginning of a recession were published in early 1982, 1990, 2001, and 2008.

2. See Congressional Budget Office, *The Budget and Economic Outlook: 2018 to 2028* (April 2018), www.cbo.gov/publication/53651.

Table 1.

Summary Measures of the Quality of CBO's and the Administration's Revenue Projections

Percent

Measure	Projection Year					
	Current Year	Budget Year	Third Year	Fourth Year	Fifth Year	Sixth Year
CBO						
Centeredness						
Average error	*	1.2	2.5	3.7	4.8	5.6
Accuracy						
Average absolute error	2.2	4.9	6.9	8.5	9.4	9.9
RMSE	2.9	7.0	9.4	10.4	11.2	11.6
Dispersion						
Two-thirds spread of errors	6.5	11.9	15.9	21.3	19.0	19.8
Administration						
Centeredness						
Average error	-0.2	1.7	3.2	4.7	6.0	7.4
Accuracy						
Average absolute error	2.3	5.2	7.5	9.3	10.4	11.5
RMSE	2.9	7.4	9.9	11.4	12.4	13.2
Dispersion						
Two-thirds spread of errors	7.0	11.7	16.5	22.5	20.8	18.6

Sources: Congressional Budget Office and Office of Management and Budget.

The projection errors underlying these summary measures are calculated as the projected amount minus the actual amount, divided by the actual amount; thus, the error is expressed as a percentage of the actual amount. A negative average error is an underestimate, and a positive average error, an overestimate.

The average absolute error is the average of projection errors with the negative signs removed from the underestimates. The RMSE is calculated by squaring the projection errors, averaging those squares, and taking the square root of that average.

The revenue projections included in this analysis are those published in calendar years 1982 through 2019, typically in January or February. The current year is the fiscal year in which the projection is made. The budget year refers to the fiscal year beginning eight to nine months after the projection is made, the third year is the fiscal year starting one year and nine months after the projection is made, and so on.

RMSE = root mean square error; * = between zero and 0.05 percent.

The average absolute error for CBO's budget-year revenue projections made since 1982 is 4.9 percent, and the RMSE is 7.0 percent. An error the size of that average absolute error in the revenue projection for 2019 that CBO released in April 2018 would correspond to an overestimate or underestimate of \$171 billion.

The sixth-year projections have larger errors—an average absolute error of 9.9 percent and an RMSE of 11.6 percent. An error the size of that average absolute error in the revenue projection for 2023 that CBO released in April 2018 would mean that actual revenues were \$419 billion higher or lower than the agency projected.

The average absolute error and the RMSE appear to level off by the sixth-year horizon; those two measures of CBO's sixth-year projections are roughly equal to those of the agency's fifth-year projections. The small sample size of projections extending beyond six years does not allow for a comprehensive assessment, so the apparent stabilizing of the measures cannot yet be confirmed.

Dispersion. The size of the range around the projection errors is referred to as the errors' dispersion. In this analysis, CBO uses the range formed by the middle two-thirds of errors—known as the two-thirds spread—as its measure of dispersion. A larger two-thirds spread of

errors implies that any single projection for that particular time horizon may be less certain.

The dispersion of CBO's revenue projection errors increases with the projection horizon. For the agency's budget-year projections, the two-thirds spread of errors is 11.9 percent; for the sixth-year projections, it is 19.8 percent.

How Do CBO's Projections Compare With the Administration's Projections?

The errors in the Administration's budget-year projections of revenues have been similar, in both size and direction, to those in CBO's projections. In the budget-year projections that it has published since 1982 (adjusted to exclude the effects of its proposed policy changes), the Administration overestimated revenues, on average, by 1.7 percent—slightly more than the 1.2 percent that CBO overestimated by, on average (see Table 1 on page 2). The RMSE for the Administration's budget-year projections is 7.4 percent, close to the 7.0 percent RMSE of CBO's budget-year projections. The accuracy of the Administration's projections of specific revenue sources was similar to that of CBO's projections.³

The Administration's sixth-year projections are less centered than CBO's projections. Whereas CBO overestimated revenues in the sixth year of the projection period by 5.6 percent, on average, the Administration overestimated revenues in the sixth year by 7.4 percent, on average. Likewise, the Administration's sixth-year projections are slightly less accurate than CBO's: The RMSE of the Administration's sixth-year projections is 13.2 percent, and that of CBO's projections is 11.6 percent. The Administration's sixth-year projection errors were, however, less dispersed than CBO's were.

What Factors Have Contributed to Differences Between CBO's Projections of Revenues and Actual Revenue Collections?

Many of CBO's revenue projection errors can be attributed to errors in the agency's economic forecast; other errors in the revenue projections arise from differences in projected and actual income relative to the size of the economy. The largest forecast errors are associated

with revenue projections produced for years near downturns in the business cycle, when gross domestic product (GDP) was significantly lower than expected. Errors have also arisen from other factors, including unexpected declines in certain types of income relative to GDP—most notably wages and salaries, corporate profits, and capital gains realizations—and changes in the share of overall income earned by the highest-earning taxpayers (who face the highest tax rates).

Projections of specific revenue sources have contributed in varying degrees to errors in the projections of total revenues. Projections of individual income taxes have contributed the most to errors in CBO's projections of total revenues because they were the largest source of revenues in every year of the period analyzed. The next two largest sources of error were the projections of corporate income taxes and payroll taxes. The projections of smaller revenue sources—excise taxes, customs duties, and estate and gift taxes—have contributed much less to the errors in the agency's projections of total revenues.

CBO's Methods for Projecting Revenues

In accordance with the rules governing baseline projections, CBO constructs its projections of federal revenues to reflect the assumption that current laws governing taxes will generally remain unchanged.⁴ The agency projects revenues largely by taking the values of the macroeconomic variables in its economic forecasts that most affect the bases on which the various federal taxes are imposed and applying the appropriate effective tax rates (which often differ significantly from the rates set by law) to them.⁵

CBO models each major source of revenues separately and projects total revenues by summing the projections of each source.⁶ Those projections are based mainly on the following macroeconomic variables:

4. CBO constructs its baseline projections in accordance with provisions set forth in section 257 of the Balanced Budget and Emergency Deficit Control Act of 1985 (2 U.S.C. §907), as amended.
5. The agency's methods involve more than simply using the past relationship between receipts and different macroeconomic measures, such as GDP, as a guide because such relationships have been significantly altered over time by changes to provisions of tax law.
6. See Congressional Budget Office, *How CBO Prepares Baseline Budget Projections* (February 2018), www.cbo.gov/publication/53532.

3. CBO and the Administration use similar data but prepare their projections independently, usually around the same time each winter.

- Wages and salaries and proprietors' income—all of which influence both individual income taxes and payroll taxes,
- Asset prices—which affect the income tax base (through capital gains realizations and distributions from tax-deferred retirement accounts) and the base for estate and gift taxes, and
- Corporate profits—the key determinant of corporate income tax revenues.

CBO also incorporates information from monthly data about actual tax collections into its projections. When tax collections from recent months deviate from the amounts that the agency estimated for the full year using its various models, CBO assesses whether the factors that *may* explain such deviations are temporary or are likely to persist. Whether the identified factors actually *were* responsible for the discrepancies often cannot be confirmed until more detailed information becomes available in the future.

When the agency determines that the differences between its projections and actual tax collections are systemic, it modifies its forecasting models and methods. Over the more than three decades covered in this report, CBO made numerous adjustments to its methods to reflect developments revealed by new data.⁷ For example, more than a decade ago, CBO incorporated into its projections of income and payroll taxes the expectation that earnings of higher-income taxpayers would grow more quickly than those of taxpayers with lower income.⁸

CBO's Methods for Assessing Its Projections

In this assessment, CBO compares its past revenue projections (adjusted to account for the effects of legislation enacted after they were prepared) with actual revenue collections and with the Administration's projections. To assess the quality of its projections, CBO focuses on three main characteristics: centeredness, accuracy, and the dispersion of projection errors. Although assessing past projections is an important part of the projection

process, several factors limit the extent to which such assessments can improve the accuracy of future projections.

Sources of Data

For this assessment, CBO examined the baseline revenue projections that it has released annually (usually early in the calendar year) since 1982.⁹ Each of those projections includes estimates for the fiscal year in which it was prepared and for at least the next 5 years; since 1992, the agency has published projections for the current year and next 10 years. For example, in January 2017, CBO released revenue projections for 2017 (the current year), 2018 (the budget year), and each of the next 9 years (see Figure 1). Each October, shortly after a new fiscal year begins, the Treasury Department reports the actual amounts of revenues for the previous fiscal year (subject to later revisions, which are typically small). Thus, the baseline projections published since 1982 provide sample sizes of 37 budget-year projections (those for 1983 to 2019) and 33 sixth-year projections (those for 1987 to 2019).¹⁰

CBO also compared its estimates with those prepared by the Administration for the same years. The Administration generally publishes its projections in February when it submits the budget to the Congress.

Calculation of Projection Errors

Differences between projected amounts and actual outcomes are referred to in this report as projection errors. On the most basic level, each projection error is calculated by subtracting actual revenue collections from the projected amount and dividing that difference by actual revenues to express the error as a percentage; a positive value represents an overestimate and a negative value an underestimate.

