How CBO Produces Its 10-Year Economic Forecast

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Abstract

As part of its mandate to provide nonpartisan analyses to assist economic and budgetary decisions by the Congress, the Congressional Budget Office prepares an economic forecast twice per year. Those forecasts are used in the agency's projections for the federal budget and cost estimates for proposed federal legislation. Forecasts of gross domestic product, inflation, interest rates, and income play a particularly significant role in the agency's budgetary analysis; for example, projections of wages and salaries are used to forecast individual income tax receipts.

This paper describes the process used to produce CBO's economic forecast. That process includes background analysis, the preparation of a series of preliminary forecasts, and several rounds of internal and external review. Central to the process is CBO's large-scale macroeconometric model, which combines the forecasts of underlying inputs to produce forecasts of the macroeconomic variables of interest. That model focuses on the interaction between aggregate demand (which includes consumer spending, business investment, residential investment, government spending, and net exports) and aggregate supply (which includes the factors that determine CBO's estimate of potential output) in the economy. The interaction of aggregate demand and aggregate supply determines the forecasts of the other variables in the model, including inflation, interest rates, the unemployment rate and incomes.

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Introduction

The mandate of the Congressional Budget Office is to provide objective, nonpartisan, and timely analyses to facilitate economic and budgetary decisions by the Congress. Twice per year, CBO prepares economic forecasts that underlie both the agency's projections for the federal budget and cost estimates for proposed federal legislation. Forecasts of gross domestic product (GDP), inflation, interest rates, and income play a particularly significant role in the agency's budgetary analysis; for example, projections of wages and salaries are used to forecast individual income tax receipts.

CBO produces its macroeconomic forecast using a group of about a dozen analysts who rely on several economic models, including a large-scale macroeconometric model (macro model). The analysts draw information from daily economic events and data, consult with economists both within and outside the federal government, and take input from senior staff at CBO. In addition, CBO's Panel of Economic Advisers reviews a preliminary version of the forecast. The panel, which is made up of widely recognized experts with a variety of backgrounds, areas of expertise, and experience, provides suggestions on methods and assumptions that CBO can incorporate in later versions of the forecast.

Like the economic forecasts of other agencies and private-sector companies, CBO's forecast centers on major macroeconomic variables. However, because the economic forecast is used as an input to the agency's budget projections, it focuses more than other forecasts do on variables that drive the projections of federal revenues and outlays, especially the different categories of income earned in producing GDP. And, by convention, CBO's forecast is based on the assumption that current laws governing federal revenues and spending will generally remain unchanged during the 10-year forecast horizon.

CBO's forecast is usually similar to those of outside forecasters because CBO generally uses widely accepted models, data sources, and methods to construct it. Producing such a mainstream forecast is useful because it allows the Congress to focus on fiscal policy rather than the details of the economic forecast. However, in certain instances, CBO's forecast may diverge from the consensus of outside forecasters. For example, outside forecasters might expect a change in fiscal policy relative to what is in current law and would probably build that change into their economic forecast. In that situation, according to convention, CBO's forecast would incorporate the assumption that fiscal policy continues as embodied in current law, and as a result, it would likely differ from outside forecasts.

CBO's Forecast Procedure

CBO's forecast procedure comprises four steps that take place over the course of about eight weeks: conducting background analysis, preparing a preliminary forecast, receiving feedback from internal and external reviewers, and preparing a final forecast (see Figure 1). Central to the

process is CBO's large-scale macro model, which combines the forecasts of underlying inputs to produce forecasts of the macroeconomic variables of interest.

Figure 1. CBO's Macroeconometric Forecast Procedure

Step 1: Background Analysis
Develop a preliminary outlook for exogenous variables (population, energy prices, foreign growth, etc.) Review most recent data and other relevant information.

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Step 2: PreliminaryForecast
Use a macroeconometric model to develop a preliminary projection of U.S. economy. Inputs to the model include projections of the exogenous variables, fiscal policy under current law, and preliminary projections of the federal budget.

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Step 3: Internal and External Review
Submit forecast for internal review (by the Director and other divisions within CBO) and external review (by CBO's Panel of Economic Advisers and Congressional budget staff).

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Step 4: Final Forecast
Incorporate feedback and final data releases to develop final economic projection. Transmit to CBO's budget and tax divisions for budget projections.

Step One: Background Analysis

Economists with expertise in various sectors of the economy perform background analysis to develop a preliminary outlook for the exogenous variables in their sector—those that are not significantly influenced by overall macroeconomic conditions and therefore are forecast separately from the macro model. Examples of such variables include the price of crude oil, the size of the working-age population, rates of labor force participation, rates of household formation, and foreign economic indicators. Background analysis might consist of a review of recent economic developments in the sector (including data releases), a review of relevant new research by outside economists, and an analysis of recent forecast errors. The result is a memorandum describing the implications of the analysis for the outlook for the underlying drivers in that sector.

Using oil prices as an example, an analyst would examine the factors that determine the price of oil, including trends in the supply of and demand for crude oil, in order to project the price of oil for the next ten years. The analyst would summarize his or her findings in a memo that would include analysis and detailed forecasts of the prices of several benchmark grades of crude oil,

such as Brent and West Texas Intermediate, for the 10-year forecast horizon. The analyst would also probably compare the preliminary forecast to those of outside forecasters as well as to the forecast implied by prices in futures markets. As with most variables in the macro model, the near-term forecast of oil prices relies more heavily on the factors that drive overall demand for oil, while the medium-term forecast relies more heavily on the factors that determine the overall supply of oil.[1] Because it is difficult to substantially increase or decrease the supply of oil in the short run, over that period swings in the demand for oil affect prices more than the quantity produced.

Once the background memos are complete, the forecast group meets to discuss the analysis and agree on a preliminary view of the exogenous variables underlying the forecast. The forecast group is composed of members of several divisions within CBO, including the Budget Analysis Division, the Financial Analysis Division, the Macroeconomic Analysis Division, the Microeconomic Studies Division, and the Tax Analysis Division.

Step Two: Preliminary Forecast
CBO next enters all of the exogenous variables into a large-scale macro model (described in the next section) and produces a preliminary forecast of the variables used in the budget projections, including GDP, unemployment, interest rates and inflation. This step is actually a compound step, an iterative process of adding the inputs to the macro model to produce a draft forecast, evaluating the results for internal consistency, revising the inputs, and then repeating the process.

During this process, members of the forecast group incorporate any newly released data, any legislative changes affecting fiscal policy since the previous forecast, and any new economic information. The inputs include forecasts of several important budget variables, including components of federal outlays and revenues, which are constructed by members of CBO's budget and tax divisions. The forecasts of many of the budget variables depend on variables in the economic forecast—lower interest rates, for example, lead to lower federal spending for debt service—and the economic forecast depends on these inputs. Some categories of federal spending, for example, are part of GDP. As a result, these budget inputs vary during the course of the forecast round as the macroeconomic and budget projections become more finely tuned.

