Congressional Budget Office

Background Paper

CBO's Long-Term Model: An Overview

June 2009

THE CONGRESS OF THE UNITED STATES

Pub. No. 3235

CBO

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June 2009

The Congress of the United States ■ Congressional Budget Office

Preface

During the past eight years, the Congressional Budget Office (CBO) has developed a sophisticated long-term microsimulation model known as CBOLT. The agency uses the model to analyze the budgetary and distributional effects of the Social Security program and other federal policies and programs, to evaluate potential reforms to federal entitlement programs, and to quantify the nation's long-term fiscal challenges. This background paper provides a short, nontechnical overview of how the CBOLT model works.

Noah Meyerson, Charles Pineles-Mark, Jonathan A. Schwabish, Michael Simpson, and Julie Topoleski wrote the paper under the supervision of Joyce Manchester. Patrick Bernhardt and Paul Cullinan provided helpful comments. Michael Treadway edited the manuscript, which Maureen Costantino prepared for publication. Lenny Skutnik produced the printed copies, Linda Schimmel coordinated the print distribution, and Simone Thomas prepared the electronic version for CBO's Web site (www.cbo.gov).

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June 2009

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Introduction

This background paper describes the Congressional Budget Office's (CBO's) long-term model, CBOLT. CBOLT was built over the past eight years to give CBO a sophisticated mathematical tool with which to analyze potential reforms to federal entitlement programs and quantify the nation's long-term fiscal challenges.

CBOLT is a microsimulation model of the U.S. population, economy, and federal budget. A microsimulation model starts with individual-level data from a representative sample of the population and projects demographic and economic outcomes for that sample through time. For each individual in the sample, CBOLT simulates birth, death, immigration and emigration, marital pairings and transitions, fertility, labor force participation, hours worked, earnings, payroll taxes, Social Security benefit claiming, and Social Security benefit levels. A complex actuarial framework wraps around the microsimulation model to provide totals for demographic and economic variables as well as additional information in areas where the microsimulation model has not yet been developed. The model projects individual demographic and economic behavior of the population, the finances of the Social Security system, and the finances of the rest of the federal government more than 75 years into the future. In recent work, CBO has added detail on Medicare, Medicaid, and other health care spending to the actuarial framework. CBOLT also includes a macroeconomic model that analyzes the federal sector's role in the larger economy and a repeated-simulation (Monte Carlo) mode that quantifies uncertainty about a variety of outcomes.

This description of CBOLT offers a short, nontechnical overview of how the model works. For more detailed descriptions of various components, see the documents listed at the end of this paper.

Model Structure

The microsimulation method used by CBO represents an innovation within the U.S. government compared with other ways of modeling the effects of federal entitlement programs. In traditional actuarial modeling (also known as cell-based modeling), shifts in economics, demographics, or policy affect only average values, such as the average Social Security benefit paid to men who are age 75. CBOLT originated as a traditional actuarial model, and its Social Security projections were based on average values for population groups classified by age, sex, and marital status. Microsimulation, however, can generate not only averages but also distributional outcomes: It can show, for example, how a particular policy change might affect individuals with low earnings differently from individuals with high earnings. Microsimulation also allows analysts to quantify the effects of different policies or assumptions on specific populations.

Input Data

The core individual-level data used in CBOLT come from the Continuous Work History Sample (CWHS), an administrative data set provided by the Social Security Administration (SSA).[1] Those data contain a history of individual earnings records for a 1 percent random sample of Social Security numbers, beginning in 1951. The data also contain demographic information and Social Security information for each individual. The information on Social Security—for Old-Age, Survivors, and Disability Insurance (OASDI)—includes claiming dates, type of claim (OAI, SI, or DI), the primary insurance amount, the monthly benefit amount, and the reason for disability.