7. See Congressional Budget Office, *Improving CBO's Methodology for Projecting Individual Income Tax Revenues* (February 2011), www.cbo.gov/publication/22007.

8. See Congressional Budget Office, *Projected Changes in the Distribution of Household Income, 2016 to 2021* (December 2019), www.cbo.gov/publication/55941.

9. Although CBO has made economic and budget projections since it began operating in 1975, the projections produced before 1982 are not comparable with those made since then because detailed data on the effects of subsequently enacted legislation are not available; those early projections are therefore excluded from this analysis.

10. CBO has not yet assessed projections for the final year of the 10-year projection periods (the eleventh-year projections) because actual data are currently available for only 15 of those projections. The agency began publishing 10-year baseline projections in 1992, but the detailed data necessary to remove the effects of subsequently enacted legislation are not available for projections published before 1996.

Figure 1.

Sample Timeline for Measuring Errors in CBO's Budget-Year Revenue Projections



Source: Congressional Budget Office.

Actual dates for the current-year and budget-year projections of revenues that were published in 2017 are provided here as an example. The timelines for measuring forecast errors are similar for all current-year and budget-year projections.

Certain adjustments to the projections are necessary, however, to make meaningful comparisons with actual outcomes. CBO's baseline projections are meant to provide a benchmark against which proposed policy changes can be measured; they therefore reflect the assumption that laws affecting revenues and spending generally remain unchanged over the projection period.¹¹ When legislation is enacted after the projections are made, it can affect actual revenues and cause those actual amounts to differ significantly from the projected values. To remove such effects from its measure of projection errors, CBO adjusted the projections to incorporate the estimated revenue effects of legislation enacted after the projections were published. (For a detailed example of how the agency adjusts its projections to calculate errors, see Box 1.) Generally, CBO uses the estimates prepared by the Joint Committee on Taxation (JCT) near the time of the legislation's enactment to make those adjustments.

Adjusting projections to account for recently enacted legislation may introduce additional errors because the estimates of legislation's effects on revenues are themselves uncertain. In addition, by longstanding convention, estimates of the budgetary effects of legislation do not reflect the feedback to the budget that arises from broad changes in the economy; thus, any such feedback contributes to the measured projection error.

11. Some exceptions to the general rule exist. One such exception is the treatment of excise taxes that are dedicated to trust funds. In that case, CBO's projections reflect the assumption that the taxes will continue into the future, even if they are scheduled to expire under current law.

The Administration's projections must also be adjusted to make them comparable with CBO's projections. In contrast to CBO, the Administration includes in its projections the estimated revenue effects of the policies that it proposes but that are not yet law.¹² To make those projections comparable with CBO's projections for the same period, CBO subtracted the estimated effects of the proposed policies (which the Administration publishes separately) from the Administration's revenue projections. In general, the Administration does not publish additional estimates of the revenue effects of legislation after it submits the budget to the Congress. When the Administration's estimates of legislation's revenue effects were unavailable, CBO used the JCT's estimates to adjust the Administration's projections.

12. The Administration's economic projections include the effects of the proposals, but the Administration does not include changes in revenues that would result from those economic effects in its separate revenue projections for the proposals. Therefore, the Administration's revenue projections with the effects of proposed policies removed may include some budgetary feedback from the policy proposals and thus are not completely comparable with CBO's baseline projections. In the past, the Administration published its revenue projections without the effects of its proposed policies as its "current services baseline"; more recently, it has published those projections as the "Balanced Budget and Emergency Deficit Control Act (BBEDCA) baseline." CBO used those estimates without any modifications, but for some details, it used the information provided separately by the Administration when the budget was released. For a list of adjustments made to the BBEDCA baseline, see Office of Management and Budget, *Budget of the United States Government, Fiscal Year 2020: Analytical Perspectives* (March 2019), Table 14-2, p. 148, www.govinfo.gov/app/details/BUDGET-2020-PER.

Box 1.**An Example of How CBO Adjusts Its Projections to Calculate Projection Errors**

The Congressional Budget Office's revenue projections reflect the assumption that current laws will generally remain unchanged. When new legislation is enacted after a projection is made, it can affect actual revenue collections and cause them to differ significantly from CBO's projected amounts. Thus, to remove the effects of those changes in law from its calculation of projection errors, CBO adjusts its projections to incorporate the effects of the legislation (as estimated by the Joint Committee on Taxation) before calculating the difference between the projected and actual amounts.¹

CBO's assessment of its January 2014 baseline projections for 2014 to 2024 offers an example of how the agency adjusts its revenue projections before comparing them with actual revenue collections (see the table). In those baseline projections, revenues totaled \$3,305 billion in 2015 (the budget year) and \$3,932 billion in 2019 (the sixth year).

1. Although CBO adjusts its projections to account for legislation that is enacted after they are produced, the agency does not typically make adjustments to account for the effects of administrative actions or other legal changes that affect revenues.

To assess the accuracy of that budget-year projection, CBO adjusted it to incorporate the effects of legislation enacted between January 2014 and the end of fiscal year 2015. Those new laws, particularly the Tax Increase Prevention Act of 2014, reduced revenues in 2015 by an estimated \$80 billion. Adjusting the January 2014 projection to incorporate the effects of the new laws yielded an adjusted projection totaling \$3,225 billion. The actual revenues in 2015—\$3,250 billion—were then subtracted from that adjusted amount, an underestimate of about \$25 billion, or 0.8 percent of the actual amount.

The sixth-year projection was similarly adjusted to incorporate the effects of legislation enacted between January 2014 and the end of fiscal year 2019, which included the 2017 tax act. Together, those adjustments lowered projected revenues by an estimated \$325 billion, resulting in an adjusted sixth-year projection of \$3,607 billion. Actual revenues in 2019 totaled \$3,462 billion; therefore, CBO overestimated revenues for that year by \$145 billion—a projection error of about 4 percent.

Continued

Both CBO's and the Administration's revenue projections include details on the different sources of federal revenues: individual income taxes, payroll taxes, corporate income taxes, excise taxes, customs duties, estate and gift taxes, and miscellaneous receipts (including remittances from the Federal Reserve System and various fees and fines). CBO evaluated those specific projections of each source of federal revenues separately.

Measures of the Quality of Projections

This evaluation focuses on three measures of CBO's forecast quality: centeredness, accuracy, and dispersion.

Centeredness. CBO intends to provide a revenue baseline that is centered—that is, one that is as likely to be higher than actual revenues as it is to be lower. To measure the centeredness of its past projections, CBO uses the average error (the arithmetic mean of the projection errors), which is the simplest and most widely used measure of forecast centeredness. But because the negative values of underestimates offset the positive values of overestimates when calculating the average error, the measure provides an imperfect view of the accuracy of projections. For example, a set of projections with small

errors in both directions that largely offset one another would produce a small average error; so, too, would a set of projections with large overestimates and underestimates, as long as the errors were approximately the same size.

Accuracy. The accuracy of a set of projections is a measure of how much projected values differ from the actual outcomes. CBO evaluates the accuracy of revenue projections using two measures: the average absolute error and the root mean square error. To calculate the average absolute error, negative signs are removed from underestimates before averaging; thus, unlike in the calculation of the average error, errors in different directions do not offset one another.

The RMSE is calculated by squaring the errors (thus removing the negative signs), averaging those squares, and taking the square root of that average. Like the average absolute error, the RMSE measures the size of errors without regard to direction, but because the errors are squared, the RMSE places a greater weight on larger projection errors.

Box 1.

Continued

An Example of How CBO Adjusts Its Projections to Calculate Projection Errors

Adjustments Made to CBO's 2014 Baseline Revenue Projections to Account for the Effects of Legislation Enacted After the Projections Were Published

Billions of Dollars

	Projection Year					
	2014 (Current Year)	2015 (Budget Year)	2016 (Third Year)	2017 (Fourth Year)	2018 (Fifth Year)	2019 (Sixth Year)
Baseline Projection of Revenues in February 2014	3,029	3,305	3,481	3,631	3,770	3,932
Estimated Effects of Subsequent Legislation Enacted in Each Period						
February 2014 to August 2014	1	3	4	5	4	2
August 2014 to January 2015	0	-81	18	11	7	5
January 2015 to August 2015		-1	*	1	1	1
August 2015 to January 2016		0	-134	-91	-62	-48
January 2016 to August 2016			*	*	*	*
August 2016 to January 2017			0	*	*	*
January 2017 to June 2017				*	*	*
June 2017 to April 2018					-163	-285
April 2018 to January 2019					0	*
January 2019 to end of fiscal year 2019						*
Total	1	-80	-111	-75	-213	-325
Adjusted Baseline Projection of Revenues	3,030	3,225	3,370	3,556	3,557	3,607
Actual Revenue Amount	3,021	3,250	3,268	3,316	3,330	3,462
Difference Between Projected and Actual Amounts	8	-25	102	240	228	145

Source: Congressional Budget Office.

The three laws enacted after CBO's January 2014 baseline projections were published that had the largest effects on revenues in the projection years were the Tax Increase Prevention Act of 2014 (December 2014), the Consolidated Appropriation Act of 2016 (December 2015), and the 2017 tax act (December 2017).

The periods identified for the enactment of legislation correspond to the intervals between successive baseline projections. CBO typically publishes its annual baseline projections in January or February and updates them in August.

