CBO
REPORT

Uncertainties in Projecting Budget Surpluses: A Discussion of Data and Methods

A Supplement to
The Budget and Economic Outlook:
Fiscal Years 2003-2012

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CONGRESSIONAL BUDGET OFFICE
SECOND AND D STREETS, SW
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Uncertainties in Projecting Budget Surpluses:
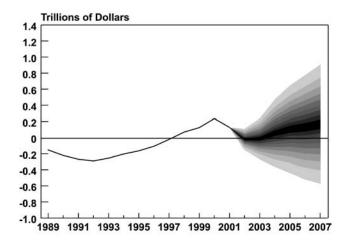# A Discussion of Data and Methods

On January 31, 2002, the Congressional Budget Office (CBO) released *The Budget and Economic Outlook: Fiscal Years 2003-2012*, which presents CBO's latest projections of federal revenues and outlays for that period. Chapter 5 of that report discusses the uncertainties in CBO's baseline projection of the total budget surplus and includes a chart (reproduced here as Figure 1) illustrating how those uncertainties increase over six years. This supplementary report describes the data and methods used to construct the chart. In brief, CBO calculated measures of uncertainty using the inaccuracies in its past projections that arose from economic and technical factors, not from legislation.

Figure 1 presents CBO's baseline projection of the budget surplus as a fan of probabilities around the mean projection for fiscal years 2002 through 2007. The fan widens as the projection extends. The baseline projection falls in the middle of the highest-probability area—the darkest part of the figure. But the figure makes clear that nearby projections—other paths in the darkest part of the figure—have nearly the same probability as the baseline. Moreover, projections that are quite different from the baseline have a significant probability of being realized.[1]

The shaded area in the figure represents the 90 percent confidence range (the range within which the actual value has a 90 percent chance of falling).

Figure 1.
Uncertainty in CBO's Projection of the Total Budget Surplus Under Current Policies

SOURCE: Congressional Budget Office.

NOTES: This figure shows the estimated likelihood of alternative projections of the surplus under current policies. The calculations are based on CBO's past track record. CBO's baseline projection falls in the middle of the darkest area. Under the assumption that current policies do not change, the probability is 10 percent that actual surpluses will fall in the darkest area and 90 percent that they will fall within the whole shaded area.

Actual surpluses will of course be affected by legislation enacted during the next five years, including decisions about discretionary spending. The effects of future legislation are not included in this figure.

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1. Technically, the probability density is highest near the baseline and falls off for more distant projections.

CBO estimates that range on the basis of the uncertainty in its historical record of budget projections—a total of 20 baselines spanning the period from 1981 to 2001.[2] In other words, the estimates of uncertainty presume that in the future, CBO will experience inaccuracies similar to those it experienced in the past, with about the same probability distribution of large and small inaccuracies.
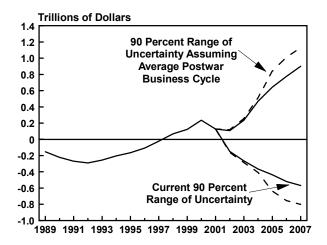
The 1981-2001 sample period, however, was not typical for the post-World War II period as a whole. It contains only two recessions (those of 1981-1982 and 1990-1991), and the first recession is not well represented in the sample because only one of the baseline projections preceded it. Since World War II, by contrast, a total of nine recessions have occurred. When CBO takes into account the greater volatility of output in that entire period, the width of the fan chart increases by roughly one-third by the fifth year (see Figure 2).

CBO introduced its fan-chart presentation of uncertainty last year in *The Budget and Economic Outlook: Fiscal Years 2002-2011*. This year's version of the chart reflects an improvement in the analysis of uncertainty: additional research that allows inaccuracies correlated with the business cycle to be distinguished from those not correlated with the business cycle.

That distinction is a useful one, because inaccuracies in the assessment of noncyclical changes are likely to grow as the projection horizon lengthens, whereas inaccuracies correlated with the business cycle would not be expected to increase in the same way. According to CBO's estimates, cyclical inaccu-

Figure 2.
Uncertainty in CBO's Projection of the Total Budget Surplus, Assuming Average Business-Cycle Activity Since 1947

SOURCE: Congressional Budget Office.

NOTE: The narrower confidence range (the outer boundary of the fan chart in Figure 1) is based on CBO's record of budget projections since 1981. The wider range represents the uncertainty in CBO's current projection if future cyclical movements of the economy follow the average pattern since 1947 rather than the less volatile pattern that has existed since 1981. The assumption is that cyclical inaccuracies will be proportionally larger if business-cycle activity is greater but that noncyclical inaccuracies will be unaffected.

racies historically have in fact been small for the first two years of a baseline, when CBO attempts to incorporate its views of the business cycle in the forecast. Those inaccuracies rise to a higher level for the later years of a projection—when CBO does not try to forecast the business cycle—but they flatten out (see Figure 3). Noncyclical inaccuracies, by contrast, increase throughout the projection period.[3]

That breakdown suggests that by the end of five years, CBO's inaccuracies in projecting the budget's bottom line have consisted, in roughly equal parts, of cyclical inaccuracies and inaccuracies in assessing

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2.   The projections are those made in July 1981 and CBO's winter projections (usually published in January) from 1983 through 2001. Insufficient data were available to use either projections made before 1981 or the projection made in early 1982. In the cases of the two years surrounding the 1981 projection, available data about the effects of legislation on changes in CBO's baseline budget projections were insufficient, and discretionary spending was not reported separately. As discussed in the following section, those data are important because the measures of inaccuracy used in this analysis were constructed by removing the effects of legislation, including discretionary spending (along with interest payments). The baseline budget projections that CBO made before 1980 were not comparable with later ones, because the early economic assumptions represented targets rather than projections.