Members of the forecast group also consult with outside experts during the forecast round (and between rounds). If, for example, an equation in the model is over- or under-forecasting a variable like inflation during the recent historical sample, analysts might seek advice from

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[1] In CBO's reports, the short run (or near term) describes the first few years of the 10-year forecast horizon and the medium term describes the later years of the 10-year forecast horizon. CBO also produces a long-term budget projection that spans 30 years.

experts in other agencies or outside of the government to understand the recent data and possibly improve the model's predictions.

Members of the forecast group apply a substantial degree of judgment to their sectors' forecast. CBO's analysts use economic theory to choose the variables that will be used in the econometric equations in the model. Those equations, which describe statistical relationships between one variable and one or more other variables in the model, are used to generate the forecasts of the variables in each analyst's sector. However, if an analyst has information about the near-term outlook, say a disruption to agricultural production caused by an extreme weather event, then he or she would adjust the forecast from the econometric equation to account for that information.[2] Similarly, if the econometric equation has a large error in the recent history, immediately reverting to the equation's forecast would cause a spike in the growth rate. If that historical error was caused by a factor that was known to be temporary (such as a labor strike), then a quick reversion to the equation's forecast would be appropriate. More commonly, the reasons for the historical error are less certain and thus would be expected to dissipate slowly, suggesting a more gradual reversion to the equation's forecast.

Step Three: Internal and External Review
The preliminary forecast receives internal and external review. It is presented to CBO staff, including senior staff, to check for objectivity and analytical soundness. Then CBO solicits feedback on the forecast from its Panel of Economic Advisers. CBO also seeks input on the economic forecast from the staffs of the House and Senate Committees on the Budget.

Step Four: Final Forecast
CBO prepares a forecast that incorporates all of the internal and external feedback and latest data releases. Once CBO's Director and other members of its executive staff have reviewed the forecast, it is finalized and transmitted to the tax and budget divisions to use as the basis for their projections of federal revenues and outlays. CBO presents its economic forecast and budget projections in a pair of reports that are released annually: *The Budget and Economic Outlook,* which is typically released in January, and an update to the outlook that is usually released in August.[3] In addition, CBO evaluates the quality of its economic forecasts by comparing them

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[2] These adjustments are made using so-called add factors. An add factor is a term that is added to an equation to adjust the forecast of that equation without respecifying or reestimating it.

[3] See Congressional Budget Office, *The Budget and Economic Outlook: 2017 to 2027* (January 2017), www.cbo.gov/publication/52370, and *An Update to the Budget and Economic Outlook: 2017 to 2027* (June 2017), www.cbo.gov/publication/52801.

with the economy's actual performance and with forecasts by other agencies and private-sector forecasters in a report that is released every other year.[4]

An Overview of CBO's Primary Forecasting Model

CBO's primary forecasting model is a large-scale macro model similar to those used by private entities and other government agencies that forecast the economy at an aggregate level.[5] CBO's macro model consists of over 900 variables and about 600 equations. Of the variables in the model, about 300 are exogenous, meaning that their forecast values are calculated outside of the model, and about 600 are endogenous, meaning that their forecast values are calculated using the equations in the model. The 600 equations in the model can be classified into two categories:

- *Stochastic equations* are those that capture a relationship that is measured with error. Usually, they represent a behavioral relationship, with the form of the equation based on an economic hypothesis about that relationship and with coefficients estimated using statistical regression techniques. For example, an equation might relate consumer spending to personal income and other variables, but the equation would not hold exactly in every period.

- *Identities* are equations that are true by definition. As an example, nominal GDP is always equal to the sum of consumer spending, investment, government spending, and net exports, no matter what values any of those components take, because nominal GDP is defined as the sum of those components.

Once forecasts of the model's inputs (that is, the exogenous variables) are added to the model, it can be solved to produce 10-year forecasts for each of the 600 endogenous variables.

The main purpose of CBO's macro model is to construct the economic forecast. Hence, the most important consideration when an analyst chooses the variables for a stochastic equation is the equation's ability to forecast an endogenous variable. With that goal in mind, an analyst would generally perform the following steps when setting up (or improving) a stochastic equation. First, he or she would use the relevant economic theory to determine what variables to include in the equation and what functional form to use. Second, the analyst would check the historical fit of the equation using standard econometric techniques. Finally, he or she would check the equation's forecasting ability by running out-of-sample forecasting tests. Such tests entail estimating the equation over a subset of the historical sample, using the estimated equation to

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[4] See Congressional Budget Office, *CBO's Economic Forecasting Record 2017 Update* (October 2017), www.cbo.gov/publication/53090.

[5] In its most basic form, an economic model is a mathematical representation of an economic relationship (or set of relationships). It is usually specified in the form of an equation (or system of equations) that relates one variable or economic statistic to one or more other variables, often using statistically estimated coefficients to capture behavioral relationships.

forecast the endogenous variable over the remainder of the sample, and comparing the forecasted values to the actual values of the endogenous variable.

Using a macro model of this type to prepare the forecast confers several advantages. It allows CBO to make forecasts based on historical data using a systematic, clearly defined method. In addition, it facilitates internal consistency—making sure that the forecasts of different sectors of the economy are consistent with one another—and allows for easy replication of methods for forecasting over time. Lastly, using models allows CBO to incorporate behavioral responses by consumers and businesses to changes in policy or economic conditions in the forecast. For example, a stock market surge that raised household wealth would most likely cause consumers to increase their spending on goods and services. Using a model allows CBO to trace the effect of that change in consumer behavior on other variables in the economy, including real GDP and inflation.

Consistency Within the Model and Between Models

As noted above, a key feature of models like CBO's macro model is that they produce forecasts that are internally consistent. This is particularly important when many variables in the model are simultaneously determined, meaning that changes in a particular variable affect other variables in the model which might, in turn, influence the first variable. For example, GDP in a given year is determined in part by the level of consumer spending in that year, because consumption is a component of final demand, along with investment, government spending, and net exports. However, consumer spending in any given year is influenced by the level of GDP in that year because faster GDP growth is likely to lead to higher incomes and more spending by consumers. Using a large-scale macro model allows CBO to produce forecasts for simultaneously determined variables, like GDP and consumer spending, that are consistent with one another.