The estimated effects on revenues of specific pieces of legislation are generally those prepared by the staff of the Joint Committee on Taxation near the time of the legislation's enactment.

* = between -\$500 million and \$500 million.

Dispersion. To measure the dispersion of its projection errors, CBO uses the two-thirds spread of errors—that is, the difference between the minimum and maximum error after removing the largest (most positive) one-sixth and smallest (most negative) one-sixth of all errors. A larger two-thirds spread implies a more uncertain forecast, whereas a smaller two-thirds spread implies that the actual outcome is likely to fall within a smaller range around the projected value.¹³

13. In some cases, CBO uses the RMSE as a measure of dispersion. Generally, the RMSE is used when errors are well centered and have an approximately normal distribution. When those

Limitations of Projection Evaluations

The measures of quality that CBO uses have limitations. To some degree, error is inherent to every projection because the data used to produce the projections may contain measurement error. Modifications that CBO has made to its projection methods over the years might have changed the nature of the errors, complicating any evaluation of the agency's projection errors. Finally, because of the highly uncertain nature of the economy,

conditions are met, about two-thirds of actual values will be within a range of plus or minus one RMSE of the projected values.

the conclusions that can be drawn from the measures are limited by the small sample size.

Measurement Error. The quality of the data that are used to project revenues can vary for many reasons. In some cases, data are collected by sampling from the population; that method of collection is useful for producing representative estimates for the entire population of the United States, but it inherently contains a margin of error.¹⁴ To avoid disclosing any confidential personal data, surveys might also use techniques—such as masking extreme values—that can introduce error into the analysis.

Methods. CBO has significantly changed its methods for projecting revenues over the years. But the agency's attempts to improve its projections by incorporating new information might have changed the characteristics of the resulting projection errors.

The calculated projection errors are themselves uncertain because the estimates of the effects of subsequently enacted legislation that are used to adjust revenue projections are not certain. What appears to be an error in a baseline projection may actually be an error in the estimate of the revenue effects of changes in law. The estimates of the effects of new legislation exhibit error in part because they use only information available at the time of enactment—not information (such as that from tax returns or actual data on GDP or other macroeconomic indicators) that became available later. Furthermore, even when all actual data are available after the fact, analysts cannot calculate the effects on revenues of past legislative changes with complete certainty.

Sample Size. The conclusions that can be drawn from this evaluation are also limited by the number of projections available. Fewer than 40 annual projections is a relatively small sample size for statistical analysis given the variability in the economy and the many different economic factors that interact with one another to determine the amount of revenues collected.

14. One well-known issue with population surveys is participation (or nonresponse) bias—the tendency of participants to share characteristics that differ from those of people who choose not to respond. Systematic nonresponse—that is, when certain characteristics of potential respondents are statistically correlated with their response rate—can lead to bias in the data.

Assessment of the Projections

CBO's projections for the budget year have tended to be more centered and more accurate than its projections for the sixth year. The same is true of the Administration's revenue projections. In general, the accuracy of CBO's budget-year and sixth-year projections has remained relatively constant over time; the largest projection errors have resulted from downturns in the business cycle.

Budget-Year Projections

CBO's budget-year projections have tended to slightly overestimate revenues; most of the overestimates occur in projections made just before a business cycle downturn. Of the projections that the agency has published since 1982, the largest errors were in the projections made just before the 2001 recession and the 2007–2009 recession for the years during and following those recessions.

Centeredness. On average, CBO's budget-year revenue projections for the years 1983 to 2019 overestimated revenues by 1.2 percent; an error of that size in CBO's budget-year projection for 2019 would amount to \$42 billion of the roughly \$3.5 trillion in total revenues projected.¹⁵

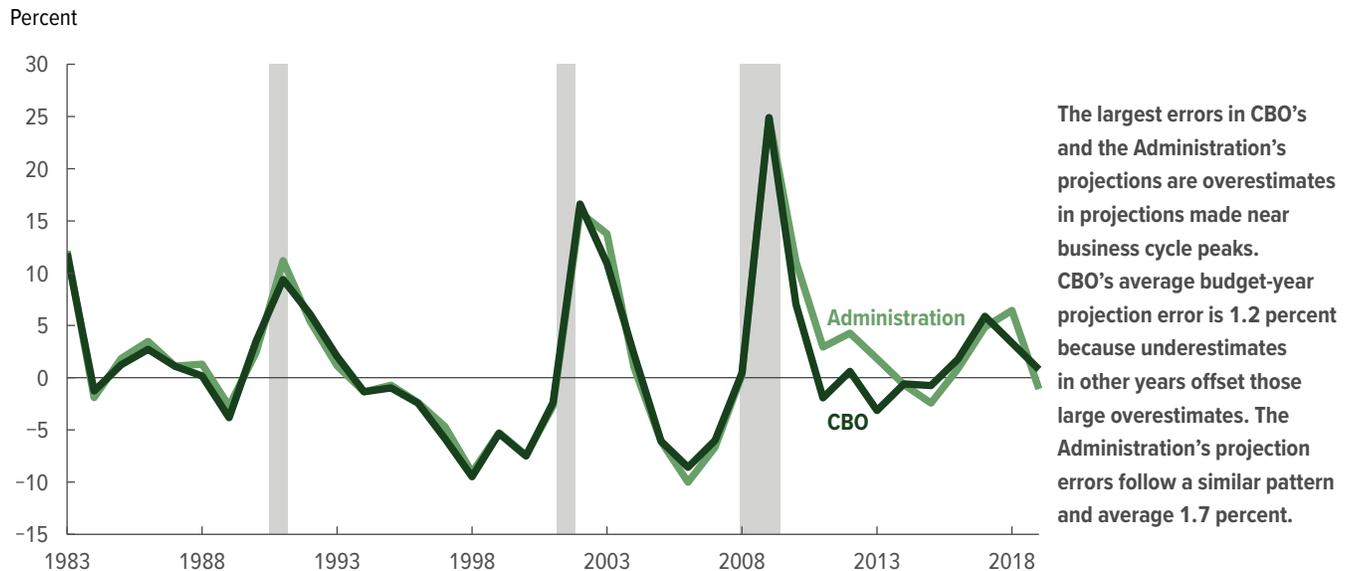
That relatively small average error of 1.2 percent does not capture the substantial variability in the errors that occurs over time. The errors in the projections that CBO made for years that fell in the middle of major business cycle downturns or that immediately followed them are much larger than that average (see Figure 2). Only 8 of the 37 budget-year projections had errors of 1.2 percent or less (regardless of the direction of the error). Just over half of the projections were overestimates. The largest error in the budget-year projections—24.9 percent—is that in the budget-year projection for 2009, which was published in January 2008. Indeed, if that single projection is excluded from the analysis, the average error for the budget-year projections is an overestimate of 0.6 percent rather than 1.2 percent.

Over the past few decades, the centeredness of the Administration's budget-year revenue projections has been similar to that of CBO's projections. By CBO's calculation, the errors in the Administration's budget-year

15. See Congressional Budget Office, *The Budget and Economic Outlook: 2018 to 2028* (April 2018), www.cbo.gov/publication/53651.

Figure 2.

Errors in CBO's and the Administration's Budget-Year Revenue Projections



Sources: Congressional Budget Office and Office of Management and Budget.

The years shown are those for which each projection was made; CBO's budget-year projections are typically published in January or February of the previous year. For example, the 0.8 percent error shown for CBO's projection for 2019 indicates that the projection of revenues for fiscal year 2019 that was published in February 2018 overestimated actual revenues by that amount.

Projection errors are calculated as the projected amount minus the actual amount, divided by the actual amount; thus, the error is expressed as a percentage of the actual amount. A negative error is an underestimate, and a positive error, an overestimate.

revenue projections averaged 1.7 percent, slightly higher than CBO's average of 1.2 percent.

Accuracy. The average absolute error for CBO's budget-year projections is 4.9 percent, and the RMSE is 7.0 percent—both of which are much larger than the average error of 1.2 percent. In this case, the fact that both the RMSE and average absolute error are notably larger than the average error indicates a significant degree of offsetting of overestimates and underestimates.

The RMSE of CBO's budget-year projections has remained relatively constant over time—the largest errors appear to be attributable to specific hard-to-predict events in recent years rather than to a broader trend of deterioration in the accuracy of CBO's projections. In particular, the largest errors occurred in projections for years following the 2001 recession and, to an even greater extent, the 2007–2009 recession, both of which involved large and sustained declines in the stock market.

The Administration's budget-year revenue projections have been about as accurate as CBO's projections. By CBO's calculation, the Administration's budget-year projections have an average absolute error of 5.2 percent and an RMSE of 7.4 percent.

Dispersion. The two-thirds spread of CBO's budget-year projections' errors was 11.9 percent. That measure suggests that, on the basis of the historical pattern of errors, there is a two-thirds chance that future budget-year revenues would be no more than about 6 percent above or below the baseline projections if current laws generally remained unchanged. The two-thirds spread of the errors in the Administration's budget-year projections is similar to that of the errors in CBO's budget-year projections.