Using administrative data rather than data from surveys has substantial benefits. Administrative earnings records provide a consistent measure of earnings for individuals over many years. In addition, the sample sizes are large: The core data file for CBOLT contains information on approximately 300,000 individuals. (CBO uses a 10 percent sample of the CWHS file in order to facilitate processing the data.) And because the earnings data are based on administrative records, they are not subject to survey respondents' errors in recalling information correctly or to issues of rounding or nonresponse.[2]

The CWHS also has a number of limitations. The CWHS data capture earnings only from workers in the covered sector—that is, workers who contribute to the Social Security system.[3] The CWHS does not include earnings of workers who do not have or do not report a valid Social Security number or whose earnings are received "under the table." Perhaps most important, the data contain only limited demographic information: sex; Social Security beneficiary status; date of birth; and, if applicable, date of death. The CWHS also lacks dates of death for many deceased people who had Social Security numbers but did not claim Social Security benefits. Earnings data above Social Security's taxable maximum have been found to be missing or unreliable

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1. The input data are drawn from a collection of administrative data sets: the Summary Earnings Record, the Detailed Earnings Record, the Numerical Identification System, and the Master Beneficiary Record. Here, the term CWHS refers to the sampling framework used by SSA to extract data from those sources. The CWHS is a 1 percent sample of Social Security numbers; the 10 percent sample of the CWHS file used by CBO results in a 1-in-1,000 random sample of Social Security numbers. In principle, such a sample should be representative of the U.S. population, although events like death and immigration do not appear to be fully recorded in the data. To adjust the data for some of those potential shortcomings, CBO extensively reweights the CWHS to make sure that the sample is in fact representative along several dimensions, such as age, sex, labor force status, and Social Security beneficiary status.

2. See, for example, Julian Cristia and Jonathan A. Schwabish, *Measurement Error in the SIPP: Evidence from Matched Administrative Records,* Congressional Budget Office Working Paper 2007-03 (January 2007).

3. In 1985, 93 percent of paid civilian workers were in the covered sector; by 2002, that share had risen to 96 percent. See House Committee on Ways and Means, *2004 Green Book: Background Material and Data on the Programs Within the Jurisdiction of the Committee on Ways and Means,* WMCP: 108-6 (March 2004), Table 1-7 and pp. 1–4.

through the early 1980s, requiring CBO to develop a procedure to impute earnings above the taxable maximum.[4]

Because the CWHS data include only earnings, age, sex, and OASDI benefit information, CBO uses data from other sources to expand the CWHS record. Additional demographic and economic data come from other data sets such as the Survey of Income and Program Participation (SIPP), the SIPP matched to other administrative earnings records, the Panel Study of Income Dynamics (PSID), and the Current Population Survey (CPS). Information from those data sources is not merged directly to the individual record in CBOLT. Rather, CBO uses these sources to estimate statistical relationships on the basis of individual characteristics that already exist in CBOLT. Those estimates provide the basis for probabilistically imputing the data that are not available in the CWHS.

CBOLT also incorporates a wide range of aggregate data. As discussed in more detail below, the model is calibrated to match the Social Security trustees' projections of the total population by age, sex, and marital status as well as mortality and fertility rates, immigration and emigration counts, and disability incidence and termination rates for each year of the projection period. For the first 10 years of the projections, CBOLT uses economic projections and projections of federal outlays and revenues produced by CBO's Macroeconomic Analysis Division, Budget Analysis Division, and Tax Analysis Division. To make the transition from the first 10 years to the long-term projection period, CBOLT phases in certain long-term assumptions over a 5- to 10-year period.

Input Assumptions

Using CBOLT requires specifying both demographic and economic assumptions. Demographic assumptions for the baseline projections come from annual Social Security trustees' reports. However, economic assumptions for the baseline projections are based on CBO's judgment and analysis, and they differ from the economic assumptions in the trustees' reports for Social Security and Medicare. In many cases, CBO assumes that variables remain at the levels reached at the end of its 10-year projection for the remaining years in the 75-year projection period. In other cases, CBO, in