CBO's macro model is the central model used to produce the forecast but it is not the only one used (see Figure 2). Analysts use side models to produce forecasts of the inputs to the large-scale model. For example, CBO forecasts the labor force participation rate with an econometric model that uses a highly disaggregated breakdown of the population by age, sex, and other demographic characteristics. In principle, the equations in the participation model could be included in the macro model, but in practice, the participation model is quite complex. So CBO forecasts the labor force participation rate in a separate model to ensure that both models are manageable.[6]

Interaction of Aggregate Demand and Aggregate Supply

CBO's macro model reflects the basic idea that aggregate economic activity is determined by the interaction of aggregate demand and aggregate supply in various markets in the economy. Aggregate demand refers to the amount of goods and services that consumers, business, and

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[6] See Joshua Montes, *CBO's Model of the Labor Force Participation Rate: Historical Determinants and Projections,* Working Paper (Congressional Budget Office, forthcoming).

governments will buy at a given price level, holding incomes and other economic variables constant. Aggregate supply refers to the amount of output that businesses are willing and able to

Figure 2. CBO's Forecasting Models

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                        │    CBO's Labor Force      │
                        │ Participation Rate Model  │
                        └──────────────────────────┘
                      (Unemployment        (Labor Force
                          Gap)*       Participation Rate)

┌──────────────────────┐  ┌────────────────────────────────────────────┐  ┌──────────────────────┐
│ Exogenous Variables  │  │       CBO's Macroeconometric Model          │  │   CBO's Budget       │
│  • Population        │  │  Aggregate Demand      Other Variables      │  │   Projections        │
│  • Energy Prices     │  │   • Consumer Spending    • Inflation        │  │  • Federal Outlays   │
│  • Foreign Growth    │  │   • Business Investment  • Interest Rates    │  │  • Federal Revenues  │
│ Policy Variables     │  │   • Residential Investment • Labor Market variables │  └──────────────────────┘
│  • Labor Supply Elasticities │ │ • Gov't Spending     - Unemployment   │
│  • Marginal Tax Rates │ │   • Net Exports          - Employment         │
│  • Other Fiscal Policies │ │                         - Wages & Comp.    │
│                      │  │  Aggregate Supply        • Incomes           │
│                      │  │   • Potential Output                         │
└──────────────────────┘  └────────────────────────────────────────────┘
                   (Investment, Potential      (Potential Output, Hours,
                     Labor Force, and           Productivity, and
                     Other Variables)           Other Variables)
                        ┌──────────────────────────┐
                        │     CBO's Forecast        │
                        │     Growth Model          │
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[* Text corrected on March 5, 2018.]

produce given the prevailing price level, holding costs and productive capacity constant. CBO's model, like the economy as a whole, determines the actual economic outcome through the interaction between aggregate demand and aggregate supply in the markets for goods and services, for labor, and for financial assets. The workings of those markets jointly determine such variables as output, employment, prices, and interest rates.

CBO's model reflects the widely held view that short-run fluctuations in economic activity are determined primarily by movements in aggregate demand, with the factors underlying aggregate supply, such as capital stocks and technology, taken as given. In particular, short-run fluctuations in real GDP are driven by cyclical movements in the categories of final demand such as consumption and investment, rather than by movements in potential output. (Potential output is

the amount of real GDP that can be produced if labor and capital are employed at maximum sustainable rates). Other variables, including wages, prices, exchange rates and interest rates, adjust as the economy moves towards equilibrium: that is, a situation where the amount of goods and services that consumers, businesses, and governments are willing to purchase is equal to the amount that businesses are willing and able to supply. However, that process is not instantaneous, so GDP does not necessarily equal potential GDP in the near term, and significant gaps between GDP and potential GDP can open over the course of a business cycle.

In the medium term, when businesses are better able to alter their inputs to production, CBO's model reflects the view that economic activity is governed mostly by changes in aggregate supply, as reflected in potential output. Those inputs to production include the supply of labor, the supply of capital services, and the level of technology in the economy. Consequently, for the latter part of the projection period, CBO does not estimate cyclical components. Instead, it projects that actual output will grow at the same rate as potential output. Other variables in the macro model are projected to equal their equilibrium levels or grow at equilibrium rates. This approach does not imply that business cycles will not occur later in the projection period. Certainly, fluctuations will continue to occur and the output gap, or percentage difference between GDP and potential GDP, will be positive for some periods and negative for others. But CBO does not attempt to predict the timing or magnitude of such cyclical fluctuations more than five years into the future. In that period, CBO interprets its forecast as falling in the middle of the range of possible outcomes, and incorporating the possibility of recessions and expansions. [7]

Aggregate Demand in CBO's Macro Model

As noted above, aggregate demand describes the purchases of goods and services by consumers, businesses, governments, and foreigners. Its components include consumer spending, business investment, residential investment, government spending, and international trade. The methods used to forecast those components and subcomponents vary, but each is based on the relevant economic theory.

Consumer Spending
CBO forecasts the consumer sector on a top-down basis, first projecting total per-capita consumer spending in real terms before splitting that total quantity into various categories of spending, including durable goods, nondurable goods, and services, and splitting those categories further into subcategories. The equation that CBO uses to project total consumer spending is estimated to fit the patterns in historical time-series data and is designed to be consistent with the aggregate consumption functions that economists derive from the theory of optimal household

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[7] CBO projects that real GDP will stay one-half of one percent below potential GDP in the medium term—as it has roughly done, on average, since World War II. See Congressional Budget Office, *Why CBO Projects That Actual Output Will Be Below Potential Output on Average* (February 2015), www.cbo.gov/publication/49890.

consumption in the presence of uncertainty and impatience.[8] Dividing total consumer spending into subcategories enables CBO to project the prices of goods and services at a finer level of detail, such as health care or motor vehicles, and to calculate consumer price inflation more accurately. In addition, breaking spending into subcategories provides insight into the sources of trends in overall consumer spending.

Factors related to income and wealth are the most important influences on CBO's projections for consumer spending, but CBO's equation also includes measures of unemployment, credit availability, and household size. Basic economic theory suggests that consumer spending by individuals is related to their "permanent" or expected lifetime incomes as long as they plan ahead and are able to borrow against future income. For a variety of reasons, many consumers' circumstances and behavior differ from that simplified ideal. Although many consumers are able to smooth their spending over time, evidence indicates that a large fraction of the population consumes only out of its current income. In CBO's forecasting equation, consumer spending is allowed to respond to current real disposable (after-tax) income as well as to an estimate of permanent income. That permanent-income concept is represented by a modified version of CBO's estimate of the real potential GDP of the economy, which for this purpose is adjusted for inflation in consumer prices rather than for economy-wide inflation.

In CBO's macro model, the effect of wealth on consumption is captured by the value of household real estate assets and the value of household equity holdings (both measured in real terms). The equation does not explicitly account for other household assets and liabilities, most notably mortgage debt.

Explaining the pattern of consumer spending during most recessions requires additional factors beyond those related to income and wealth. Periods of elevated unemployment help explain sharp contractions of consumer spending. (CBO uses a survey-based measure of expected future unemployment to explain history and forecasts that measure of expected unemployment so that it adjusts over time to equal CBO's projection of actual unemployment). Credit market factors are also allowed to influence consumer spending through the Federal Reserve's survey measure of banks' willingness to make consumer loans; CBO projects that measure as a function of real and financial variables that drive credit risk (that is, the risk of default on consumer loans) over the business cycle.