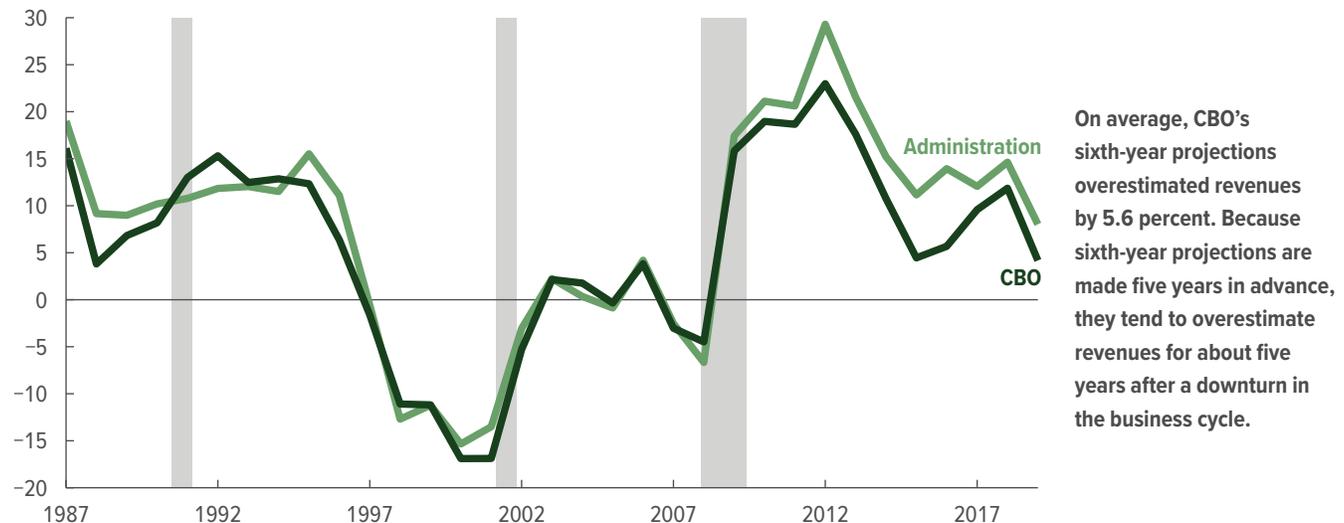
Sixth-Year Projections

CBO's sixth-year revenue projections have been less centered and less accurate than its budget-year projections. Unlike the budget-year projections' errors, which include a substantial amount of offsetting of underestimates and overestimates, large overestimates dominated the errors

Figure 3.

Errors in CBO's and the Administration's Sixth-Year Revenue Projections

Percent



Sources: Congressional Budget Office and Office of Management and Budget.

The years shown are those for which each projection was made; CBO's sixth-year projections are typically published about four years and eight or nine months (in January or February) before the projection year begins. For example, the 4.2 percent error shown for CBO's projection for 2019 indicates that the projection of revenues for fiscal year 2019 that was published in February 2014 overestimated actual revenues by that amount.

Projection errors are calculated as the projected amount minus the actual amount, divided by the actual amount; thus, the errors are expressed as a percentage of the actual amount. A negative error is an underestimate, and a positive error, an overestimate.

in the projections for the longer horizon. In total, 24 of the 33 sixth-year projections overestimated revenues. The predominance of overestimates and their magnitude resulted in less centered and less accurate projections.

Centeredness. CBO overestimated revenues in its sixth-year projections for 1987 to 2019 (those published between 1982 and 2014) by an average of 5.6 percent (see Figure 3). Those 33 projections include overestimates attributable to recessions (the projections for 2003 and 2004 and for 2009 to 2014) and underestimates for years in the middle of economic expansions (the projections for 1997 to 2000). If the projections for 2009 to 2014 (whose errors averaged 17.5 percent) are excluded, CBO still overestimated revenues in its sixth-year projections, on average, but by a much smaller 3.0 percent.

The average errors for CBO's projections grow progressively larger as those projections extend further into the future. On average, CBO *underestimated* revenues for the current year by less than 0.1 percent, but for all other projection years, the agency tended to overestimate

revenues. The average error for the budget-year projections is an overestimate of 1.2 percent, and that average error increases to 2.5 percent for the third-year projections, 3.7 percent for the fourth-year projections, 4.8 percent for the fifth-year projections, and 5.6 percent for the sixth-year projections (see Table 1 on page 2).

Accuracy. The RMSE and average absolute error also tend to be larger for projections extending further into the future, although there is evidence that the errors level off after the sixth-year projections. The RMSE of CBO's current-year revenue projections is 2.9 percent; it increases to 7.0 percent for the budget-year projections and to 9.4 percent for the third-year projections. Although the RMSE continues to grow with each year that the projection is extended through the sixth year, it does so at a slower rate, reaching 10.4 percent for the fourth-year projections, 11.2 percent for the fifth-year projections, and 11.6 percent for the sixth-year projections. A similar pattern exists for the average absolute error, which is 9.9 percent for the agency's sixth-year projections.

Box 2.**CBO's Revenue Projections and the Coronavirus Pandemic**

Because actual revenue collections in 2020 will not be known until October, the effects of the 2020 coronavirus pandemic on revenues were not fully known when this report was prepared. The Congressional Budget Office expects federal revenues to decline sharply in 2020 and 2021 and to fall well below the amounts in the baseline projections that the agency made prior to the pandemic; however, actual revenues remain uncertain, partly because they depend on the severity of the pandemic and its economic effects as well as on the responses of state, local, and federal policymakers to the crisis.¹

In the past, the projections that CBO made near the peak of a business cycle had errors that were many times larger than those in projections produced during other times. The average of all the errors in CBO's budget-year projections is 1.2 percent,

but the average of the errors in projections produced near business cycle peaks is 15.7 percent.² In the budget-year projection that the agency produced in early 2008, before the 2007–2009 recession had been identified as a recession, CBO overestimated revenues by 24.9 percent.

For CBO's past projections as a whole, there was a two-thirds chance that actual revenues would be no more than 6 percent greater than or less than CBO's budget-year baseline projection of revenues if current laws at the time the projection was made remained unchanged. But if the error in the budget-year projections for 2020 and 2021 is comparable to those in previous projections made near recessions, they will fall well outside that two-thirds spread of errors.

1. Two examples of federal responses are H.R. 6201, the Families First Coronavirus Response Act (Public Law 116-127) and H.R. 748, the CARES Act (P.L. 116-136), which were enacted on March 18 and 27, 2020, respectively. Both of those laws will probably contribute to actual revenues' falling well below the amounts in CBO's baseline projections.

2. The four budget-year projections produced near business cycle peaks were released near the beginning of calendar years 1982, 1990, 2001, and 2008 and projected revenues for fiscal years 1983, 1991, 2002, and 2009. The National Bureau of Economic Research has determined that a recession began in February 2020.

The Administration's sixth-year projections were slightly less accurate, as measured by the average absolute error and RMSE, than CBO's sixth-year projections. The Administration's sixth-year projections have an average absolute error of 11.5 percent and an RMSE of 13.2 percent, according to CBO's calculations. In part, those values reflect the Administration's including in its projections the effects that its proposed policies are projected to have on economic outcomes. If those policies are not enacted, the economic effects do not materialize.

Dispersion. The two-thirds spread of the errors in CBO's sixth-year projections is 19.8 percent. That spread suggests that there is a two-thirds chance that actual revenue collections in the sixth year would be no more than 10 percent greater than or less than the amount in the agency's sixth-year projection if current laws generally remained unchanged. The errors in the Administration's sixth-year projections were slightly less dispersed than CBO's; they have a two-thirds spread of 18.6 percent.

Projections Since the 2007–2009 Recession

The period from the 2007–2009 recession through 2019 was marked by continuous but modest economic

growth. And after falling in 2008 and 2009, revenue collections—particularly individual income taxes, payroll taxes, and corporate taxes (the three major sources of revenues)—rose steadily through 2019. Because there had not been a downturn in the business cycle between the 2007–2009 recession and 2019, CBO's budget-year revenue projections for the years since 2010 have been more centered and their errors less dispersed than those of earlier years. (For an analysis of the possible effects of the 2020 coronavirus pandemic on revenues and CBO's projections, see Box 2.)

Whereas the average error for the budget-year projections for 1983 to 2010 is 1.4 percent, the average drops to 1.2 percent when projections for budget years after 2010 are included.¹⁶ The accuracy of the projections has improved since 2009, and the errors in the projections for 2011 to 2019 were less variable than were those in the projections for the entire 1983–2019 period as a

16. The errors of the budget-year projections made in 2018 include the effects of the 2017 tax act on revenue collections (even though the projections were adjusted after the legislation was enacted to account for its effects). The law continues to affect projected revenues throughout the projection period.

whole: The average absolute error for the projections for 2011 to 2019 is 2.1 percent, and the RMSE is 2.7 percent—significantly lower than the average absolute error of 4.9 percent and RMSE of 7.0 percent calculated for all 37 of CBO's budget-year projections that were analyzed.

The average error for CBO's sixth-year projections for 1987 to 2014 is 5.3 percent, slightly smaller than the full sample's average error of 5.6 percent. Unlike the budget-year projections, the sixth-year revenue projections do not improve soon after economic downturns, in part because many of the those projections were made in the years before the corresponding recession began and thus reflected the historical trends that were used to make projections until it became clear that a downturn had occurred. Nevertheless, the accuracy of the sixth-year projections has improved since the 2007–2009 recession, and the errors in the projections for 2015 to 2019 were less dispersed.