3.   CBO did not begin making 10-year projections until 1996. Before that, its baseline typically extended for five years beyond the current year. Because there are not yet any uncertainty measures for the sixth through the tenth year, this analysis focuses on a five-year projection horizon.
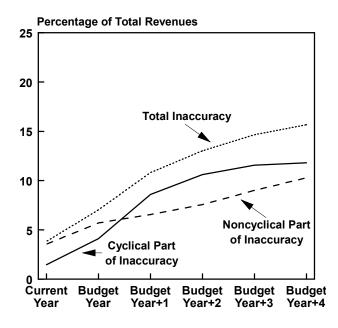
economic and other noncyclical trends that underlie the budget.

The analysis also suggests that if CBO had been confronted over the past two decades with a less stable economy—one more representative of the cyclical experience of the entire post-World War II period—the cyclical component would have been roughly twice as large as the noncyclical component by the end of five years (see Figure 4).

Whether the next decade will more closely resemble the past 20 years or the entire postwar period

Figure 3.
Cyclical and Noncyclical Parts of CBO's Inaccuracies in Projecting the Primary Surplus

SOURCE: Congressional Budget Office.

NOTES: The lines in this figure show root-mean-square errors (RMSEs), a type of average that ignores the signs of individual errors and gives greater weight to larger errors. The RMSE of total inaccuracy is calculated by squaring the RMSEs of the cyclical and noncyclical parts, adding them together, and taking the square root of the sum. Thus, the combined RMSE is smaller than the sum of the two components' RMSEs.

The primary budget surplus is the difference between federal revenues and federal outlays excluding net interest.

Figure 4.
Cyclical and Noncyclical Parts of CBO's Inaccuracies in Projecting the Primary Surplus, Assuming Average Business-Cycle Activity Since 1947
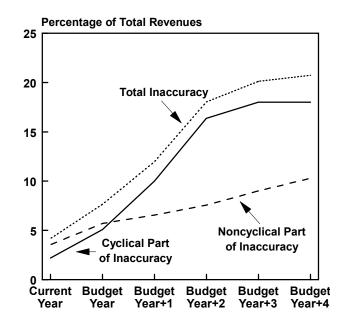
SOURCE: Congressional Budget Office.

NOTES: The lines in this figure show root-mean-square errors (RMSEs), a type of average that ignores the signs of individual errors and gives greater weight to larger errors. The RMSE of total inaccuracy is calculated by squaring the RMSEs of the cyclical and noncyclical parts, adding them together, and taking the square root of the sum. Thus, the combined RMSE is smaller than the sum of the two components' RMSEs.

This figure represents the inaccuracies in CBO's projections assuming that future cyclical movements of the economy follow the average pattern since 1947 rather than the less volatile pattern that has existed since 1981. The assumption is that cyclical inaccuracies will be proportionally larger if business-cycle activity is greater but that noncyclical inaccuracies will be unaffected.

The primary budget surplus is the difference between federal revenues and federal outlays excluding net interest.

cannot be determined in advance. However, recent research suggests that a structural change in the economy occurred in the early 1980s, which may explain why cyclical movements have been fewer and milder in the past two decades and may presage a relatively stable economy in the future. Analysts differ on the

precise nature of the structural change.[4] But if it persists, Figure 1 may portray the uncertainties in CBO's projection of the surplus better than the wider range in Figure 2 does.

Preparing the fan chart involved two stages. In the first stage, CBO constructed measures of its past projection inaccuracies that remove the effects of changes in legislation and other factors. In the second stage, CBO constructed probability distributions at six time horizons, beginning with the current fiscal year (the one in which the projection was made) and covering the next five years. The probability distributions were derived from a model that distinguishes between inaccuracies that appear to stem from the difficulty of forecasting the business cycle and inaccuracies that are not correlated with the business cycle and appear to stem from other causes.

Stage One: Constructing the Measures of Inaccuracies

Creating measures of inaccuracies in CBO's past budget projections involved adjusting those projections for several factors: legislation (including laws that affect discretionary spending) and net interest on the federal debt.

CBO subtracted from its projections of revenues and outlays the estimated effects of laws dealing with revenues or mandatory spending that were enacted after the projections were made. That adjustment was necessary because CBO's baseline projections are intended to show the expected level of the budget surplus or deficit assuming that current tax and spending policies remain the same.[5] Without that adjustment, the measures of inaccuracies would include the effects of later legislation, which would run counter to the purpose of the baseline.

CBO also excluded discretionary spending from both the baseline projections and actual outlays. The effect of omitting discretionary spending is to treat all discrepancies between actual discretionary spending and baseline projections of such spending in the same way as differences resulting from other budget legislation.[6] CBO decided on that treatment for two reasons: because levels of discretionary spending are determined anew each year through appropriation acts and because that treatment would permit the use of a longer historical record.

Inaccuracies in projecting net interest largely depend on inaccuracies in projecting the government's publicly held debt. That debt, in turn, is the cumulation of annual budget deficits (minus surpluses), so inaccuracies in projecting net interest depend on the cumulation of other inaccuracies in projecting the deficit or surplus. CBO therefore excluded net interest from its initial calculations of projection inaccuracies. In the subsequent step, however, it incorporated into the fan-chart calculations the effects of other misestimates on net interest.