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[8] See Carroll, Christopher D., "A Theory of the Consumption Function, With and Without Liquidity Constraints," *Journal of Economic Perspectives,* vol. 15, no. 3 (Summer 2001), pp. 23–45, www.jstor.org/stable/2696555. An alternative rationale for such empirical relationships assumes that a large fraction of consumers simply follow a rule of thumb when consuming their current income rather than making fully rational forward-looking decisions about spending and saving. See John Y. Campbell and N. Gregory Mankiw, "Consumption, Income and Interest Rates: Reinterpreting the Time Series Evidence," in *NBER Macroeconomics Annual 1989*, vol. 4 (MIT Press, 1989), pp. 185–246.

Finally, CBO allows a role for the population in its forecast of consumer spending because such spending is modeled on a per-capita basis. The equation for consumer spending also includes the number of households because economies of scale within households mean that consumer spending by a given number of people is lower when they are grouped in larger households.

CBO forecasts the components of overall consumer spending by projecting each component as a share of total spending. Using this approach, CBO derives projections for three categories of durable goods (motor vehicles and parts, electronics, and other durables), three categories of nondurable goods (food, energy goods, and other nondurables) and three categories of services (housing, energy services, and other services). Given CBO's projection for total consumer expenditures, a parallel equation provides the basis for a projection for nondurable goods and services, which in turn allows the calculation of a residual projection for durable goods. Within durables, the shares of motor vehicles and electronics are projected according to an assessment of historical trends. Within the combined aggregate of nondurable goods and services, expenditures on housing services are determined as a function of the housing capital stock, and then the shares of other categories of nondurable and service expenditures are projected in line with trends in historic shares.

Business Investment
CBO forecasts the components of business investment on a disaggregated basis, in real terms. Those components include five categories of producers' durable equipment (computers and peripherals, mining and oilfield machinery, agricultural machinery, communication equipment, and other equipment), three categories of intellectual property products (software, research and development, and entertainment, literary, and artistic originals), three categories of nonresidential structures (mining, farm, and other structures), and the change in private inventories.

Most categories of business investment are modeled using a modified neoclassical specification—a specification in which the economy's capital stock is a function of output and the cost of capital.[9] In that specification, the level of investment responds most strongly to the growth of output—both past growth and expected future growth—a relationship known as the accelerator. One way that businesses respond to changes in demand for their output is to adjust their stock of capital assets, including factories, vehicles, and equipment, by changing their level of investment in those assets. Because businesses' expectations of future demand depend on their expectations of potential output, the factors that drive the growth of that potential output, including labor supply and productivity, also boost business investment. Aside from the growth

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[9] In CBO's specification, investment is a function of the growth of output and the level of the cost of capital. In the standard neoclassical specification, investment is a function of the growth of output and changes in the cost of capital. See Mark Lasky, *CBO's Model for Forecasting Business Investment*, Working Paper (Congressional Budget Office, forthcoming).

of output, investment also depends on the cost of capital, which includes firms' cost of funds (in equity markets, debt markets, or both), the price of new investment, taxes, and depreciation. The cost of funds to firms is affected by domestic interest rates, which reflect the influence of national saving in the United States and the demand for U.S. assets by residents of foreign countries.

The speed and size of accelerator responses vary with the type of investment. The response of investment to output is slowest for structures, which take time both to plan and to build. The response of investment to output is most rapid and largest for inventories. Real inventory investment has turned negative in every U.S. recession since World War II. Investment in intellectual property products is the category of investment least responsive to the business cycle.

Investment in capital specific to the mining and farming sectors is modeled differently from investment in other capital. Investment in those sectors, rather than depending primarily on growth of demand, depends primarily on the price of output. For example, investment in mining structures is highly responsive to the domestic price of crude oil.

Residential Investment
CBO uses a single equation to forecast real private residential investment, which is composed primarily of new single-family construction, new multi-family construction, brokers' commissions and other ownership transfer costs, and improvements. That equation includes the following variables to explain movements in those components during the historical sample and project them during the forecast horizon:

- Housing starts and value added per start to capture movements in new construction,

- Total home sales and the average sales price to explain brokers' commissions and other transfer costs, and

- Disposable income and sales of existing homes to explain home improvements.

The most important driver of the real value of new construction of both single-family and multi-family residences is the number of new housing units started, or housing starts, while the value added per start (roughly, the sale price of a home minus the cost of land) drives the current-dollar value of new construction per start. The key determinant of housing starts in the long run is household formation, which is the net change in the total number of households. In CBO's macro model, household formation depends primarily on demographics; that demographically driven component equals the headship rate (the number of households per person) for an age group times the change in the number of people in that age group. In addition, employment growth and mortgage lending standards influence household formation.

Housing starts depend on a variety of additional factors in the short run. An excess of housing supply, which is a function of the difference between the total number of housing units and the total number of households, reduces the need for additional units, thus reducing starts. Housing starts depend positively on the prospect that home prices will appreciate (based on recent appreciation), on increases in bank loan officers' willingness to make consumer loans, and on the level of home prices (an indicator of the incentive to build). Housing starts depend negatively on the mortgage rate and the tightness of mortgage lending standards. The value added per housing start is modeled as a function of income per household.

Transfer costs are modeled as home sales times the average sales price times transfer costs as a percentage of the sales price. The turnover rate (home sales as a fraction of the total housing stock) depends on the same factors as housing starts but with a larger role for the mortgage rate. Home improvements are modeled using disposable income and sales of existing homes.

Government Spending

CBO forecasts government spending on a disaggregated basis, using the breakdown found in the national income and product accounts (NIPAs). The forecast of federal spending on a NIPA basis is adjusted to be consistent with the projection of federal outlays in CBO's baseline budget projections, which are set on a budget basis.[10] To ensure that consistency, most of the forecasts of the components of federal spending are done in nominal terms and are then combined with corresponding forecasts of price indexes to calculate the forecast in real terms. In contrast, most other sectors in the model, including the components of state and local spending, are forecast in real terms.

In CBO's macro model, as in the NIPAs, total federal spending is the sum of federal consumption expenditures and federal gross investment.[11] Each of those components is broken down into defense and nondefense categories, and federal consumption expenditures are further divided into such categories as compensation paid to federal workers and depreciation of fixed assets owned by the federal government. Most of those federal government transactions are exogenous to CBO's macro model and are projected, in nominal terms, by analysts in the budget division. While most federal spending is treated as exogenous to CBO's macro model, calculating its forecast involves a number of iterations between divisions within CBO to ensure

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[10] For a detailed discussion and description of the relationship between CBO's baseline federal budget projections and CBO's projections of the federal sector recorded on a NIPA basis, see Congressional Budget Office, CBO's *Projections of Federal Receipts and Expenditures in the National Income and Product Accounts* (September 2016), www.cbo.gov/publication/51922.