4. For more information on earnings measurement issues in the CWHS in the early 1980s, see Wojciech Kopczuk, Emmanuel Saez, and Jae Song, *Uncovering the American Dream: Inequality and Mobility in Social Security Earnings Data Since 1937,* Working Paper No. 13345 (Cambridge, Mass.: National Bureau of Economic Research, August 2007); and Jonathan A. Schwabish, *Identifying Rates of Emigration in the United States Using Administrative Earnings Records,* Congressional Budget Office Working Paper 2009-01 (March 2009). The Social Security taxable maximum is the level of earnings up to which workers pay Social Security taxes. In 2009, for example, the taxable maximum is $106,800. For purposes of estimating the finances of the Social Security system under current law, only those earnings up to the taxable maximum are important. The imputation methodology is potentially important, however, for simulating the effects of increasing the taxable maximum and for assigning other demographic information to each person in the microsimulation sample.

consultation with its panel of economic advisers, reaches different conclusions about the long-term value of certain variables. For example, the trustees' reports use an assumed value of future real wage growth. CBO instead uses the 50-year average historical value for total factor productivity (discussed below) in combination with its own assumptions about the gap between two standard measures of consumer and overall inflation (the consumer price index and the gross domestic product [GDP] deflator), as well as the earnings share of compensation, to derive the long-term rate of real (inflation-adjusted) wage growth.

Both the demographic and the economic assumptions can be modified to reflect policy changes as specified in reform proposals or to measure the sensitivity of results to various assumptions. In addition, policy levers such as replacement rates in the Social Security benefit formula or future rates of growth of health care spending can be varied to illustrate the effects of proposed changes to programs. Figure 1 lists the key assumptions and policy levers. (In addition, a much wider array of policy options can be simulated by modifying the computer code.)

Demographics

CBOLT sets baseline demographic assumptions using historical data as well as the Social Security trustees' aggregate population projections, which are generally provided by categories of age, sex, and marital status. To more accurately portray the U.S. economy, the microsimulation model requires details beyond the number of people within each age, sex, and marital status group. Because the core CWHS data on which CBOLT is based include only age, sex, and earnings for each individual, additional characteristics such as education and marital status are imputed to individuals in the model using relationships observed in survey data.[5]

Given the number of observations in a population category, the model assigns demographic characteristics to each individual such that the overall distribution matches that observed in the data. To do so, the model assigns a random number between 0 and 1 to each person for a given characteristic; those random draws are then compared with probabilities estimated in models outside CBOLT (using, for example, the CPS). The probability that an individual is assigned a specific characteristic depends on other characteristics that have already been assigned. For example, the probability that a married 27-year-old woman gives birth in a given year might be 5 percent, as reflected in the SIPP; if the CBOLT-generated random draw for that woman is less than 0.05, she gives birth to a child in the model. The same process applies to a single 42-year-old woman, but the probability of her giving birth is much lower.

5. For example, see Congressional Budget Office, *Assigning Education Status in CBO's Long-Term Microsimulation Model,* Background Paper (October 2008); and Kevin Perese, *Mate Matching for Microsimulation Models,* Congressional Budget Office Technical Paper 2002-3 (November 2002).

Figure 1.

Key Parameters in the Congressional Budget Office's Long-Term Model

Assumptions	Policy Levers
■ Fertility ■ Mortality ■ Immigration ■ Disability incidence and termination rates ■ Total factor productivity ■ Inflation (consumer price index) ■ Difference between growth rates of the price index for gross domestic product and the consumer price index ■ Unemployment ■ Government and corporate bond rates ■ Return on equities ■ Health care cost growth	■ Parameters of the Social Security benefit formula, such as replacement rates and "bend points" (or amounts of earnings used in conjunction with replacement rates in calculating benefits) ■ Statutory retirement ages ■ Delayed retirement credits ■ Actuarial adjustments for early claiming ■ Tax rates ■ Maximum taxable earnings ■ Parameters for individual accounts ■ Changes in health cost growth for Medicare, Medicaid, and other health care spending

Source: Congressional Budget Office.