CBO calculated inaccuracies for each year covered by the winter baseline projections that it published from 1981 through 2001. In most years, those projections were issued in January or February, although in 1996, publication was delayed until May. For reasons involving the availability of data, CBO used its July 1981 projection in place of the one pub-

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4.   Although there seems to be general agreement in the recent economics literature that the growth of output has become more stable and that the expansion phases of business cycles are likely to be longer in the future than in the past, economists disagree about the causes of that increased stability. Those disagreements concern the importance of factors such as monetary policy, financial markets and institutions, inflation, supply shocks, and the behavior of inventory investment. For discussions of those and other points, see Margaret M. McConnell and Gabriel Perez-Quiros, "Output Fluctuations in the United States: What Has Changed Since the Early 1980's?" *American Economic Review,* vol. 90, no. 5 (December 2000), pp. 1464-1476; Olivier Blanchard and John Simon, "The Long and Large Decline in U.S. Output Volatility," *Brookings Papers on Economic Activity*, no. 1 (2001), pp. 135-174; and Marcelle Chauvet and Simon Potter, "Recent Changes in the U.S. Business Cycle," *The Manchester School*, vol. 69, no. 5 (special issue 2001), pp. 481-508.

5.   For more information about the purpose of CBO's baseline and the rules that govern its construction, see Congressional Budget Office, *The Budget and Economic Outlook: Fiscal Years 2003-2012* (January 2002), Chapter 1.

6.   In CBO's usual analyses of changes in its projections since the previous baseline, CBO allocates a small proportion of any changes in assumptions about discretionary outlays to the categories of economic or technical revisions (ibid., Box 5-1). In CBO's classifications, economic revisions are ones that stem from changes in the agency's economic forecast, and technical revisions are ones that cannot be attributed to new legislation or to changes in the components of the economic forecast.

Table 1.
How CBO's January 1994 Revenue Projection Was Adjusted for Subsequent Legislation
(In billions of dollars)

	Fiscal Years					
	1994	1995	1996	1997	1998	1999
Baseline Projection of Revenues	1,251	1,338	1,411	1,479	1,556	1,630
Subsequent Legislation						
January 1994 to August 1994	0	0	0	0	0	0
August 1994 to January 1995	0	1	-1	-1	-3	-3
January 1995 to August 1995		*	*	*	*	*
August 1995 to May 1996		0	*	*	*	*
May 1996 to August 1996			-1	-3	-2	-2
August 1996 to January 1997			*	1	*	*
January 1997 to September 1997				2	-10	-7
September 1997 to January 1998				*	*	*
January 1998 to August 1998					1	1
August 1998 to January 1999					0	*
January 1999 to July 1999						*
July 1999 to January 2000						0
Total	0	*	-2	-1	-14	-11
Adjusted Baseline Projection of Revenues	1,251	1,338	1,409	1,478	1,542	1,619

SOURCE: Congressional Budget Office.

NOTES: The only major changes in tax law enacted after CBO's January 1994 baseline projection were made in the Taxpayer Relief Act of 1997. Its effects were incorporated into CBO's September 1997 baseline projection. Two other adjustments are notable but relatively minor. The January 1995 baseline reflected various reductions in tariff rates, primarily those in the Generalized System of Preferences. The downward adjustment in the August 1996 baseline projection reflected two bills: the Health Insurance Portability Act of 1996 (H.R. 3103) and the Small Business Job Protection Act of 1996 (H.R. 3448).

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

lished in February 1982.[7] The resulting sample was small: only 20 current-year projections, declining to 15 five-year-ahead projections.[8] (The sample size diminishes because projections made in the past five years can be compared with actual outcomes only through 2001.)

The estimated effects of legislation dealing with revenues or mandatory spending were taken primarily from information published in CBO's twice-yearly reports on the budget and economic outlook. Most of those reports show the multiyear budgetary effects of legislation enacted since the previous projection. For cases in which estimates were not available (as will be discussed below), substitutes were constructed.

7.   Specifically, CBO did not have enough information in its files to include the estimated effects of legislation enacted between February 1982 and February 1983. Much better data were available for the slightly longer period of July 1981 through February 1983.

8.   The sample size could have been doubled by including the updated projections that CBO typically publishes in the summer, but those updates are closely related to the winter baselines and do not really offer additional information useful for calculating inaccuracies.

Revenues

As required by the Congressional Budget Act of 1974, the Joint Committee on Taxation (JCT) estimates the effects of tax legislation—bills that alter

Table 2.
Inaccuracies in CBO's Baseline Projections of Revenues That Are Attributable to Economic and Technical Factors (As a percentage of actual revenues)

Date the Projection Was Published	Fiscal Year for Which the Projection Was Made					
	Current Year	Budget Year	Budget Year + 1	Budget Year + 2	Budget Year + 3	Budget Year + 4
July 1981	-2.1	-8.5	-22.1	-22.2	-23.1	-28.4
February 1983	-0.9	1.3	0.3	-3.2	-2.3	-3.8
February 1984	0.4	-1.2	-5.7	-5.9	-8.7	-7.0
February 1985	-0.1	-2.6	-2.4	-4.8	-3.2	-8.3
February 1986	-1.2	-1.1	-3.4	-1.7	-6.2	-13.1
January 1987	2.4	-0.1	1.2	-3.9	-11.5	-15.3
February 1988	1.4	3.8	-0.7	-7.4	-10.5	-12.4
January 1989	0.8	-3.5	-9.5	-12.5	-13.4	-12.9
January 1990	-3.4	-9.4	-12.2	-13.3	-12.6	-12.4
January 1991	-3.6	-6.1	-8.2	-7.8	-7.9	-6.3
January 1992	0.4	-2.0	-2.4	-2.4	-0.7	1.8
January 1993	1.0	1.4	1.3	3.3	6.7	11.3
January 1994	0.6	1.0	3.0	6.4	10.5	11.4
January 1995	-0.2	2.5	6.6	10.9	11.9	17.1
May 1996	1.7	5.9	10.9	12.3	17.8	16.8
January 1997	4.4	9.5	10.9	16.7	15.6	
January 1998	3.3	5.3	11.9	11.1		
January 1999	0.7	7.5	6.9			
January 2000	4.1	2.3				
January 2001	-3.8					

SOURCE: Congressional Budget Office.