Serial Correlation in CBO's Projection Errors

CBO's projection errors show some degree of serial correlation—that is, projections tend to err in the same direction in consecutive years. For example, one overestimate of budget-year revenues is likely to be followed by another overestimate of budget-year revenues the next year. That tendency suggests that as new information becomes available, CBO may not be incorporating all of it into the agency's projections (in part because of the difficulty of determining whether a deviation from the historical pattern marks a persistent change in the trend or is only a temporary deviation). Projections produced shortly before and during economic downturns tended to overestimate revenues in the short term and were repeatedly revised downward, whereas projections made during periods of economic booms produced underestimates that were repeatedly revised upward. To some degree, those projection errors were related to the business cycle, but even after a shift from expansion to recession became apparent, it still took time for CBO to incorporate that information and the related effects on revenues into its projections.

Although that pattern could be evidence that CBO is not optimally incorporating new information into its projections (particularly those for the budget-year), serial correlation can result from many factors. The errors in projections for a year that is multiple years in the future will naturally exhibit some degree of serial correlation. Because projections of revenues are based on current

information, the error in a projection for a year that is several years in the future will compound the random error (the error stemming from what is unknown about the future) in the projections for each of the years before it that were prepared at the same time. For example, the error in a projection for the third year of the projection period will include, to some degree, the random error in the current-year and budget-year projections as well as the random error in the third-year projection itself. Thus, all else equal, the sixth-year projections have larger errors than the budget-year projections.

Constraints on CBO's ability to acquire and incorporate new information in its projections also contribute to the serial correlation of its projection errors. Detailed data from tax returns, for example, are typically not available to CBO until at least two and a half years after the first related tax payments are made to the Treasury. Such lags in the availability of information make it difficult for CBO and other forecasters to recognize structural breaks in trends in a timely manner.¹⁷

CBO's analysis of the serial correlation of its projection errors suggests that, as expected, the budget-year projections of revenues better incorporate the latest information than do the sixth-year projections.¹⁸ In the past, analysts from outside CBO have found similar results concerning the serial correlation in the agency's projections. One such study of the projections that CBO made between 1985 and 1999 found that *revisions* to those

17. See Barbara Rossi and Tatevik Sekhposyan, "Forecast Rationality Tests in the Presence of Instabilities, With Applications to Federal Reserve and Survey Forecasts," *Journal of Applied Econometrics*, vol. 31, no. 3 (April/May 2016), 507–532, <https://doi.org/10.1002/jae.2440>; and Olivier Coibion and Yuriy Gorodnichenko, "What Can Survey Forecasts Tell Us About Information Rigidities?" *Journal of Political Economy*, vol. 120, no. 1 (February 2012), 116–159, <https://doi.org/10.1086/665662>.

18. To test for serial correlation between its projection errors, CBO calculated the Durbin-Watson statistic for its budget-year and sixth-year projections. Durbin-Watson values range from zero to 4—zero indicates positive serial correlation, 4 indicates negative serial correlation, and 2 indicates no serial correlation. For CBO's budget-year revenue projections, the Durbin-Watson value is 1.16, indicating that the errors have a positive serial correlation—an overestimate of revenues in one budget-year projection is likely to be followed by an overestimate in the next budget-year projection published one year later. The Durbin-Watson value for the sixth-year revenue projections is 0.29, which indicates that the positive serial correlation of the errors in the agency's sixth-year projections is even greater than that of the errors in its budget-year projections.

projections were serially correlated and thus concluded that the agency was not optimally incorporating new information into its projections.¹⁹ Other studies have come to similar conclusions about CBO's projections.²⁰

Although it is evident that CBO's projection errors exhibit some serial correlation, that correlation has varied over the past 30 years. Adjusting for the average correlation over the entire period would therefore have improved the accuracy of some projections and worsened it for others. Overall, the accuracy of CBO's projections, as measured by the RMSE, would not have been systematically improved had the agency adjusted its projections on the basis of the past pattern of revisions; in fact, that method would have overcompensated for the correlation and caused the projections to err in the opposite direction in many cases.

Differences Between This Analysis and CBO's 2015 Report on Its Revenue Forecasting Record

This report incorporates five more years of revenue projections than the 2015 report, extending the analysis to include the agency's projections for 2019.²¹ Since the publication of the previous report, the average error for CBO's budget-year projections has increased slightly, but the average absolute error and RMSE have declined. Together, those three measures suggest that the agency has continued to systematically overestimate revenues but that its projection errors have been less dispersed in recent years than they were in the past. For the

19. See Alan J. Auerbach, "On the Performance and Use of Government Revenue Forecasts," *National Tax Journal*, vol. 52, no. 4 (December 1999), pp. 767–782, www.jstor.org/stable/41789430.

20. Several studies that examined how well CBO incorporates relevant information in its economic forecasts—a characteristic referred to as forecast efficiency—found that the agency has been relatively efficient. See, for example, Robert Krol, "Forecast Bias of Government Agencies," *Cato Journal*, vol. 34, no. 1 (Winter 2014), pp. 99–112, <https://tinyurl.com/y7cmapw3> (PDF, 88 KB); Stephen M. Miller, "Forecasting Federal Budget Deficits: How Reliable Are US Congressional Budget Office Projections?" *Applied Economics*, vol. 23, no. 12 (December 1991), pp. 1789–1799, <http://doi.org/10.1080/00036849100000168>; and Michael T. Belongia, "Are Economic Forecasts by Government Agencies Biased? Accurate?" *Review*, vol. 70, no. 6 (Federal Reserve Bank of St. Louis, November/December 1988), pp. 15–23, <http://tinyurl.com/yhze7ah>. Although statistical tests can identify sources of inefficiency in a forecast after the fact, they generally do not indicate how such information could be used to improve forecasts when they are being made.

21. See Congressional Budget Office, *CBO's Revenue Forecasting Record* (November 2015), www.cbo.gov/publication/50831.

sixth-year projections, the three error measures followed a similar pattern.

The single largest change in tax policy since 2015 was the 2017 tax act (Public Law 115-97), which made significant changes to the tax code.²² (For a discussion of previous changes in tax law and how they affected CBO's projection errors, see Box 3.) CBO's budget-year projection for 2018 (made in 2017) had an error of 3.3 percent, and its sixth-year projection for that year (made in 2013) had an error of 11.9 percent. Those projections were adjusted to account for the estimated effects of the 2017 tax act before the errors were calculated. The error in the budget-year projection for 2018 is less than the average absolute error for the budget-year projections (4.9 percent), but the error in the sixth-year projection is greater than the average absolute error for the agency's sixth-year projections (9.9 percent).

Some Sources of Projection Errors

CBO's forecast of the economy—particularly the agency's projections of GDP—is a primary input into the agency's revenue projections, so errors in that forecast can translate into errors in the revenue projections. The errors in the economic forecast stem mostly from the difficulty of anticipating turning points in the business cycle and of recognizing changes in fundamental economic relationships or long-term trends.

Errors in other components of the agency's economic forecast—including changes in the composition of national income, the relationship between national income and the associated tax bases, the relative growth rates of asset prices and GDP, the distribution of income among taxpayers, and the effects of recent changes in policies—can also contribute to errors in CBO's projections of revenues as a percentage of GDP, as can other unanticipated developments that are not related to the economy.

Errors Related to Projections of GDP

CBO's revenue projections largely hinge on the projections of the overall state of the economy, typically measured by GDP and national income, and those economic forecasts, in turn, rely on forecasts of wages and salaries, corporate profits, and noncorporate business income. Historically, revenue projections made around business

22. For additional discussion of the tax provisions included in the 2017 tax act, see Congressional Budget Office, *The Budget and Economic Outlook: 2018 to 2028* (April 2018), pp. 108–110, www.cbo.gov/publication/53651.

Box 3.

Errors in Revenue Projections Made Near the Enactment of Major Tax Legislation

The enactment of major tax legislation, which has often coincided with a downturn in the economy, can confound the analysis of projection errors. The size of the effects that changes in tax law have on revenues collected appears to be related to the state of the economy; therefore, although the Congressional Budget Office made adjustments to its projections to account for the effects of legislation enacted after a projection was made—adjustments that are themselves subject to error—errors have tended to be larger in projections prepared just before the enactment of major tax legislation. Some of the magnitude of those errors is attributable to the unanticipated economic downturns, and some may be attributable to errors in estimates of the effects of the legislation.

The relationship between the enactment of tax legislation, downturns in the economy, and the size of the error in CBO's projections is illustrated by the figure. Before 2000, the adjustments made to budget-year projections to account for the effects of legislation enacted after a projection was prepared were relatively small, measured as a percentage of the projection, and they tended to be positive. That trend began with the budget-year projection for 1983, published before the Tax Equity and Fiscal Responsibility Act of 1982 was enacted. In that projection, CBO overestimated revenues by 12 percent. The adjustment that the agency made to the projection to account for the effects of that law increased the projected amount by 3 percent—which contributed to the overestimate of revenues. The adjustments to account for the effects of the Tax Reform Act of 1986 and the Omnibus Budget Reconciliation

Act of 1993 amounted to roughly 2 percent of the budget-year projections for 1987 and for 1994. The resulting errors in the projections for those years were relatively small, 1.1 percent and -1.4 percent, respectively. The effects of the Omnibus Budget Reconciliation Act stemmed mainly from provisions that increased the individual income tax rates (including the rates and exemption amounts of the alternative minimum tax) and increased the corporate tax rate to 35 percent.