To "marry" people in the CBOLT sample, a matching methodology forms married couples such that the correlations between spouses' earnings, ages, and education are consistent with observed data. Marital pairings can change each year as couples can divorce, singles and divorcees can marry, or a spouse can become widowed.

Mortality rates by age and sex match the Social Security trustees' projections, but CBOLT's microsimulation framework also accounts for differential mortality, that is, the fact that mortality rates also depend on marital status, household lifetime earnings, and education. Accounting for differential mortality is important in making projections for Social Security, because it results in a more accurate distributional analysis. In particular, recipients with higher benefits tend to live longer than average, and those with lower benefits tend to die sooner.[6] Consequently, incorporating differential mortality leads to higher projections of overall Social Security outlays.

CBO adopts the trustees' projections of total immigration and emigration by year, age, and sex. Immigrants enter the CBOLT population and are assigned education and fertility levels based on immigrant-specific distributions. They are also assigned a marital status, and married immigrants are matched to other immigrants to form families.[7] Other characteristics come from distributions for the general population. Although the total number of foreign-born persons who emigrate from the United States comes from the trustees, CBO has developed an independent methodology that uses administrative earnings records to determine the characteristics of people who choose to emigrate.[8]

CBOLT does not have information about individuals' race, state (or other geographic location), or assets, nor does it have full information on income (such as pensions and investment income) other than earnings and Social Security benefits. For individuals who receive Social Security benefits, a simple imputation procedure estimates total income. CBOLT uses that estimate to compute income tax paid on benefits.

Labor Force Participation and Earnings

Labor market outcomes are fundamental when analyzing Social Security and other age-related policy issues, because both the payroll taxes collected from individuals and the benefits paid to individuals depend on earnings. Aggregate earnings are projected in the macroeconomic sector of CBOLT, and individual earnings are scaled to match that aggregate. The distribution of earnings plays a key role in the distribution of taxes and benefits across the population. For each individual, CBOLT projects labor force participation status (that is, whether the individual is in or out of the labor force), full-time or part-time status, hours worked, unemployment, and annual earnings.[9]

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6. See Congressional Budget Office, *Growing Disparities in Life Expectancy,* Issue Brief (April 2008); and Julian Cristia, *The Empirical Relationship Between Lifetime Earnings and Mortality,* Congressional Budget Office Working Paper 2007-11 (August 2007).

7. After their first year in the sample, unmarried immigrants enter the general marriage pool and can be matched with either natives or immigrants.

8. See Jonathan A. Schwabish, *Identifying Rates of Emigration in the United States*; and Charles Pineles-Mark, Jonathan A. Schwabish, and Michael Simpson, "Incorporating Immigrant Flows into Microsimulation Models" (paper presented at the Second General Conference of the International Microsimulation Association, Ottawa, Canada, June 8–10, 2009).

9. For more details about the methodology described in this section, see Congressional Budget Office, *Projecting Labor Force Participation and Earnings in CBO's Long-Term Microsimulation Model,* Background Paper (October 2006). The current formulation of the labor force and earnings modules does not treat immigrants differently from other workers.

For each of those assignments of labor force participation and annual earnings, CBOLT uses 30 years of CPS data to compute probabilities based on a number of characteristics, including:

- Age,
- Sex,
- Lifetime educational achievement,
- Marital status,
- Number of children under 6 years of age (for women),
- Educational status (namely, whether the person is currently in school), and
- Social Security benefit status.

Using 30 years of CPS data allows CBOLT to identify both long-term economic trends and cohort-specific behavior at the individual level. Since 1976, the labor force information included in the CPS, such as hours and weeks worked, has been measured more or less consistently.[10] CBO updates the labor force equations periodically by incorporating the most recent CPS data to account for recent trends in the labor market.