NOTE: Forecast inaccuracies are actual revenues minus projected revenues, adjusted for the effects of legislation.

income, estate and gift, excise, or payroll taxes—at the time that the legislation is being considered by the Congress.[9] CBO produces estimates for legislation that affects customs duties and miscellaneous receipts that are classified as revenues.

Those estimated effects of tax legislation were used to adjust each baseline projection of revenues. For example, the projection made in January 1994 for fiscal year 1999 was adjusted downward from $1,630 billion to $1,619 billion (see Table 1 on the previous page). That adjustment reflected all tax laws enacted after January 1994 and through fiscal year 1999. The law with the largest budgetary impact was the Taxpayer Relief Act of 1997, which JCT estimated

would reduce revenues in 1999 by $7 billion.[10] Similar adjustments were made for the other years in the baseline projections. The differences between those adjusted projections and actual revenues represent the inaccuracies attributable to economic and technical factors (see Table 2).

CBO's and JCT's estimates of the effects of tax legislation are not revised after their initial publication, even though later economic and technical information might permit better estimates. (For instance, knowledge about an actual tax base, such as wages or corporate profits, in a given year would improve estimates of how a change in tax law would affect revenues.) Using unrevised data on the effects of legisla-

9.   See Section 201(f) of the Congressional Budget Act of 1974 (as amended), 2 U.S.C. 601(f).

10.   See Congressional Budget Office, *The Economic and Budget Outlook: An Update* (September 1997), p. 36.

Table 3.
Inaccuracies in CBO's Baseline Projections of Outlays That Are Attributable to
Economic and Technical Factors (As a percentage of actual revenues)

Date the Projection Was Published	Fiscal Year for Which the Projection Was Made					
	Current Year	Budget Year	Budget Year + 1	Budget Year + 2	Budget Year + 3	Budget Year + 4
July 1981	-2.4	-1.6	-0.7	-4.1	-3.5	-3.4
February 1983	-1.3	-2.0	-0.8	0.1	-0.2	0.2
February 1984	-0.8	*	-0.1	-0.6	-0.8	-1.4
February 1985	0.3	1.4	0.6	0.8	0.3	7.5
February 1986	2.0	1.6	1.9	1.1	8.3	8.7
January 1987	-1.1	0.8	-0.5	6.3	6.4	7.2
February 1988	0.7	-0.5	5.6	5.8	6.7	4.5
January 1989	-1.1	5.7	5.2	6.1	4.0	5.2
January 1990	4.4	3.9	4.7	2.5	3.7	2.1
January 1991	-7.1	-7.4	-3.8	-1.0	3.3	2.7
January 1992	-5.7	-7.7	-3.6	-0.9	1.1	-2.1
January 1993	-3.3	-3.0	-4.4	-2.7	-3.5	-4.0
January 1994	-1.2	-1.4	-1.3	-3.6	-4.1	-4.8
January 1995	-1.0	-2.3	-4.0	-4.3	-5.0	-5.8
May 1996	-0.9	-2.7	-3.9	-4.1	-4.8	-5.6
January 1997	-1.8	-1.9	-2.8	-3.9	-4.1	
January 1998	-0.7	-1.3	-2.4	-2.3		
January 1999	-0.1	-1.1	-0.8			
January 2000	-0.4	*				
January 2001	-0.3					

SOURCE: Congressional Budget Office.

NOTES: Forecast inaccuracies are actual outlays minus projected outlays, adjusted for the effects of legislation. They exclude inaccuracies in the baseline projections of discretionary spending (which are assumed to be attributable solely to legislation) and in the baseline projections of net interest (which depend on the inaccuracies in the surplus excluding interest).

   * = between -0.05 percent and 0.05 percent.

tion may overstate the true uncertainty of CBO's budget projections, all other things being held equal.

Outlays

The estimated effects of legislation on outlays (excluding net interest) were also taken largely from CBO's reports on the budget and economic outlook. However, as with revenues, some adjustment to that information was necessary.

- **Baseline Projections of Discretionary Spending**. As noted above, differences between actual and projected levels of discretionary spend-

ing were assumed to be attributable to legislation. But the July 1981 projection did not include a separate category for discretionary spending. For that baseline only, discretionary spending was approximated by adding the projections for defense, other grants to state and local governments, and other federal operations.[11]

- **Insufficient Details About Legislation.** In some cases, the estimated effects of legislation were not published in enough detail to separate

11. See Congressional Budget Office, *Baseline Budget Projections: Fiscal Years 1982-1986* (July 1981), p. 38.

Table 4.
Inaccuracies in CBO's Baseline Projections of the Primary Surplus or Deficit
(As a percentage of actual revenues)