[11] From the perspective of the NIPAs, the government sector is both a producer and a consumer. Its workforce uses purchased goods, services and government-owned capital (buildings, equipment, software, and research and development) to produce services for the public at large. Because those services are consumed by the public, such purchases, by convention, are regarded as government consumption expenditures in the NIPAs. Government gross investment consists of spending for the additions to and the replacement of the stock of government-owned capital.

that any macroeconomic feedback to the federal budget is properly accounted for. Specifically, preliminary forecasts of GDP, interest rates and other economic variables are used by analysts in the budget division to calculate a preliminary forecast of federal outlays and their components. That preliminary budget forecast is then used in subsequent runs of the macro model. The updated forecasts of economic variables are used to compute an updated budget forecast. This process of iterating back and forth ensures the consistency of the macro model with CBO's baseline projections of federal revenues and outlays.

Total state and local government spending, as measured in GDP, is the sum of consumption expenditures and gross investment at the state and local level. State and local consumption expenditures are further broken down into the same subcategories as federal consumption expenditures. Some of the state and local government variables are exogenous to CBO's macro model, but the major elements in state and local government spending are determined by the model.

Real compensation of state and local government employees, the largest component of state and local government consumption expenditures, is projected within CBO's macro model. The key determinants of real compensation of state and local government employees are the previous quarter's deflator—a type of index that measures price levels—for state and local government compensation, federal grants-in-aid to state and local governments, state and local government current receipts (less federal grants-in-aid), and state and local government current expenditures (less compensation of state and local government employees). The deflator for state and local government compensation is also endogenous to CBO's macro model and depends, in part, on the average wage per hour prevailing in the overall economy. The nominal value of compensation of state and local government employees is calculated as the product of the real value of such compensation and corresponding price deflator.

Real state and local gross investment, in CBO's macro model, is influenced by the resources available to state and local governments, as reflected in property tax receipts and in capital grants paid by the federal government. In addition, it is affected by overall economic activity, as reflected in the output gap and the growth of potential output, and by the price deflator for state and local investment. The growth of the price deflator for state and local gross investment is modeled as a function of past values of the price index for private fixed investment in mining and oilfields and of core PCE (personal consumption expenditure) inflation. The nominal value of state and local gross investment is then derived as the product of real state and local gross investment and its deflator.

Net Exports
CBO forecasts total exports and total imports separately to generate a forecast of net exports. The major components of exports and imports are projected in real terms: four categories of trade in

goods (capital goods, agricultural goods, petroleum products, and other traded goods) and two categories of trade in services (transit and travel services, and other traded services).

CBO's projections for most categories of imports are driven primarily by two factors: domestic demand and relative prices. Economic theory and empirical evidence suggest that when domestic demand for goods and services increases, demand for corresponding imported goods and services rises. Therefore, in CBO's macro model, imports of goods and services respond to changes in domestic demand for those goods and services. In addition, imports tend to rise when the prices for foreign goods and services fall relative to comparable domestic prices. To account for that dynamic, CBO constructs and projects import-weighted indexes for foreign consumer prices and the exchange value of the dollar.[12] Those indexes are then included as exogenous, explanatory variables in CBO's macro model. In that model, declines in foreign prices and increases in the value of the dollar both lead to stronger growth in imports by lowering the price of foreign goods and services (in terms of dollars) relative to the prices for domestic goods and services.

CBO uses a similar method to project most categories of exports. To model foreign demand for U.S. goods and services, CBO estimates and forecasts an export-weighted index of foreign output as an exogenous input to the export equations. Increases in foreign output signal greater demand for U.S. goods and services, leading to stronger U.S. exports. In addition, CBO constructs export-weighted indexes of foreign prices and the exchange value of the dollar to account for how changes in the price of U.S. exports relative to foreign goods and services affect exports. When foreign prices rise or the exchange value of the dollar falls, U.S. goods and services become more competitive in foreign markets, boosting U.S. exports.

Imports and exports of petroleum products are modeled differently than other categories of traded goods and services. Those variables are modeled differently because trade flows in petroleum products are much more sensitive to domestic production than are other categories of traded goods and services. In CBO's macro model, real exports of petroleum products are projected as a function of domestic petroleum production and the price of crude oil. Given that projection, CBO then calculates its forecast of real imports of petroleum products as the difference between the domestic production of petroleum products (less real exports) and the real consumption of petroleum products.

CBO's projections of nominal U.S. trade flows have important implications for the agency's projection of international investment flows. When U.S. expenditures on goods and services

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[12] CBO's measure of the exchange value of the dollar is an export-weighted average of the exchange rate index between the dollar and the currencies of leading U.S. trading partners. CBO's forecast of the exchange rate in the near term is based on the forecast of that rate provided by Consensus Economics, which averages the exchange rate forecasts of a large number of outside forecasters.

exceed foreign expenditures on U.S. goods and services, the United States is said to run a trade deficit. Together with the net foreign investment income, the trade balance determines the current account balance. A current account deficit must be accommodated by borrowing from abroad; a surplus means the country is a net lender. The current account balance, in turn, is equal to the national savings-investment balance: the difference between the economy's saving made available from consumers, businesses and government to finance capital investment minus the actual domestic spending on capital goods and structures. Therefore, any adjustment in a country's current account balance must be associated with an equivalent modification of its savings-investment balance. That is, any reduction in the U.S. current account (or the trade deficit) must be associated with an increase in savings out of income, a decrease in investment, or a combination of the two.

Aggregate Supply in CBO's Macro Model

As noted above, aggregate supply describes the ability of the economy to produce goods and services. In CBO's macro model, aggregate supply is closely related to CBO's estimate of potential output, which is equal to the amount of real GDP attainable if the nation's labor and capital are employed at maximum sustainable rates. Potential output is an estimate of the trend around which economic activity fluctuates over business cycles. It serves as the agency's primary long-term measure of economic activity. CBO forecasts potential output using a separate model, the forecasting growth model. However, that model is closely linked to the macro model to ensure that the forecast of potential output is fully consistent with the forecast of investment and other variables in the macro model.[13]

In CBO's forecasting growth model, the estimate of potential output is built up from estimates of the potential values of most of the inputs to production—that is, trend values that exclude variation in the actual values of inputs that are attributable to business cycle fluctuations. To calculate those business-cycle effects, the agency uses the gap between the unemployment rate and the "natural rate" of unemployment, which is the rate that is consistent with sustainable levels of employment.[14] The resulting values measure not only the sustainable trends in those inputs but also their sustainable capacity to contribute to productive activity.

An important determinant of potential output is the size of the potential labor force. CBO builds up an estimate of the aggregate potential labor force based on trends in participation and growth

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[13] See Robert Shackleton, *Estimating and Projecting Potential Output Using CBO's Forecasting Growth Model*, Working Paper (Congressional Budget Office, forthcoming).

[14] The natural rate of unemployment is defined as the rate arising from all sources of unemployment except fluctuations in aggregate demand. Deviations of the actual rate of unemployment from the natural rate are taken to be a primary measure of the state of the business cycle: If the unemployment rate exceeds the natural rate, the economy is operating below its sustainable level; if it falls below the natural rate, the economy is operating beyond its sustainable level.

among different demographic groups in the population using a separate model of labor force participation rates. The agency next combines the potential labor supply with its estimate of the natural rate of unemployment to calculate an estimate of potential employment. It then distributes that employment to several different sectors of the economy and estimates potential output in each sector separately.