Lifetime earnings paths for each individual in the CBOLT sample can be characterized by the sum of three components. The first is the predicted value from an earnings equation that is estimated using CPS data; those predictions amount to average earnings for that person's age, sex, education, and birth cohort group. The second is the value of the individual's "permanent" earnings differential, or the gap between that person's earnings and the average for the person's group.[11] That differential captures the observed tendency for an individual's earnings to be highly persistent over time. The third is an annual transitory shock, which measures any additional (but temporary) variation in a person's earnings compared with predicted values. That combination of a permanent gap and transitory shocks generates earnings in the CBOLT sample that are consistent with both cross-sectional (across individuals at a

10. The CPS has been modified a number of times over its history. For example, categories of educational attainment were changed in the March 1992 survey, and information about people's status as foreign- or native-born was added in the March 1994 survey. For more details, see Congressional Budget Office, *Assigning Education Status in CBO's Long-Term Microsimulation Model,* Appendixes A and B.

11. The assignment of the permanent differentials differs slightly depending on whether the person has earnings as specified in the CWHS data or is "born" in the CBOLT sample.

given time) and longitudinal (for the same individual over time) observations on variability.[12]

Financial Projections for Social Security, Medicare, and Medicaid

For a number of years, CBOLT produced long-term estimates of the Social Security system but not of other entitlement programs. In recent years, CBO has introduced modeling related to the large federal government health insurance programs—Medicare and Medicaid—and other health care spending.[13]

Benefit Claiming and Benefit Levels

Claiming behavior—the decision of when to claim Social Security retirement benefits—is based on the probability of claiming at various ages for a given birth cohort, the early and normal retirement ages, and the Medicare eligibility age. As of this writing, the method for assigning people to claim benefits in a particular year is fairly simple and relies only on age and sex. Improvement of that section of the model is under way so that benefit claiming may ultimately depend on additional individual characteristics such as marital status, education, and lifetime earnings. Benefit computation is mechanical, but complex. CBOLT simply applies existing Social Security rules (or an alternative hypothetical policy) for each beneficiary and computes both worker and auxiliary benefits.[14]

Social Security Disability Insurance

CBOLT adopts the incidence rates for receipt of Social Security Disability Insurance by age and sex provided by the Social Security trustees. Using historical data on beneficiary status and earnings, however, CBOLT estimates the probability of being a disabled beneficiary, taking account of the individual's lifetime earnings decile. In particular, low earners are more likely to become disabled beneficiaries than are high earners. Because individual benefits are based on earnings histories, total disability benefits are lower than they would be if all earners (of a given age and sex) in the microsimulation were equally likely to become disabled beneficiaries.[15]

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12. The variance of the permanent shock is nonzero but much smaller than the variance of the transitory shock; see, for example, Christopher Carroll, "The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence," *Brookings Papers on Economic Activity,* no. 2 (1992), pp. 61–152. For background research associated with this variability in earnings, see Congressional Budget Office, *Recent Trends in the Variability of Individual Earnings and Household Income* (June 2008).

13. See Congressional Budget Office, *The Long-Term Outlook for Health Care Spending* (November 2007), and *The Long-Term Budget Outlook* (June 2009).

14. The CBOLT microsimulation framework also calculates payment of auxiliary benefits—such as those received by surviving spouses, dependent children, or disabled family members—because the model links spouses and children.

15. See Congressional Budget Office, *Is Social Security Progressive?* Issue Brief (December 2006).

Mortality rates for disabled beneficiaries are substantially higher than overall mortality rates and vary by age, sex, and years of disability across individuals in the DI program. Again, those rates are provided for categories of DI beneficiaries by the Social Security trustees.

Projections of Social Security

The microsimulation approach makes it possible to examine how simulated individuals' payroll taxes and benefits under current law compare with the same outcomes under proposed alternatives. Individuals' demographic and economic behaviors in the model determine their Social Security taxes paid and benefits received. CBO analysts can vary all of the standard values in the current Social Security system (for example, tax rates, benefit formulas, early and normal retirement ages, actuarial reductions for early claiming, and credits for delayed retirement; see Figure 1). Using information for each person in the CBOLT sample, the model estimates payroll taxes on the basis of the same earnings that ultimately feed into the calculation of Social Security benefits.[16] CBOLT can also project the Social Security financing implications of common reform options such as progressive price indexing or earnings sharing as well as various types of individual accounts, including those with benefit guarantees.[17]

Taxation of Benefits

CBO's Tax Analysis Division computes the ratio of income taxes paid on Social Security benefits to GDP for each year of the 75-year projection period. Because income taxes on benefits depend on total taxable income, CBOLT uses imputed values of unearned income from pensions and other sources to estimate the distribution of individual income taxes on benefits. CBOLT then distributes the total amount of taxes paid on benefits among the appropriate individuals on the basis of imputed total income.