Date the Projection Was Published	Fiscal Year for Which the Projection Was Made					
	Current Year	Budget Year	Budget Year + 1	Budget Year + 2	Budget Year + 3	Budget Year + 4
July 1981	0.3	-6.9	-21.3	-18.1	-19.6	-25.0
February 1983	0.4	3.3	1.1	-3.3	-2.1	-4.0
February 1984	1.2	-1.3	-5.5	-5.3	-7.9	-5.6
February 1985	-0.4	-4.1	-2.9	-5.7	-3.5	-15.8
February 1986	-3.2	-2.7	-5.3	-2.8	-14.5	-21.7
January 1987	3.5	-1.0	1.7	-10.2	-17.9	-22.5
February 1988	0.7	4.3	-6.3	-13.2	-17.2	-16.9
January 1989	1.9	-9.2	-14.7	-18.7	-17.4	-18.1
January 1990	-7.8	-13.3	-17.0	-15.8	-16.2	-14.4
January 1991	3.5	1.4	-4.4	-6.8	-11.1	-9.0
January 1992	6.1	5.7	1.2	-1.5	-1.9	3.9
January 1993	4.3	4.4	5.6	6.0	10.2	15.3
January 1994	1.8	2.4	4.4	10.1	14.6	16.2
January 1995	0.8	4.7	10.6	15.2	16.9	22.9
May 1996	2.6	8.6	14.7	16.4	22.6	22.4
January 1997	6.2	11.4	13.7	20.6	19.7	
January 1998	3.9	6.6	14.3	13.4		
January 1999	0.8	8.6	7.8			
January 2000	4.3	2.3				
January 2001	-3.5					

SOURCE: Congressional Budget Office.

NOTE: Forecast inaccuracies are actual surpluses minus projected surpluses, adjusted for the effects of legislation. They exclude inaccuracies in the baseline projections of discretionary spending (which are assumed to be attributable solely to legislation) and in the baseline projections of net interest (which depend on the inaccuracies in the surplus excluding interest).

out the effects of legislation on discretionary spending. In other cases, the information was published for some but not all of the six years in the baseline budget projection. One or both of those problems applied to the following periods: August 1986 to January 1987, August 1987 to February 1988, August 1994 to January 1995, and January 1998 to August 1998. In those cases, supplemental information from CBO's files was used to estimate the needed numbers.

As with revenues, the estimated effects of legislation on outlays (including both discretionary and mandatory spending) were used to adjust each baseline projection of outlays. After removing interest payments, the differences between those adjusted projections and actual outlays are the inaccuracies

attributable to economic and technical factors (see Table 3 on the previous page).

Primary Budget Surplus or Deficit

The difference between revenues and outlays excluding net interest is known as the primary budget surplus (or deficit when negative). Correspondingly, CBO's inaccuracies in projecting revenues, minus its inaccuracies in projecting noninterest outlays, equal its inaccuracies in projecting the primary surplus or deficit (see Tables 4 and 5). As described above, that calculation excludes legislative changes. In stage two, the inaccuracies in projecting the primary budget surplus or deficit were cumulated into inaccura-

Table 5.
The Historical Record of CBO's Baseline Budget Projections (In billions of dollars)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Actual													
Budget Surplus or Deficit (-)	-79	-128	-208	-185	-212	-221	-150	-155	-153	-221	-269	-290	-255
Less: Net Interest	69	85	90	111	130	136	139	152	169	184	195	199	199
Equals: Primary Surplus or Deficit (-)	-10	-43	-118	-74	-83	-85	-11	-3	17	-37	-75	-91	-56
Projections													
July 1981 Baseline													
Primary surplus or deficit (-)	18	43	87	143	201	268							
Inaccuracy	-28	-86	-205	-218	-283	-353							
Effect of legislation	-30	-43	-77	-97	-140	-161							
Inaccuracy excluding legislation	2	-42	-128	-121	-144	-192							
February 1983 Baseline													
Primary surplus or deficit (-)			-123	-116	-124	-133	-142	-151					
Inaccuracy			5	42	41	48	131	148					
Effect of legislation			3	19	33	73	149	184					
Inaccuracy excluding legislation			2	22	8	-26	-18	-36					
February 1984 Baseline													
Primary surplus or deficit (-)				-95	-81	-85	-94	-101	-120				
Inaccuracy				21	-2	*	83	98	137				
Effect of legislation				12	7	42	128	170	192				
Inaccuracy excluding legislation				8	-9	-43	-45	-72	-55				
February 1985 Baseline													
Primary surplus or deficit (-)					-84	-69	-70	-63	-65	-66			
Inaccuracy					1	-16	59	60	82	29			
Effect of legislation					4	15	84	111	116	192			
Inaccuracy excluding legislation					-3	-31	-25	-51	-34	-163			
February 1986 Baseline													
Primary surplus or deficit (-)						-70	-36	-11	14	39	56		
Inaccuracy						-16	25	7	3	-76	-131		
Effect of legislation						9	48	55	30	74	98		
Inaccuracy excluding legislation						-25	-23	-48	-28	-150	-229		
January 1987 Baseline													
Primary surplus or deficit (-)							-39	-28	-15	18	46	69	
Inaccuracy							28	25	32	-55	-121	-160	
Effect of legislation							-2	33	15	50	68	86	
Inaccuracy excluding legislation							30	-9	16	-105	-189	-246	
February 1988 Baseline													
Primary surplus or deficit (-)								-7	-10	17	39	50	72
Inaccuracy								4	27	-54	-114	-141	-128
Effect of legislation								-2	-16	11	25	47	67
Inaccuracy excluding legislation								6	43	-65	-139	-188	-195

(Continued)