For the bulk of the economy—the nonfarm business sector, which historically accounts for about three-quarters of total GDP—CBO uses a framework that focuses mainly on the amount of labor (measured as the potential number of hours worked), the productive services provided by capital (including physical capital such as plant and equipment as well as more abstract types of capital such as intellectual property), and the joint productivity of those factors, referred to as potential total factor productivity (TFP). (In contrast to the other inputs to production, the agency does not adjust its measure of capital services to remove the effects of business cycle fluctuations— although the use of the capital stock varies during the business cycle, the potential flow of services will always be related to the quantity of capital in the sector rather than to the amount of capital that is currently being used.) Most of the other sectors are modeled mainly in terms of the potential number of employees and their potential labor productivity. An exception is the owner-occupied housing sector, which is modeled as a function of the stock of owner-occupied housing and is largely unaffected by business-cycle fluctuations.

In CBO's forecasting growth model, the forecast for capital services is a function of the future size of the capital stock, which is significantly affected by CBO's forecast of business investment. To ensure consistency between the forecast of potential output and the forecast of business investment from the macro model, CBO again uses an iterative procedure. Taking the forecasts of business investment and other less important variables from the macro model as inputs, the growth model calculates a forecast of potential output, which is then applied in subsequent runs of the macro model. That forecast of potential output affects the medium-term forecast for real GDP growth in the macro model, which in turn causes further changes to the forecast for business investment. The updated investment forecast is then entered in the growth model and the process is repeated until the investment forecast is fully consistent with the resultant forecast for potential output growth. Although the equations used to compute potential output could be embedded in the macro model, there are a large number of them. Consequently, they are maintained in a separate model to ensure that both models are manageable.

CBO projects potential TFP on the basis of historical trends in TFP growth. However, projecting trends in TFP is particularly challenging because it is, by definition, a measure of unexplained growth in output. In addition, it has been marked, historically, by lengthy periods of relatively steady growth followed by rather abrupt transitions to substantially different growth rates. The agency therefore applies a substantial degree of judgment to its projections of potential TFP rather than simply projecting the most recent estimated trend. The projection for the potential

labor force is discussed below, in the section that describes the macro model's labor market variables.

Other Variables in CBO's Macro Model

In CBO's macro model, the interaction of aggregate demand and aggregate supply in the market for goods and services has implications for other variables in the model. In the near term, changes in real GDP are determined primarily by movements in aggregate demand because potential output in the economy adjusts slowly to changing conditions. If, for example, the level of aggregate demand falls short of potential GDP in a given year, then there will be slack (or unused resources) in the economy. Markets adjust to bring aggregate supply and aggregate demand into balance through changes in prices, wages, interest rates, and exchange rates. In the example above, one would expect wages and prices to grow more slowly, the unemployment rate to be higher, and interest rates to be lower than would be the case if GDP were equal to or exceeded potential GDP. Those adjustments are caused by the balance of demand and supply and, in turn, have implications for demand in the future: Lower prices and interest rates would be expected to spur faster growth in demand for certain categories of goods and services. Similarly, lower wages might increase the demand for labor, lowering the unemployment rates. All of those feedbacks would combine to close the output gap over time, bringing aggregate demand back up to potential output. In the medium term, after those adjustments are complete, CBO projects that potential output and aggregate demand will balance and that real GDP will grow at the same rate as potential output.

Inflation
CBO produces forecasts for many different measures of inflation, including consumer price inflation as measured by the price index for personal consumption expenditures (PCE price index) and the consumer price index (CPI), and economywide inflation as measured by the GDP deflator. CBO models these inflation measures at both an aggregate level and a detailed, component level. Overall, CBO's macro model includes nearly 100 price indexes, including deflators for various categories of spending in the NIPAs, price indexes for various components of the CPI, and other price indexes that are required for the projections of federal spending and revenues.

Among the price indices that CBO forecasts, the central measure is the core PCE price index, which is defined as the price index for all items in PCE excluding food and energy. CBO focuses on the PCE price index largely because it is the measure used by the Federal Reserve to set its inflation target—currently at 2 percent per year. CBO focuses on core inflation instead of overall inflation because, by eliminating the volatility in the overall measure caused by swings in food and energy prices, core inflation provides a better indicator of where inflation is headed in the medium term.

To forecast core PCE inflation, CBO uses a variant of a Phillips curve equation. A standard Phillips curve equation links changes in core inflation to three sets of macroeconomic variables: variables measuring inflation expectations, variables measuring the extent of excess aggregate demand as modeled by the unemployment gap, and variables measuring shocks from aggregate supply. CBO's Phillips curve equation also contains several features that reflect the changing nature of inflation dynamics over the past fifty years. For example, CBO uses past inflation rates to model inflation expectations before the late 1990s, but a combination of past inflation and a constant inflation target to model inflation expectations afterwards. By allowing the process of expectations formation to change over time, CBO's Phillips curve captures the so-called anchoring of long-term inflation expectations in the U.S. since the late 1990s, which in turn is associated with the gradual shift of monetary policy toward a new framework known as inflation targeting. In addition, the slope of the Phillips curve, which captures the negative relationship between unemployment and inflation, is estimated to have decreased during the past three decades, reflecting the decreased responsiveness of inflation to changes in the labor market conditions observed in the data since the mid-1980s.

For the near term, however, CBO augments the Phillips curve forecast using information gleaned from a bottom-up approach based on forecasts of the components of overall consumer prices. Specifically, CBO uses side equations to forecast the major components of the core PCE price index, such as the price indexes for shelter, motor vehicles and parts, computers and other electronic goods, and medical care goods and services. These equations are designed to capture recent trends in those components and to account for sector-specific factors and other idiosyncratic shocks to the individual price indexes. For example, core PCE inflation was much lower than the Federal Reserve's target during the first half of 2017 despite the fact that there was very little slack in the economy. It turned out that nearly half of the difference between the data and the target could be explained by a sharp but temporary decline in the price of wireless phone services, after the Bureau of Labor Statistics introduced new methodology for quality adjustment and wireless service carriers started to offer unlimited data packages. The impact of such idiosyncratic shocks will not be captured by the Phillips curve, but will be accounted for under the bottom-up approach.

CBO relies on the bottom-up approach to forecast inflation in the very near term, a period that varies in length depending on economic conditions but is usually a year or two, and relies on the Phillips curve to forecast inflation for the remaining years of the forecast horizon.

Monetary Policy and Interest Rates
CBO projects interest rates on Treasury securities of various maturities, the most important of which are the 3-month Treasury bill rate and the 10-year Treasury note rate. The agency's forecasts of rates on Treasury securities of other maturities are based on the forecasts of those two key rates. CBO's method for projecting interest rates on Treasury securities differs by the time period covered by the forecast and the maturity of the security being forecast.