Projections of Medicare, Medicaid, and Other Health Care Spending

CBOLT models Social Security in detail at the individual level, but the current version of the model projects health care spending at an aggregated level in its actuarial section. Projections of health care spending begin with per capita spending

16. The model ultimately scales individual earnings such that earnings missing from the administrative records and noncovered earnings are included in the total.

17. In general, progressive price indexing changes the basic Social Security benefit formula such that initial benefits for the highest-earning beneficiaries would grow with prices, initial benefits for the lowest earners would continue to grow with average earnings, and initial benefits for other groups would grow at a weighted average of those two rates. For an example of an analysis of progressive price indexing, see Congressional Budget Office, "Long-Term Analysis of S. 2427, the Sustainable Solvency First for Social Security Act of 2006," letter to the Honorable Robert F. Bennett (April 5, 2006). "Earnings sharing" refers to an alternative method of calculating Social Security benefits in which the combined earnings of a married couple are split evenly between the two partners. For an example of an analysis of earnings sharing, see Jonathan A. Schwabish, Michael S. Simpson, and Julie Topoleski, "Earnings Sharing and Social Security Solvency" (paper presented at the Fall Conference of the Association for Public Policy Analysis and Management, Washington, D.C., November 8–10, 2007).

amounts for different categories of service within the Medicare and Medicaid programs (inpatient hospital services or physicians' services, for example), then account for changes in the size and age composition of the population, time until death

(for Medicare), economic growth, and assumed rates of excess health cost growth.[18] Excess health cost growth is the difference between growth in per capita health care spending and growth in per capita GDP, after an adjustment for the effects of changes in the age composition of the population.

Assumptions about excess health cost growth in CBOLT differ for Medicare, Medicaid, and other health care spending and are based on CBO's 10-year baseline for Medicare and Medicaid, historical averages of excess cost growth rates, and an assumed future slowdown in excess cost growth.[19] Excess health cost growth rates can also vary for different categories of cost within the Medicare and Medicaid programs. The model projects all other health care spending, which includes payments by private insurers, consumers' out-of-pocket spending, spending by state and local governments, and other federal spending on health care such as that by the Department of Veterans Affairs medical system.

In the future, health status and health status transitions will be modeled at the individual level. Health status may ultimately be linked to work, marital status, fertility, mortality, and health care expenditures.[20]

Other Aspects of the Model

CBOLT also includes a number of other features that enhance its analytic capabilities.

Macroeconomic Framework

CBOLT has a macroeconomic framework in which total economic output is determined by productivity, hours of labor, and the stock of productive capital. Total factor productivity accounts for changes in total output that are not caused by changes in inputs such as capital and labor. CBO sets total factor productivity growth exogenously, generally at its long-run historical average. Hours of labor are a function of labor force growth and unemployment, and the capital stock depends on rates of depreciation and investment. Depreciation is set proportional to the amount of capital, and investment is a function of private saving and government saving or dissaving

18. For further detail, see John Sabelhaus, Michael Simpson, and Julie Topoleski, *Incorporating Longevity Effects into Long-Term Medicare Projections,* Congressional Budget Office Technical Paper 2004-2 (January 2004)

19. For further detail, see Congressional Budget Office, *The Long-Term Outlook for Health Care Spending* (November 2007), and *The Long-Term Budget Outlook* (June 2009).