Table 5.
Continued

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Actual												
Budget Surplus or Deficit (-)	-153	-221	-269	-290	-255	-203	-164	-107	-22	69	125	237
Less: Net Interest	169	184	195	199	199	203	232	241	244	241	230	223
Equals: Primary Surplus or Deficit (-)	17	-37	-75	-91	-56	*	68	134	222	310	354	460
Projections												
January 1989 Baseline												
Primary surplus or deficit (-)	14	42	52	63	73	85						
Inaccuracy	3	-79	-127	-154	-129	-85						
Effect of legislation	-16	16	28	50	71	142						
Inaccuracy excluding legislation	19	-95	-155	-204	-201	-227						
January 1990 Baseline												
Primary surplus or deficit (-)		42	47	57	58	76	92					
Inaccuracy		-79	-122	-148	-114	-76	-24					
Effect of legislation		2	19	37	67	128	171					
Inaccuracy excluding legislation		-80	-140	-185	-182	-204	-195					
January 1991 Baseline												
Primary surplus or deficit (-)			-99	-77	4	67	173	176				
Inaccuracy			24	-14	-60	-67	-105	-42				
Effect of legislation			-13	-29	-9	18	46	88				
Inaccuracy excluding legislation			37	15	-51	-85	-150	-131				
January 1992 Baseline												
Primary surplus or deficit (-)				-151	-113	-29	51	82	52			
Inaccuracy				60	57	29	17	52	170			
Effect of legislation				-6	-9	14	37	79	109			
Inaccuracy excluding legislation				66	66	15	-20	-27	61			
January 1993 Baseline												
Primary surplus or deficit (-)					-112	-81	-53	-37	-49	-65		
Inaccuracy					56	81	121	171	271	375		
Effect of legislation					6	26	45	83	110	112		
Inaccuracy excluding legislation					50	55	76	87	161	263		
January 1994 Baseline												
Primary surplus or deficit (-)						-22	41	62	57	69	57	
Inaccuracy						22	27	72	165	241	297	
Effect of legislation						-1	-5	8	6	-10	1	
Inaccuracy excluding legislation						23	32	63	159	252	296	
January 1995 Baseline												
Primary surplus or deficit (-)							59	53	46	56	40	26
Inaccuracy							9	81	176	254	314	434
Effect of legislation							-2	12	8	-8	6	-30
Inaccuracy excluding legislation							11	69	168	262	309	465

(Continued)

Table 5.
Continued

	1996	1997	1998	1999	2000	2001
Actual						
Budget Surplus or Deficit (-)	-107	-22	69	125	237	127
Less: Net Interest	241	244	241	230	223	206
Equals: Primary Surplus or Deficit (-)	134	222	310	354	460	333
Projections						
May 1996 Baseline						
Primary surplus or deficit (-)	96	75	64	52	39	38
Inaccuracy	38	147	246	302	421	295
Effect of legislation	*	11	-7	3	-37	-150
Inaccuracy excluding legislation	38	136	254	300	458	446
January 1997 Baseline						
Primary surplus or deficit (-)		123	133	114	95	105
Inaccuracy		99	177	240	365	228
Effect of legislation		1	-19	-11	-51	-163
Inaccuracy excluding legislation		98	196	251	417	392
January 1998 Baseline						
Primary surplus or deficit (-)			239	246	241	252
Inaccuracy			71	108	219	81
Effect of legislation			4	-13	-71	-186
Inaccuracy excluding legislation			67	121	290	267
January 1999 Baseline						
Primary surplus or deficit (-)				339	349	358
Inaccuracy				15	111	-25
Effect of legislation				*	-62	-179
Inaccuracy excluding legislation				15	173	154
January 2000 Baseline						
Primary surplus or deficit (-)					400	395
Inaccuracy					60	-62
Effect of legislation					-27	-107
Inaccuracy excluding legislation					88	46
January 2001 Baseline						
Primary surplus or deficit (-)						487
Inaccuracy						-154
Effect of legislation						-84
Inaccuracy excluding legislation						-70

SOURCE: Congressional Budget Office.

NOTES: Inaccuracies in projections of discretionary spending are assumed to be attributable solely to legislation and are included in the rows
labeled "effect of legislation."

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

Box 1.
Regression Equation for the Analysis of Uncertainty

To estimate the effect of the business cycle on the inaccuracy of its past budget projections, the Congressional Budget Office used the following regression equation:

$$e_{t,h} = \beta_1 w_h d_{t+h} + \beta_2 (1 - w_h) g_{t+h} + residual_{t,h}$$

where $e_{t,h}$ = the inaccuracy in projecting the primary surplus or deficit (as a percentage of actual revenues) for the h-year-out forecast published in fiscal year t

g_{t+h} = the GDP gap in year $t+h$

d_{t+h} = the change in the GDP gap between the level known at the time of the projection and the level in the year for which the projection was made (in other words, $d_{t+h} = g_{t+h} - g_{t-1}$)

(Note that g_t is not known at the time of the projection published in January of year t.) The projection horizon h runs from the current year ($h = 0$) through the budget year ($h = 1$) to the fourth year after the budget year ($h = 5$).

The variables d_{t+h} and g_{t+h} are multiplied by weights w_h and $(1 - w_h)$ that restrict their effect at different projection horizons. The weights are chosen so that, for the four- and five-year-ahead projections, the forecast inaccuracy depends only on g_{t+h}, and for the current year, the inaccuracy depends only on d_{t+h}. In other words, $w_4 = w_5 = 0$ and $w_0 = 1$. The weights at other horizons are $w_1 = 0.8$, $w_2 = 0.5$, and $w_3 = 0.1$. Those weights are not determined statistically but represent a reasonable transition from CBO's near-term forecast to its medium-term projection.

The two measures g_{t+h} and d_{t+h} are assumed to have different impacts on forecast inaccuracies (different β_1 and β_2) because, although g_{t+h} is completely unforeseen (for out-years), d_{t+h} can be partly forecast, especially for the current budget year. β_1 and β_2 are estimated at 1.0 and 7.2, respectively, both with a standard error of 0.6.