Since 2000, adjustments made to budget-year projections to account for legislation enacted after the projections were prepared have been negative—that is, they lowered CBO's projected revenues—and larger than the earlier adjustments. Tax legislation enacted between 2000 and 2009—the Economic Growth and Tax Relief Reconciliation Act of 2001, the Jobs and Growth Tax Relief Reconciliation Act of 2003, and the tax provisions of the American Recovery and Reinvestment Act of 2009—coincided with business cycle downturns. Adjustments made to account for those changes in law reduced baseline budget-year projections by between 4 percent and 7 percent and thus partly accounted for the diminished revenues during downturns. The Congress extended many of the provisions of those three laws in 2010 and shortly thereafter enacted the Temporary Payroll Tax Cut Continuation Act of 2011. To account for the effects of those two changes in law, CBO adjusted its budget-year projection for 2011 downward by more than 15 percent, resulting in an estimate that was within 2 percent of the actual outcome.

Continued

cycle peaks have had the largest errors. For example, in the budget-year projections that CBO released in early 1982, 1990, 2001, and 2008—near the beginning of recessions—the agency significantly overestimated the amount of revenues that would be collected in 1983, 1991, 2002, and 2009. (In each of those cases, the lag between economic activity and the payment of taxes caused the largest discrepancies between projected and actual revenues to occur after the recession began.) Those four projections overestimated revenues by between 9 percent and 25 percent. The RMSE of those four projections is 16.8 percent, whereas the RMSE of all of CBO's other budget-year projections is 4.6 percent (see

Figure 4). The errors in the Administration's projections have exhibited a similar pattern.

As it does with its revenue projections, CBO regularly assesses its past economic forecasts.²³ From those assessments, the agency has gleaned the following key insights about the errors in its economic forecasts:

- Forecast errors tend to be large around business cycle peaks, just before a recession begins. In some cases, the error occurred because the recession was

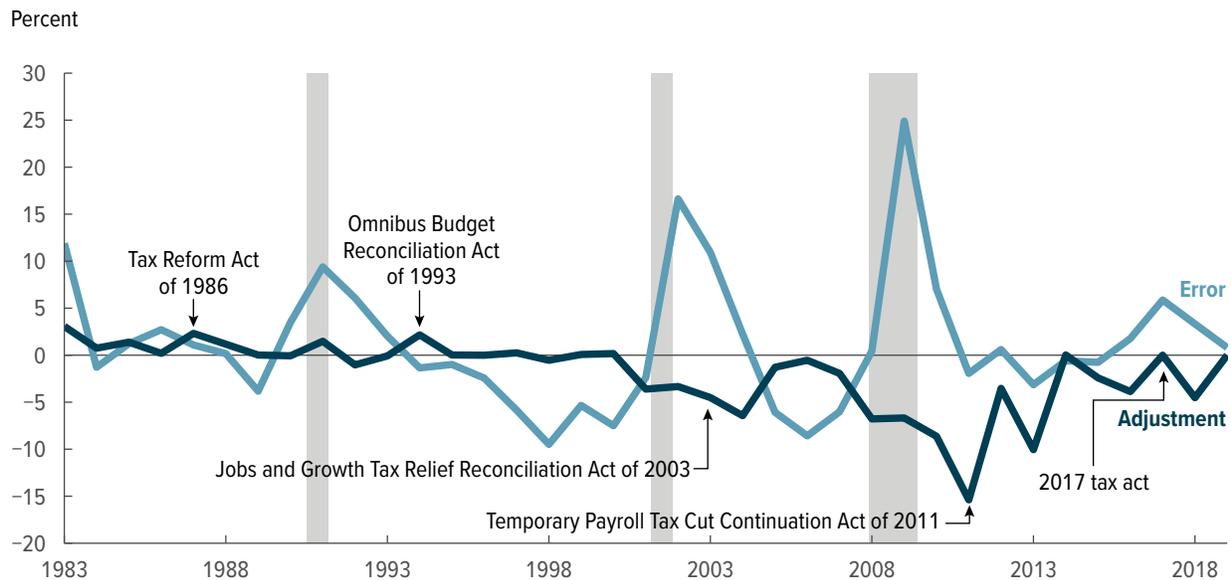
23. For the latest such assessment, see Congressional Budget Office, *CBO's Economic Forecasting Record: 2019 Update* (October 2019), www.cbo.gov/publication/55505.

Box 3.

Continued

Errors in Revenue Projections Made Near the Enactment of Major Tax Legislation

Adjustments Made to CBO's Budget-Year Projections to Account for the Effects of Major Tax Legislation



Source: Congressional Budget Office.

The years shown are those for which each projection was made; CBO's budget-year projections are typically published in January or February of the previous year. For example, the 0.8 percent error shown for CBO's projection for 2019 indicates that the projection of revenues for fiscal year 2019 that was published in February 2018 overestimated actual revenues by that amount.

Projection errors are calculated as the projected amount minus the actual amount, divided by the actual amount; thus, the error is expressed as a percentage of the actual amount. A negative error is an underestimate, and a positive error, an overestimate.

The adjustment to account for legislation enacted after each projection was prepared is expressed as a percentage of the projected amount.

prompted by shocks that were unforeseeable when the forecast was made; in others, widely different forecasts appeared equally probable because the recession occurred during a period of especially great economic uncertainty.

- Trends in productivity, one key variable underlying CBO's forecasts of potential and real GDP, can change in unexpected ways. Two important determinants of productivity growth, in particular—shifts in capital accumulation and the effects of specific policies on incentives to invest—can be difficult to identify until several years after they occur.

Errors Related to Other Factors

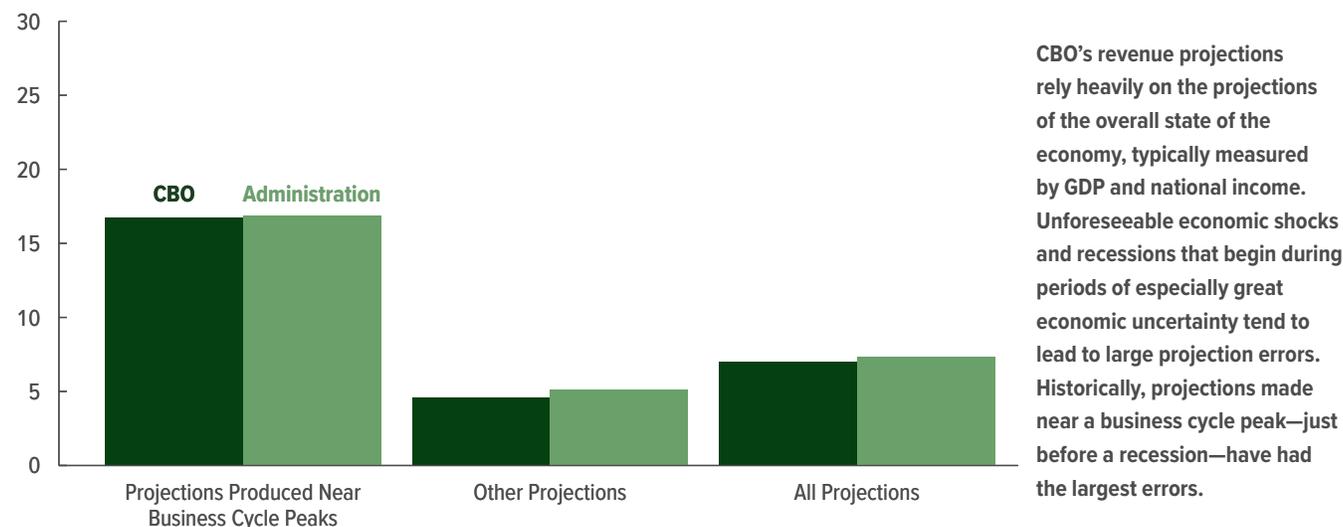
Errors in projections of revenues as a percentage of GDP can also be related to the difficulty of projecting the components of national income for a given level of GDP. National income comprises income from various sources that are taxed at different effective rates. Those sources of income can vary in terms of how fast they grow, how volatile they are, and to whom they accrue—all of which can affect revenues.

Further, growth rates of those income sources calculated on the basis of amounts reported on tax returns may differ from those calculated on the basis of income in the national income and product accounts compiled by the Bureau of Economic Analysis (BEA). Wages and salaries,

Figure 4.

Root Mean Square Errors of CBO's and the Administration's Budget-Year Revenue Projections Produced Near Business Cycle Peaks Compared With Those of Projections Produced at Other Times

Percent



Sources: Congressional Budget Office and Office of Management and Budget.

The four budget-year projections produced near business cycle peaks were those published near the beginning of calendar years 1982, 1990, 2001, and 2008 for fiscal years 1983, 1991, 2002, and 2009. The projection published in February 1982, which significantly overestimated revenues for 1983, is included, although the previous business cycle peak occurred in July 1981.

The projection errors underlying each root mean square error (RMSE) are calculated as the projected amount minus the actual amount, divided by the actual amount. The RMSE is calculated by squaring the projection errors, averaging those squares, and taking the square root of that average.