The main input to CBO's short-term forecast of the three-month Treasury bill rate is the expected path of the federal funds rate—the interest rate that financial institutions charge each other for overnight loans on their monetary reserves. Because that rate is targeted by the Federal Reserve, CBO's projection of the federal funds rate is based on an equation that characterizes the Federal Reserve's response to movements in the economy. That equation, referred to as the Taylor rule, relates the nominal federal funds rate to the output gap, the difference between the projected inflation rate and the Federal Reserve's target inflation rate of 2 percent, and the neutral policy rate. The neutral policy rate is the value of the federal funds interest rate when output is equal to potential and the inflation rate is at the target rate. CBO uses the Taylor rule to forecast the federal funds rate given the agency's forecasts of the output gap and inflation and compares that forecast with those of outside forecasters as well as to the forecast implied by prices in futures markets. CBO then uses the forecasted federal funds rate to project the three-month Treasury bill rate based on the historic relationship between the two rates.

CBO's projection of the nominal 10-year Treasury note rate in the near term is based on the forecast of the 3-month Treasury bill rate plus a forecast of the term premium—the compensation that bondholders require for the extra risk associated with holding a long-term security instead of a series of shorter-term securities. CBO's forecast of the term premium takes account of factors that determine the demand for long-term securities, including the desire on the part of investors to buy such securities as a hedge against possible shocks to inflation and equity prices and the Federal Reserve's program of quantitative easing, which involves large-scale purchases of long-term securities.[15]

CBO's projection of interest rates over the medium term focuses on the 10-year Treasury note rate. CBO's method for projecting that rate begins with an analysis of the factors that affect those rates after the economy transitions to its average relationship with potential output. The agency considers how those factors are projected to differ in the medium term relative to their values between 1990 and 2007, a period of stable expected inflation and relatively mild economic fluctuations. The factors examined are:

- *Growth of the labor force.* All else being equal, slower growth in the number of workers will tend to increase the amount of capital per worker in the long term, reducing the return on capital and, therefore, the return on government bonds and other investments.

- *Share of total income received by higher-income households.* Higher-income households tend to save a greater proportion of their income. As their share of total income rises, the

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[15] For further discussion of factors that have recently pushed down the term premium, see Congressional Budget Office, *The Budget and Economic Outlook: 2017 to 2027* (January 2017), www.cbo.gov/publication/52370.

total amount of saving available for investment tends to rise as well. As a consequence, the amount of capital per worker rises and interest rates fall.

- *Growth of TFP.* For a given rate of investment, lower productivity growth reduces the return on capital and results in lower interest rates, all else being equal.

- *Financial markets' appetite for risk.* All else being held constant, an increase in the demand for low-risk assets tends to reduce the interest rate on Treasury securities.

- *Federal debt as a percentage of GDP.* Increased federal borrowing tends to crowd out private investment in the long term, reducing the amount of capital per worker and increasing both the return on capital and interest rates over time.

- *Net inflows of capital from other countries.* All else being held constant, decreasing net inflows of capital from other countries tend to decrease domestic investment and the amount of capital per worker, thus boosting rates of return on Treasury securities.

- *Demographics.* As the population ages, the number of workers in their prime saving years declines relative to the number of older people who are drawing down their savings. As a result, the total amount of savings available for investment decreases (all else being equal), which will tend to reduce the amount of capital per worker and thereby push up interest rates.

CBO projects short-term interest rates over the medium term based on the projected 10-year rate and a forecast of the term premium, the same two bases used to forecast the rates over the short term. Similarly, CBO forecasts the term premium based on the historical relationship between short-term and long-term rates but also considers factors which are likely to cause the term premium to behave differently than it has in the past. For example, the size of the Federal Reserve's balance sheet and the demand for Treasury securities as a possible hedge against unexpectedly low inflation are two factors that are likely to keep the term premium below its historical average over the medium term.

In the transition from the short-term forecast to the medium-term forecast, CBO projects that the adjustments in interest rates will be consistent with the projected movement in the underlying factors. As the economy transitions from its current position to its historical relationship with potential output and inflation reaches the Federal Reserve's target rate of 2 percent, interest rates are expected to adjust to levels that are consistent with long-term trend values of the factors listed above.

Labor Markets
CBO's macro model includes a host of labor market variables, some of which are largely insulated from fluctuations in the other sectors of the model and other variables that are quite

sensitive to such fluctuations. The methods used to forecast these labor market variables, which include the labor force, the unemployment rate, average weekly hours, compensation growth, and productivity, vary widely.

The civilian labor force is a critical labor market variable in CBO's macro model because it feeds into both the demand side and the supply side of the economy. CBO forecasts the labor force using a separate model that combines projections of the population, broken down by age, sex, education, and race, with projections of labor force participation rates for those same demographic groups.[16] That model includes equations that explain changes in the participation rate of each demographic group as a function of the unemployment gap (a measure of the state of the business cycle) and a set of structural variables that affect an individual's decision to participate in the labor force, including life expectancy, disability status, presence of children, marital status, and fiscal policy. Using that model ensures that CBO's forecast of the labor force reflects any expected changes in the age composition of the population as well as expected changes in incentives to work, in educational attainment or in the racial or ethnic composition of the population.

CBO also uses the participation model to project the potential (or cyclically adjusted) labor force. To do so, CBO uses the model's equations to forecast the participation rates of each demographic group, but under the assumption that the unemployment gap equals zero during the entire forecast horizon. The resultant forecast of the potential labor force participation rate for each demographic group is combined with a population projection for each group to forecast the potential labor force, which is used to project potential output in CBO's forecasting growth model.

In the near term, CBO forecasts the unemployment rate using an equation that relates changes in the unemployment rate to the forecast for the growth of real GDP. In addition, CBO examines recent trends in the underlying flows of workers into and out of unemployment using high-frequency data to supplement the information conveyed by the growth in real GDP. In the medium term, when CBO makes no attempt to forecast business-cycle fluctuations, the unemployment rate is forecast to reach its historical relationship with the natural rate of unemployment.

CBO's estimate of the natural rate of unemployment, over the historical sample and in the forecast period, is calculated outside of the macro model using the detailed demographic data that are used to calculate the labor force participation rate. CBO calculates the rate by breaking the population down by age, sex, education, and race and estimating a constant natural rate of

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[16] A labor force participation rate is defined as the share of the population that has a job or is actively searching for a job.

unemployment for each of those demographic groups.[17] CBO then computes the overall natural rate as a weighted average of the natural rates of those demographic groups, where the weights in that calculation are the labor force participation rates for the demographic subgroups. An implication of this procedure is that virtually all of the variation through time in the overall natural rate arises because of demographic shifts (that is, changes in the population shares of the demographic groups) rather than changes in the natural rates of the subgroups.