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cies in projecting publicly held debt, which were used to estimate the uncertainty of CBO's projections of net interest.

Stage Two: Constructing Probability Distributions

The historical record of inaccuracies in projecting the primary surplus or deficit (adjusted for legislation) presented in Table 4 forms the basis for the statistical calculations that CBO used to derive the probability distributions underlying the fan chart.

As noted above, CBO's record of projections is both short and possibly unrepresentative (in that it does not contain a historically normal number of business cycles). In the absence of a rich sample, estimates may be improved if additional information can be brought to bear. In this case, CBO used its knowledge of its forecasting procedures and of business cycles, as well as its historical record, to draw

more reliable conclusions about the probability distribution of inaccuracies in its budget projections.

The Statistical Model for Inaccuracies in the Primary Surplus or Deficit

With the effects of legislation removed, CBO's past inaccuracies are closely related to inaccuracies in forecasting economic variables. Thus, they should be affected by errors in the projection of the business cycle. Forecasting the course of a business cycle over more than two years is virtually impossible, so CBO has traditionally tried to incorporate the business cycle into its economic projections in a serious way only for the current year and the budget year.[12] In its projections for longer horizons, CBO simply assumes that gross domestic product (GDP) will, on

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12. In relation to CBO's baseline, the current year is the fiscal year in which the projection is made and the budget year is the following fiscal year (the one for which the budget is under consideration). Years beyond the budget year are referred to as out-years.

average, adhere to its trend (or "potential") path.[13] That assumption recognizes that, in fact, GDP will sometimes be above and sometimes below its potential, but CBO cannot forecast those boom or recession periods more than a couple of years ahead.

Given the way in which CBO makes its economic projections, its budget projections can be expected to show a certain pattern of inaccuracies. As long as CBO continues to do a reasonably good job of projecting the business cycle, that cycle should not contribute much to the inaccuracy of budget projections for the current year. For the budget year, its contribution should be slightly larger (because errors in forecasting increase with the horizon) but still modest. For later years, however, cyclical factors should loom larger. CBO assumes that by the last two years of the five-year projection horizon, GDP will be at or close to its potential level. Thus, whenever the economy is in fact above or below its potential, none of that difference will be reflected in the budget projections. Consequently, as the projection horizon lengthens, the budget misestimates that result from miscalculating the business cycle should grow in importance, until they reach their maximum in the last two years of the five-year period.

According to that analysis, the portion of budget inaccuracies attributable to the business cycle may be estimated by using the correlation between those inaccuracies and the GDP gap (the percentage difference between actual GDP and its potential value). For projections several years ahead, the *level* of the GDP gap is a good indicator of unexpected cyclical conditions. For projections only one or two years ahead, by contrast, the *change* in the GDP gap is a better indicator than the *level*, because the approaching levels of the gap are likely to be quite similar to the recent level.

Using the GDP gap and its change to measure unforeseen changes in cyclical conditions, CBO estimated by means of a linear regression what portion of its past inaccuracies was attributable to business cycles (see Box 1). Restrictions on the regression incorporate the exogenous information that, of the two variables, the change in the GDP gap is the main source of uncertainty over shorter horizons and the

level of the gap over longer ones. For the intermediate year (the first year after the two-year forecast), both the level of the GDP gap and its change are significant sources of uncertainty.

The portion of the overall inaccuracies explained by the two business-cycle variables in the regression is called the cyclical part. The rest, the noncyclical part, represents the inaccuracies that result from such factors as noncyclical changes in average tax rates, capital gains realizations, the share of GDP that goes to taxpayers in high tax brackets, and federal spending for Medicare and Medicaid.[14]

CBO does not expect its projection inaccuracies to display a negative or positive bias—otherwise it would change its projections. Accordingly, CBO assumed that the probability distribution of its projection inaccuracies was centered around a zero average. That assumption is not contradicted by the data.

Calculating the Distribution of Inaccuracies from the Model

The statistical model computes coefficients that relate misestimates of the surplus or deficit (shown in Table 4) to the business-cycle variables. Given the historical pattern of the business cycle, those coefficients can be used to describe the distribution of inaccuracies that might be expected to occur simply because of the business cycle. One way to describe that distribution is through the root-mean-square error (RMSE), a kind of average error that ignores the signs of individual errors and gives extra weight to large errors.[15] The model assumes that the RMSE of the cyclical part of misestimates will rise to a plateau (see Figure 3 on page 3).

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13.   See Congressional Budget Office, *CBO's Method for Estimating Potential Output: An Update* (August 2001).

14.   See CBO, *The Budget and Economic Outlook: Fiscal Years 2003-2012*, Chapters 3 and 4.

15.   The RMSE is calculated by squaring each projection inaccuracy, averaging the squares, and taking the square root of the result. (For distributions with a mean of zero, it is equal to the standard deviation.) The RMSE forms the basis for CBO's calculation of the fan chart. Roughly speaking, a band of plus or minus one RMSE from a projection encompasses about two-thirds of the likely variation —that is, the outcome is likely to be within one RMSE of the estimate about two-thirds of the time. Other confidence intervals in the fan chart are calculated from RMSEs.