The revenue projections included in this analysis are those for fiscal years 1983 to 2019, which were generally published in January or February of the previous year.

for example, may differ because BEA includes wages of workers who do not file tax returns or who misreport their wages. Similarly, taxable profits reported on corporate tax returns may differ from the profits recorded in the national income accounts because BEA calculates aggregate profits by subtracting the losses of unprofitable businesses from the profits of profitable ones, but unprofitable businesses do not typically pay corporate income taxes. When estimating the growth rates of income sources, CBO uses data on historical patterns to partially account for those differences, but any deviations from the historical patterns introduce error into the projections.

The difficulty of projecting the distribution of household income—and especially of specific income sources—contributes to the errors in the revenue projections. If, for example, the amount of wages and salaries that accrues

to high-income taxpayers (who face the highest tax rates) is higher or lower than CBO projects, total revenues will differ from the agency's projections. In past recessions, certain volatile categories of taxable income—such as corporate profits and capital gains realizations—declined in relation to GDP, and the highest-earning taxpayers unexpectedly earned a smaller share of overall income, which pushed down effective tax rates.²⁴ Also, errors in projections of components of the tax base that correspond to income from previous years—taxable pension distributions and capital gains, for example—contribute to errors in projections of revenues as a percentage of GDP.

24. For more information about the uncertainty in projections of sources of household income, see Congressional Budget Office, *Projected Changes in the Distribution of Household Income, 2016 to 2021* (December 2019), p. 16, www.cbo.gov/publication/55941.

Finally, certain other developments unrelated to either new legislation or to the state of the economy can also contribute to projection errors. The Administration may take unanticipated actions in setting policy or issuing regulations. For example, the President has broad discretion in setting tariff policy, which affects the amount of customs duties that are collected. Finally, legal decisions in tax cases and the Internal Revenue Service's published rulings interpreting the tax code can affect the size of the tax base in ways that CBO did not anticipate by, for example, broadening a tax provision's scope.

Comparison of Errors Related to Projections of GDP With Those Related to Other Factors

To examine the relative importance of errors in projections of the state of the economy versus other factors in determining the size of errors in its revenue projections, CBO compared the error measures of its forecasts of GDP with those of its projections of revenues as a share of GDP. The agency concluded that the errors in the projections of revenues as a percentage of GDP are larger than the errors in the GDP projections for shorter horizons but that the errors in the two types of projections tend to converge over longer horizons (see Table 2). Specifically, the agency found the following:

- The RMSE of CBO's budget-year projections of revenues as a percentage of GDP is 5.2 percent, whereas the RMSE of forecasts of GDP is 2.4 percent.²⁵
- At the fourth-year projection horizon, the average error for the GDP forecasts and the average error for the projections of revenues as a percentage of GDP are nearly equal; the RMSEs of the two sets of projections begin to converge, but that of the projections of revenues as a percentage of GDP (6.6 percent) still exceeds that of the forecasts of GDP (4.5 percent).
- At the sixth-year projection horizon, the average error for the projections of revenues as a percentage of GDP equals the average error for the fourth-year projections, whereas the average error for the GDP forecasts continues to increase. The RMSE of CBO's

sixth-year projections of GDP (6.6 percent) exceeds that of the agency's sixth year projections of revenues as a percentage of GDP (6.2 percent).

Because the measure *revenues as a percentage of GDP* is itself a percentage, the projection errors associated with it can also be expressed in percentage points (that is, as the difference between the projected and actual percentages of GDP). CBO's sixth-year projections of revenues as a percentage of GDP (which averaged 18.6 percent of GDP over the years covered in this analysis) have an RMSE of 1.2 percentage points and an average absolute error of 1.0 percentage point.

Interactions Between Different Sources of Errors

Errors in CBO's forecasts of GDP have tended to move together with errors in its projections of revenues as a percentage of GDP (see Figure 5). At turning points in the business cycle, misestimates of revenues as a percentage of GDP have tended to be more cyclical than misestimates of GDP.

The relationship between misestimates of GDP and those of other revenue-determining factors appears strongest during business cycle downturns, but it is also evident during cyclical booms. During recessions, CBO has overestimated not only GDP but also key components of the tax base relative to GDP, such as capital gains realizations, pension distributions, and corporate profits. The overestimates of those components have often exceeded, in percentage terms, the overestimate of GDP. Misestimates of GDP and misestimates of revenues as a percentage of GDP have exhibited a similar relationship even when the economy was not experiencing a cyclical downturn. For example, in the late 1990s, an unexpected cyclical boom resulted in CBO's underestimating GDP and, to a greater extent, revenues as a percentage of GDP.

Errors in Projections of Different Sources of Federal Revenues

The amount of uncertainty about factors affecting revenues varies substantially by revenue source. Of CBO's budget-year revenue projections, those of corporate income taxes have the highest RMSE—27.6 percent—and those of payroll taxes, the lowest—3.3 percent (see Figure 6). The RMSE of the projections of corporate receipts is enlarged by a few sizable errors; the median

25. The RMSEs for GDP forecasts and for projections of revenues as a share of GDP do not sum to the corresponding RMSE for projections of total revenues because of interactions between the two and because of the squaring of the errors.

Table 2.

Error Measures for CBO's Projections of GDP, Revenues as a Percentage of GDP, and Total Revenues

Percent	Projection Year		
	Budget Year	Fourth Year	Sixth Year
GDP			
Average error	0.1	1.7	3.5
Average absolute error	1.7	3.4	5.4
RMSE	2.4	4.5	6.6
Revenues as a Percentage of GDP			
Average error	1.1	1.8	1.8
Average absolute error	3.7	5.4	5.0
RMSE	5.2	6.6	6.2
Total Revenues			
Average error	1.2	3.7	5.6
Average absolute error	4.9	8.5	9.9
RMSE	7.0	10.4	11.6
Addendum			
Revenues as a Percentage of GDP (Percentage points)			
Average error	0.2	0.3	0.3
Average absolute error	0.8	1.1	1.0
RMSE	1.2	1.3	1.2

Source: Congressional Budget Office.

The projection errors underlying these summary measures are calculated as the projected amount minus the actual amount, divided by the actual amount; thus, the error is expressed as a percentage of the actual amount. A positive average error is an overestimate.

The average absolute error is the average of projection errors with the negative signs removed from the underestimates. The RMSE is calculated by squaring the projection errors, averaging those squares, and taking the square root of that average.

CBO typically publishes its annual baseline projections in January or February. The budget year is the fiscal year beginning eight to nine months after the projection is made; the fourth year is the fiscal year beginning two years and eight to nine months after the projection was made, and the sixth year is the fiscal year beginning four years and eight to nine months after the projection is made.

The errors for projections of GDP and for projections of revenues as a percentage of GDP do not add to up to the errors for projections of total revenues because of interactions between the two.

RMSE = root mean square error.

absolute error is much smaller—11.4 percent—and the average absolute error is 17.5 percent.²⁶

CBO's projections of individual income tax receipts, the largest source of federal revenues, have an RMSE of 9.6 percent. The projections of customs duties and of excise taxes have RMSEs of 11.0 percent and 8.6 percent, respectively. And the projections of miscellaneous receipts (fees and fines and Federal Reserve earnings) and

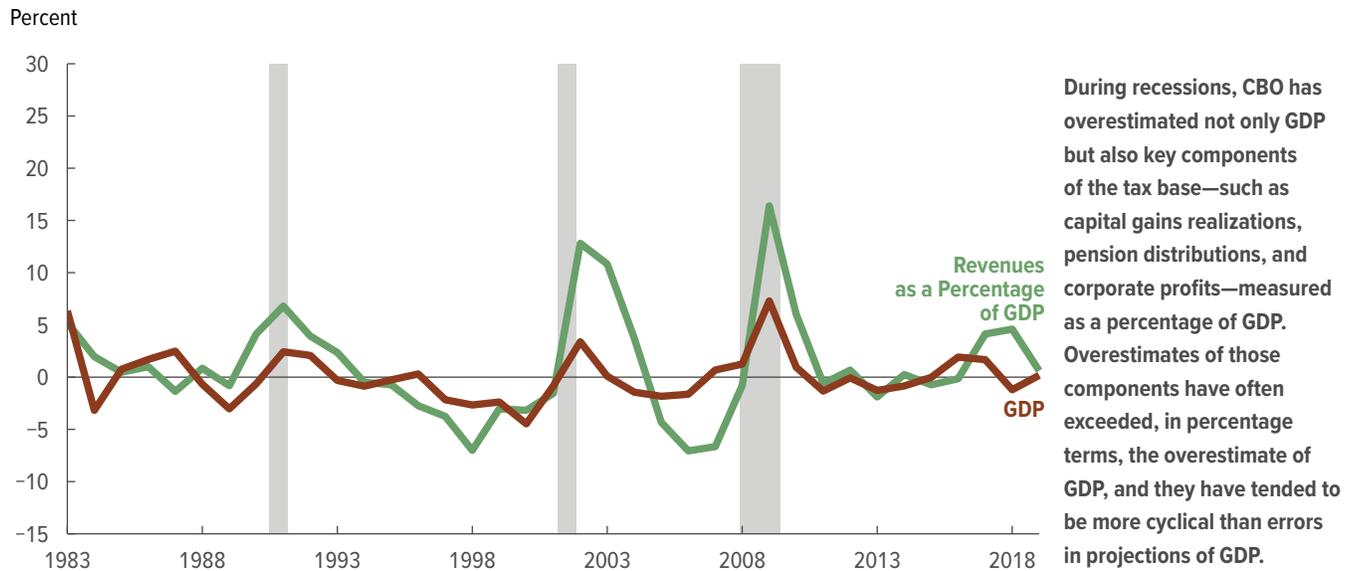
of estate and gift taxes have RMSEs of 15.1 percent and 17.0 percent, respectively.