20. For further information on why modeling health status and transitions is important at the individual level, see Julie Topoleski and Joyce Manchester, "Modeling Health Status and Health Transitions in Microsimulation Models" (paper presented at the Second General Conference of the International Microsimulation Association, Ottawa, Canada, June 8–10, 2009).

(surpluses or deficits). Government saving or dissaving is a direct result of current revenue and noninterest spending and, through interest payments on the debt, of past revenue and spending policies.

In its projections, CBO assumes that private saving offsets most of the projected dissaving by the federal government. CBOLT has a number of rules that can be used to determine private saving rates. The objective of those rules is to allow the capital stock to grow sufficiently to produce productivity and real wage growth close to levels observed in history—that is, to have a stable future macroeconomic base on which to analyze reform proposals for federal spending programs such as Social Security, Medicare, and Medicaid. Nevertheless, the necessity of imposing extreme rules to offset the rising national debt in current projections demonstrates the unsustainable nature of the federal government's fiscal position. If those rules were not in place, and if federal deficits followed their projected path, the model would show large government deficits crowding out private investment, which would decrease the amount of productive capital per worker and slow the growth of output; at some point, the model would stop functioning.[21]

Calibration with CBO's 10-Year Baseline

Aggregate projections from CBOLT for the first 10 years follow CBO's published 10-year baseline projections.[22] In some cases, assumptions imposed on the model ensure that it produces results that correspond to CBO's baseline projections. Medicare and Medicaid spending and macroeconomic aggregates such as productivity, inflation, and GDP fall in that category. In other cases, such as the projected 10-year path of Social Security benefits, alignment factors are used to adjust the underlying calculations. For example, if CBO's published projection of DI benefits in 2010 was 2 percent higher than estimated in CBOLT, the alignment factor would equal 1.02, and so the computed 2010 total would be multiplied by 1.02. At the end of the 10-year projection period, depending on the context, the alignment factors are either held constant or phased out to target long-run assumptions.

Federal Budget Framework

A budget accounting system in CBOLT tracks all categories of federal spending and revenues.[23] Beyond the first 10 years, during which spending in the model matches CBO's published projections, estimates of spending (other than that for major entitlements, which are modeled directly in CBOLT) are generally fixed proportions of

21. For a more complete description, see "The Economic Impact of Rising Federal Debt" in Congressional Budget Office, *The Long-Term Budget Outlook* (June 2009), pp. 16–18.

22. For CBO's most recent 10-year baseline, see Congressional Budget Office, *An Analysis of the President's Budgetary Proposals for Fiscal Year 2010* (June 2009).

23. The amounts differ from projections by CBO's Budget Analysis Division because projections based on CBOLT are on a calendar year, not a fiscal year, basis.

Figure 2.

Stochastic Variables in CBO's Long-Term Social Security Projections

Demographic Inputs	Economic Inputs
■ Overall fertility rate	■ Total factor productivity growth rate
■ Mortality improvement by age and sex	■ Inflation
■ Net annual immigration	■ Unemployment
■ Overall disability incidence	■ Gap between marginal product of capital and real (inflation-adjusted) 10-year bond rates
■ Overall disability termination	■ Change in earnings share of compensation
	■ Gap between CPI-W and core price index

Source: Congressional Budget Office.

Notes: CPI-W = consumer price index for urban wage earners and clerical workers.

For additional information, see Congressional Budget Office, *Quantifying Uncertainty in the Analysis of Long-Term Social Security Projections*, Background Paper (November 2005).

projected GDP. However, CBOLT does offer the flexibility of setting any desired level or growth rate of expenditures, including fixing expenditures in real or nominal dollars. Effective rates of major types of taxes—personal income, corporate income, payroll, and other—are calculated by CBO's Tax Analysis Division and fed directly into CBOLT. With all noninterest spending and taxes in place, the model then computes interest spending by the federal government and the resulting annual deficits and debt.