That model does not account for all of a given projection inaccuracy, however. What is left, the noncyclical part, also has a distribution that can be summarized by its RMSE. Like the cyclical component, that part of a misestimate rises as the projection horizon lengthens, but it does not plateau (see Figure 3). For simplicity, CBO assumes that the noncyclical influences captured in the residual from the regression are independent of the cyclical component at each horizon.[16] That assumption is nearly correct and makes little difference to the results.[17]
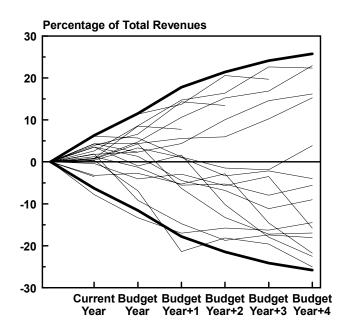
The estimated RMSEs for the cyclical and noncyclical parts can be combined to form an estimate of the RMSE for overall budget misestimates. Two RMSEs are combined by squaring each of them, adding those squares together, and taking the square root of the sum. That calculation yields a combined RMSE that is less than the sum of the two component RMSEs (see Figure 3).

The model's estimate of the distribution of budget misestimates appears generally consistent with CBO's past record. Out of 105 past projection inaccuracies for the primary surplus or deficit in fiscal years 1981 through 2001, only 3 percent fall outside the calculated 90 percent confidence range—a range that ought, in a large enough sample, to encompass 90 percent of the observations (see Figure 5).

The inaccuracies in projecting the primary surplus or deficit for a given year have so far been formulated as a percentage of that year's actual revenues. For each year in the projection through 2007, the estimated RMSE of the inaccuracies can be converted into dollars by multiplying it by CBO's current baseline projection of total revenues.

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16. The fitted part and the residual from the regression are taken, respectively, to be the cyclical and noncyclical parts of the projection inaccuracies. By construction, those two parts are uncorrelated for the whole regression sample, which pools the inaccuracies for the six different horizons, but they have sample correlations different from zero at individual forecast horizons.

17. Because the sample of projections is small, to estimate the distribution of inaccuracies with any confidence, CBO assumed that the inaccuracies shown in Table 4 were generated by a normal distribution. The sample kurtosis and skewness of the inaccuracies are consistent with that assumption. The assumption of a normal distribution is not rejected at any of the horizons for either of those statistical measures at any conventional significance level.

Figure 5.
CBO's Past Inaccuracies in Projecting the Primary Surplus, Compared with the Constructed 90 Percent Confidence Range

SOURCE: Congressional Budget Office.

NOTE: Each thin line represents the actual inaccuracies of the set of projections made in a given year. The thick lines represent the 90 percent confidence range constructed from CBO's statistical model for inaccuracies. That range encompasses nearly all of CBO's past record.

Uncertainty in Projections of the Total Surplus

The uncertainty range for CBO's projection of the total surplus or deficit (shown in Figure 1) requires information about how the predicted inaccuracies in the primary budget (the budget excluding net interest) will affect the government's debt-service costs. Those inaccuracies are run through a simple debt-service model that tracks how inaccuracies in projecting surpluses or deficits translate into inaccuracies in projecting debt; the model applies an interest rate that is a weighted average of CBO's current baseline projections of rates on three-month Treasury bills and 10-year Treasury notes. That model is an approximation of the model that CBO uses for its budget projections.

The extent to which projection inaccuracies for the primary surplus are correlated across horizons is

Table 6.
Estimated Probability Distribution of Total Budget Surpluses (In billions of dollars)

Percentile	2002	2003	2004	2005	2006	2007
5	-149	-264	-364	-437	-520	-568
10	-120	-209	-272	-318	-377	-406
15	-101	-172	-209	-237	-280	-297
20	-86	-142	-160	-173	-203	-210
25	-73	-117	-118	-118	-138	-135
30	-61	-94	-80	-69	-79	-68
35	-51	-73	-44	-23	-24	-6
40	-40	-53	-11	20	28	53
45	-30	-33	22	62	78	110
50	-21	-14	54	103	128	166
55	-11	5	85	145	177	222
60	-1	24	118	187	228	279
65	10	44	151	230	280	338
70	20	66	187	276	334	400
75	32	88	22	325	393	467
80	45	114	267	380	459	542
85	60	143	317	444	536	629
90	79	181	379	524	632	739
95	108	236	471	644	775	901

SOURCE: Congressional Budget Office.

NOTES: These numbers—constructed using the percentiles of the standard normal distribution and a simple probability model based on CBO's track record—are the estimated data that underlie the fan chart presented as Figure 1. The row in the table corresponding to the 50th percentile is CBO's current baseline projection of the surplus.

These estimates permit the construction of probability statements about CBO's baseline projection of the total budget surplus. For example, the table indicates that there is a 90 percent chance that the budget's balance in 2003 (the budget year) will be somewhere between a deficit of $264 billion and a surplus of $236 billion, and a 50 percent chance that the surplus in 2007 (the budget year + 4) will be within about $300 billion of the baseline projection. (That last calculation takes the range from the 25th to the 75th percentiles and halves it.)

important for the computation of debt-service costs. When those inaccuracies are highly correlated, they have a large accumulated effect on outstanding debt, and the associated change in the government's interest burden is large. In calculating the probability distribution of projection inaccuracies for the total surplus (including net interest), CBO assumed that the cyclical and noncyclical parts will continue to have the same correlation structure as in the past.[18]

The percentiles for the total surplus that are used to draw the fan chart are computed by multiplying the values associated with the various percentiles for the standard normal distribution by the calculated RMSE of the probability distribution of the total surplus at different horizons. Those percentiles are shown in Table 6.

CBO will continue its efforts to refine these calculations. It welcomes suggestions for improving the methodology.

18.   The uncertainty that arises from the impact on net interest increases the RMSE of the probability distribution of projection inaccuracies. However, it does not alter the assumption that inaccuracies are normally distributed, because the changes in debt-service costs are a linear function of the current and past changes in the primary budget. The RMSE of the total surplus, in fact, is computed using that linear relationship.

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