The difference in outcomes by revenue source is largely explained by characteristics of the tax bases for the different revenue sources. The tax bases vary in terms of stability and predictability. The primary tax base for payroll taxes is wages and salaries, and it tends to change at more stable rates over time than most other tax bases, making it generally more predictable. Corporate profits, on the other hand, fluctuate significantly over the business cycle and are notoriously difficult to project accurately. It is therefore not surprising that projections of payroll taxes

26. The median absolute error is the error that, on the basis of magnitude, falls in the middle of all of the errors (when the direction of the errors is ignored). Half of the errors are larger than the median error, and half are smaller.

Figure 5.

Errors in CBO's Budget-Year Projections of GDP and Revenues as a Percentage of GDP



Source: Congressional Budget Office.

The years shown are those for which each projection was made; CBO's budget-year projections are typically published in January or February of the previous year.

Projection errors are calculated as the projected amount minus the actual amount, divided by the actual amount; thus, the error is expressed as a percentage of the actual amount. A negative error is an underestimate, and a positive error, an overestimate.

GDP = gross domestic product.

have been the most accurate and projections of corporate income taxes the least accurate. Individual income taxes—the largest single source of revenues (accounting for 45.9 percent of total revenue collections, on average, over the 1983–2019 period)—are based primarily on wages and salaries, but they also include taxes on other sources of income, such as proprietor's business income and capital gains realizations, which can vary significantly from year to year because of price changes and other market forces.

The projections of the smaller sources of revenues—excise taxes, estate and gift taxes, customs duties, fees, and other miscellaneous sources, all of which combined have averaged less than the amount of receipts from corporate income taxes—depend on factors related to specific areas of the economy that can vary significantly and change unexpectedly. For example, estate and gift taxes are assessed on the wealth of large estates, which can fluctuate widely with asset prices. Revenues from

miscellaneous fees and fines can vary substantially for industry-specific reasons.

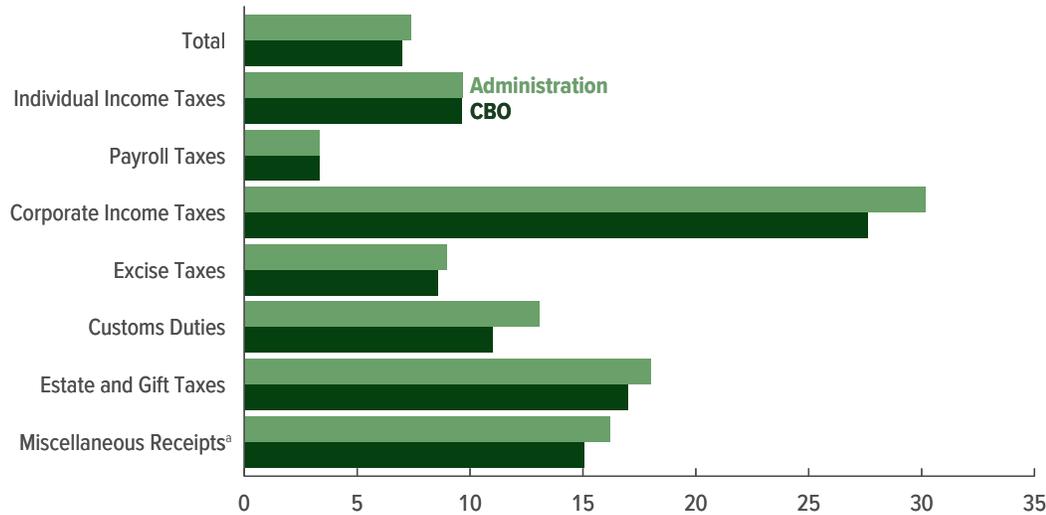
The relative contribution of each source to the total projection error depends on the size of the source's share of total revenues and the size of the projection error associated with the source. The projections for specific tax sources that contribute the most to the errors in projections of total revenues are not necessarily those with the largest errors. A relatively small error in a projection of a source that accounts for a large share of federal revenues can result in a large error in the projection of total revenues, just as a large error in a projection of a source that accounts for a small share of revenues can result in a small error in the projection of total revenues.

CBO calculated the error in the projections of each revenue source relative to the error in projections of total revenues to determine which source-specific projections have contributed the most to the errors in the projections for total revenues. By that metric, projections of revenues

Figure 6.

Root Mean Square Errors of CBO's and the Administration's Budget-Year Revenue Projections, by Revenue Source

Percent



The differences in the accuracy of the projections of different revenue sources are largely explained by characteristics of the tax bases of each of the sources. Some tax bases (such as corporate profits) can fluctuate a great deal over the business cycle, whereas other tax bases (such as wages and salaries, which make up the base of the payroll tax) are more stable.

Sources: Congressional Budget Office and Office of Management and Budget.

In this figure, the root mean square error (RMSE) of projections of revenues from a single tax source relative to total revenues is shown; that measure allows the errors in projections of each source to be compared with one another. The projection errors underlying the RMSE relative to total revenues are calculated as the projected amount of revenues from the specific source minus the actual amount, divided by actual total revenues from all sources. The RMSE is calculated by squaring the projection errors, averaging those squares, and taking the square root of that average.

The revenue projections included in this analysis are those for fiscal years 1983 to 2019, which were generally published in January or February of the previous year.

a. Includes remittances from the Federal Reserve System and various fees and fines.

from the largest source, individual income taxes, which have an RMSE relative to total revenues of 4.4 percent, have contributed the most to the errors in CBO's budget-year projections of total revenues (see Table 3). The projections of revenues from the third largest source, corporate income taxes, have an RMSE relative to total revenues (2.3 percent) that is larger than that of the second-largest source, payroll tax receipts (1.3 percent)—even though corporate income tax receipts have averaged

less than one-third of the amount of payroll tax receipts over the past few decades. The relatively large variability of corporate income taxes over the business cycle magnifies their importance in determining total accuracy. The projections of smaller revenue sources have contributed much smaller amounts to projection errors for total revenues; the RMSE relative to total revenues of projections of each of those sources—excise taxes and customs duties, for example—is 0.5 percent or less.

Table 3.

Root Mean Square Errors of CBO's Budget-Year Projections, by Revenue Source

Percent

	RMSE	Average Share of Total Revenues	RMSE Relative to Total Revenues
Individual Income Taxes	9.6	45.9	4.4
Payroll Taxes	3.3	35.9	1.3
Corporate Income Taxes	27.6	9.7	2.3
Excise Taxes	8.6	3.6	0.4
Customs Duties	11.0	1.3	0.2
Estate and Gift Taxes	17.0	1.0	0.2
Miscellaneous Receipts ^a	15.1	2.6	0.5
Total Revenues	7.0	100	n.a.

Source: Congressional Budget Office.

The projection errors underlying the RMSE of projections of revenues from each source are calculated as the projected amount of revenues from the specific source minus the actual amount, divided by the actual revenues from that source. The projection errors underlying the RMSE relative to total revenues are calculated as the projected amount of revenues from the specific source minus the actual amount, divided by actual total revenues from all sources; that measure allows the errors in projections of each source to be compared with one another.

The RMSE is calculated by squaring the projection errors, averaging those squares, and taking the square root of that average.

The RMSE of projections of revenues from a single tax source relative to total revenues can be approximated by multiplying together the RMSE of projections of revenues from that source and that source's average share of total revenues over the period. However, the more that a revenue source's share of total revenues varies over the period, the less precise that approximation becomes. The amount shown for the RMSE relative to total revenues is the precise calculation.

The revenue projections included in this analysis are those for fiscal years 1983 to 2019, which were generally published in January or February of the previous year.

RMSE = root mean square error.

a. Includes remittances from the Federal Reserve System and various fees and fines.



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About This Document

Each winter, the Congressional Budget Office issues a report on the state of the budget and the economy. This document provides background information on the centeredness, accuracy, and dispersion of the revenue projections included in those reports. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

James Williamson prepared the report with guidance from John McClelland, Joseph Rosenberg, and Joshua Shakin. Aaron Feinstein and Edward Gamber provided comments. Natsuki Arai from the National Chengchi University (Taiwan) and Byron Lutz from the Board of Governors of the Federal Reserve System also provided feedback. (The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.) Tess Prendergast fact-checked the report.

Jeffrey Kling and Robert Sunshine reviewed the report. The editor was Bo Peery, and the graphics editor was Robert Rebach. This report is available on CBO's website (www.cbo.gov/publication/56499).

CBO continually seeks feedback to make its work as useful as possible. Please send any comments to communications@cbo.gov.

A handwritten signature in black ink, appearing to read "Phillip L. Swagel".

Phillip L. Swagel
Director
August 2020