Modeling Uncertainty

To investigate the degree of uncertainty surrounding specific Social Security projections, CBOLT can be run repeatedly, using input assumptions drawn from various distributions, to create probability distributions of outcomes around the central projections.[24] Such procedures, known as Monte Carlo simulations, are especially important for long-term projections because uncertainty compounds over time. Moreover, certain types of reforms can increase or decrease uncertainty significantly.

24. See Congressional Budget Office, *Quantifying Uncertainty in the Analysis of Long-Term Social Security Projections,* Background Paper (November 2005).

Eleven inputs are varied in the standard Monte Carlo runs (see Figure 2). For runs that include private investments, returns on corporate bonds and equities can also be varied. The model is run hundreds of times, each time with an independently drawn set of input assumptions. The probability distributions of the inputs are based on time-series analyses of historical patterns. In particular, the model assumes that future uncertainty can be described on the basis of variation observed in the past. Of course, the distribution is sensitive to the chosen historical time period and the selected time-series equations.

Appendix: Publications About CBOLT

Documentation

Jonathan A. Schwabish, *Identifying Rates of Emigration in the United States Using Administrative Earnings Records,* Congressional Budget Office Working Paper 2009-01 (March 2009).

John Sabelhaus and Lina Walker, "Economic Flexibility in Microsimulation: An Age-Centered Regression Approach," *International Journal of Microsimulation*, vol. 2, no. 2 (2009), pp. 1–14.

Congressional Budget Office, *Assigning Education Status in CBO's Long-Term Microsimulation Model,* Background Paper (October 2008).

—, *Growing Disparities in Life Expectancy,* Issue Brief (April 2008).

—, *Is Social Security Progressive?* Issue Brief (December 2006).

—, *Projecting Labor Force Participation and Earnings in CBO's Long-Term Microsimulation Model,* Background Paper (October 2006).

—, *Quantifying Uncertainty in the Analysis of Long-Term Social Security Projections,* Background Paper (November 2005).

John Sabelhaus, Michael Simpson, and Julie Topoleski, *Incorporating Longevity Effects into Long-Term Medicare Projections,* Congressional Budget Office Technical Paper 2004-02 (January 2004).

Kevin Perese, *Mate Matching for Microsimulation Models,* Congressional Budget Office Technical Paper 2002-3 (November 2002).

Note: All documentation cited is available on CBO's Web site at www.cbo.gov/publications.

Analyses

Congressional Budget Office, *The Long-Term Budget Outlook* (June 2009).

—, *Updated Long-Term Projections for Social Security* (August 2008).

—, *The Long-Term Budget Outlook* (December 2007).

—, *The Long-Term Outlook for Health Care Spending* (November 2007).

—, "Long-Term Analysis of S. 2427, the Sustainable Solvency First for Social Security Act of 2006," letter to the Honorable Robert F. Bennett (April 5, 2006).

—, "Long-Term Analysis of the Liebman-MacGuineas-Samwick Social Security Proposal," letter to the Honorable Jim Kolbe (February 8, 2006).

—, "Long-Term Analysis of the Diamond-Orszag Social Security Plan," letter to the Honorable Larry E. Craig (December 22, 2004).

—, "Long-Term Analysis of H.R. 3821, the Bipartisan Retirement Security Act of 2004," letter to the Honorable Jim Kolbe (July 21, 2004).

—, "Long-Term Analysis of Plan 2 of the President's Commission to Strengthen Social Security," letter to the Honorable Larry E. Craig (July 21, 2004).

Note: All analyses cited are available on CBO's Web site at www.cbo.gov/publications.

Related Publications

Jonathan A. Schwabish and Julie H. Topoleski, "Risk Tolerance and Retirement Income Composition," *Journal of Pension Economics and Finance,* vol. 8, no. 2 (April 2009), pp. 131–151.

Jonathan Schwabish, Julie Topoleski, and Ignez Tristao, "Can America Afford to Get Sick?" *National Tax Journal,* vol. 60, no. 3 (September 2007), pp. 407–418.

Julian Cristia, *The Empirical Relationship Between Lifetime Earnings and Mortality,* Congressional Budget Office Working Paper 2007-11 (August 2007).

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