CBO forecasts two overall measures of employment. One is based on the Current Population Survey (the household survey) and the other on the Current Employment Statistics Survey (the establishment survey). Employment from the household survey is forecast using an identity that sets household employment to equal the difference between the total labor force and the number of unemployed, which is equal to the unemployment rate times the labor force. The forecast of employment from the establishment survey is based on an equation that relates its rate of growth to the growth of real GDP. In general, those two measures of employment are closely correlated but not identical because of different source data and definitions. CBO checks to ensure that the relationship between the forecasts of those two measures is consistent with historical trends.

In addition, CBO projects total hours worked in the economy by combining its forecast of establishment employment with a forecast of average weekly hours of private industry workers. The latter series is forecast by extrapolating its trend rate of growth during recent history.

CBO forecasts several measures of hourly wages and compensation, including the employment cost index (for compensation and for wages and salaries), average hourly earnings, and hourly compensation in the nonfarm business sector.[18] In the near term, forecasts of the variables related to labor earnings are based on the degree of slack in the labor market and on recent trends in the series. In the medium term, the forecasts are based on long-term trends in productivity growth, inflation, and the amount of slack in the labor market. In CBO's macro model, growth in labor productivity, or output per hour in the nonfarm business sector, is calculated as the difference between the growth of real output in the nonfarm business sector and the growth of hours worked in that sector, in both the near term and the medium term.

Income Categories
CBO's budget projections are significantly affected by the forecasts of the various types of income in the economy, largely because different types of income are taxed at different rates.

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[17] For most of the historical sample (1949 to 2005), CBO calculates the natural rates for each demographic subgroup using a traditional Phillips curve. For the years since 2005 and in the forecast, CBO estimates that each demographic subgroup's natural rate is equal to that group's observed unemployment rate in 2005—a year when most economists agree that the U.S. labor market was roughly in equilibrium.

[18] Different measures of wages and compensation are useful for different tasks. Some are important inputs for CBO's budget projections; others are important inputs for other sectors of the macro model.

One could consider two different forecasts, each with identical paths for GDP, that had different implications for the budget because one had a higher proportion of income paid as wages and salaries (which have a relatively high effective tax rate) and the other had a higher share of fringe benefits (which have a relatively low rate).

CBO's macro model includes many income categories, including gross national product, national income, and personal income, but wages and salaries and corporate profits are the most important inputs into CBO's budget projections. Wages and salaries, combined with fringe benefits, make up the largest share of national income: compensation paid to employees. Although fringe benefits are a substantial fraction of total compensation, they are generally taxed lightly, so they are less important to CBO's budget projections than are wages and salaries. In CBO's macro model, wages and salaries are equal to the sum of private and government wage and salary payments. Private and government wages are forecast using different methods:

■ Private wages and salaries are built up from other variables in the labor market sector. Specifically, they are modeled as a function of CBO's forecasts of wages per hour (the employment cost index) and total hours worked (itself a function of employment and average weekly hours).

■ Government wages and salaries are forecast based on labor compensation at the federal level and at the state and local level. Federal compensation is exogenous to the structural macro model and is produced by CBO's budget division. State and local government compensation is forecast using state and local tax receipts, federal grants to state and local governments, and non-compensation spending by state and local governments. Fringe benefits in the government are forecast as a share of total government compensation.

Corporate profits are determined following the logic that, for any individual business, profits are calculated as the amount that is left after costs, including the cost of labor and interest payments, are subtracted from total revenue. On a national basis, CBO forecasts corporate profits as the difference between total national income and the sum of labor income, proprietors' income, rental income, business interest payments, payments for taxes on production and imports (largely sales and property taxes), business transfer payments, and the net of subsidies paid by governments and the surplus of government-sponsored enterprises.[19]

The major income categories that are used to calculate corporate profits are forecast using a variety of methods:

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[19] Other income categories in the model, including net income receipts from the rest of the world, consumption of fixed capital, and the statistical discrepancy, are used to calculate gross national product, net national product, and national income.

- Proprietors' income is generally forecast as a share of overall private income, after the effects of the business cycle have been accounted for;

- Rental income is modeled as a function of the residential capital stock;

- Business interest payments are forecast using interest rates and the level of business debt;

- Taxes on production and imports are modeled as a function of GDP growth and, for property taxes, the residential capital stock.

The other, smaller, income categories are either exogenous to the model or are forecast based on the forecast of nominal GDP growth.

Federal Fiscal Policy

Federal fiscal policy—that is, policy governing taxes and spending—affects both aggregate demand and aggregate supply (or potential output) in the economy. Consistent with other elements of the macroeconomic forecast, changes in fiscal policy affect the overall economy in the near term primarily by influencing aggregate demand, which leads to changes in output relative to potential output. In the longer term, fiscal policy primarily affects aggregate supply by altering people's incentive to work and save as well as businesses' incentive to invest.

Fiscal policy affects aggregate demand not only through government spending on goods and services, which contributes directly to GDP, but also through the federal tax code and federal transfer programs. For example, changes to the law governing the taxation of investment spending could alter businesses' incentive to invest and would thereby affect the private demand for investment goods. Similarly, changes to the structure of the tax system might raise or lower households' average tax rates, thereby changing their tax liability and their disposable (that is, after-tax) income, which could affect the demand for consumer goods and services. Likewise, changes in the laws that dictate mandatory spending could modify federal transfer payments to individuals, which would also change households' disposable income and hence the demand for consumer goods and services. Fiscal policy also affects aggregate demand via automatic stabilizers—the automatic decreases in revenues and increases in outlays that occur when the economy weakens—which tend to dampen the size of cyclical movements in the economy by supporting or restraining aggregate demand.[20]

Fiscal policy affects aggregate supply through various channels, including the tax code. For example, policies that reduce marginal tax rates—the percentage of an additional dollar of

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[20] Frank Russek and Kim Kowalewski, *How CBO Estimates Automatic Stabilizers*, Working Paper 2015–07 (Congressional Budget Office, November 2015), www.cbo.gov/publication/51005.

earnings that is unavailable to a taxpayer because it is paid in taxes—generally encourage more work and saving, increasing aggregate supply. As another example, policies that increase the federal deficit typically crowd out private spending on investment, ultimately lowering aggregate supply in the economy. Fiscal policy may also affect aggregate supply by altering the amount of government investment (for example, spending or tax subsidies for infrastructure, education and training, or research and development).

CBO's tax division supplies the structural macroeconomic model with forecasts of effective marginal tax rates on both capital and labor income. The tax division's projections of those marginal tax rates reflect changes in the population and in economic activity but assume that current laws governing taxes remain in place. These rates account for such factors as expiring tax provisions, projections of the distribution of income, expected retirement account distributions, and the effects of real bracket creep. The budget division translates CBO's baseline outlay projections into a NIPA framework and then supplies time series of federal purchases and transfers for use in the macro model. The federal policies supplied by the budget and tax divisions ultimately manifest themselves in CBO's macroeconomic forecast by affecting the economy's aggregate demand, the economy's aggregate supply, or both.