Congressional Budget Office
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Key Methods That CBO Used to Estimate the Macroeconomic Effects of the 2017 Tax Act—Supplemental Material for *The Budget and Economic Outlook: 2018 to 2028*

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In this document, the Congressional Budget Office describes key aspects of the methods that it used to estimate the macroeconomic effects of Public Law 115-97, originally called the Tax Cuts and Jobs Act and called the 2017 tax act in this document. The estimates are discussed in Appendix B of *The Budget and Economic Outlook: 2018 to 2028* (April 2018), www.cbo.gov/publication/53651.

https://go.usa.gov/xQcZD

In the Congressional Budget Office's baseline economic projections, the 2017 tax act's major effects on gross domestic product (GDP) stem partly from increases in investment, on net, and from increases in the supply of labor—which tend to boost potential output. In addition, increases in consumption boost actual output in relation to potential output during the first half of the projection period. Those factors, along with the act's effects on federal budget deficits, are also projected to affect inflation and interest rates, which have important budgetary effects.

To analyze most of those effects, CBO used its standard approaches, augmented with information from recent research and from new approaches developed to examine the act's international effects.[1] The resulting estimates were integrated into CBO's large-scale macroeconometric model to inform the agency's economic projections, which incorporate the assumption that current law—including the tax act—remains in place.[2]

CBO originally prepared a set of those economic projections in early December 2017. The agency then adjusted them to account for the major pieces of legislation that had been enacted subsequently. Those adjusted projections also reflect economic data released through early February 2018. The effects of the 2017 tax act were the second-to-last major adjustment to the projections; the last adjustment incorporated the effects of the Bipartisan Budget Act of 2018 and a preliminary projection of the funding provided by the Consolidated Appropriations Act, 2018.

Investment

In CBO's analysis, the tax act boosts investment, on net, and therefore increases potential output. The main factors that tend to increase investment are changes in the user cost of capital, incentives for some businesses to locate production in the United States, and other increases in economic activity. Those factors are partially offset by increased federal borrowing, which tends to decrease investment.

Effects of Changes in the User Cost of Capital

The user cost of capital, which is the gross pretax return on investment that provides the required return to investors after covering taxes and depreciation, is affected by the act's changes to tax rates on business income, the tax treatment of depreciation, and the deductibility of certain expenses.

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[1] For a general discussion of those standard approaches, see Congressional Budget Office, *How CBO Analyzes the Effects of Changes in Federal Fiscal Policies on the Economy* (November 2014), www.cbo.gov/publication/49494.

[2] For a general description of that macroeconometric model, see Robert W. Arnold, *How CBO Produces Its 10-Year Economic Forecast*, Working Paper 2018-02 (Congressional Budget Office, February 2018), www.cbo.gov/publication/53537.

- Lower tax rates on business income set by the act reduce the pretax return required to cover those taxes. However, they also lower the value of depreciation allowances, so the pretax return required to cover depreciation is higher. The first effect is larger than the second, so the lower tax rates reduce the user cost of capital in CBO's estimates.[3]

- The act also reduces the user cost of capital by allowing businesses to expense investment in equipment, which increases the present discounted value of depreciation allowances through 2022; those increases phase out over the following five years. However, the act increases the user cost of capital for intellectual property by requiring research and development outlays to be amortized rather than expensed, beginning in 2022.

- The act increases the user cost of capital for residential investment by limiting the deductibility of property taxes and mortgage payments and by reducing the number of taxpayers using those deductions in response to a higher standard deduction. Those provisions end in 2026.

Expectations About the Expiration of Tax Provisions. In CBO's estimates, 20 percent of businesses and households expect provisions scheduled to expire in 2026 to actually expire at that time, and 80 percent make their financial decisions on the basis of current tax policy (which is the equivalent of expecting the expiring provisions to be extended). The agency formulated those estimates to be consistent with the treatment of past expirations of major tax provisions. For example, at the beginning of 2013, a number of individual income tax provisions were scheduled to expire, resulting in widespread tax increases. Instead, the enactment of the American Taxpayer Relief Act of 2012 on January 1, 2013, extended the lower tax rates for taxpayers receiving approximately 85 percent of total income. Furthermore, a smaller group— accounting for 70 percent of total income—saw not only the extension of their low tax rates but also the extension of other tax reductions. Therefore, among people who expect future treatment of expirations to be similar to past treatment, the large majority would reasonably expect the expiring provisions of the 2017 act to remain in effect. Other factors influence expectations about such expirations as well, and no consensus exists in the economic literature about how

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[3] For related discussion, see Congressional Budget Office, *Taxing Capital Income: Effective Marginal Tax Rates Under 2014 Law and Selected Policy Options* (December 2014), www.cbo.gov/publication/49817.

households and businesses set their expectations of future fiscal policy. However, several studies highlight the importance of those expectations.[4]

Estimates of Effects on Investment. In CBO's estimation, a 1 percent decrease in the user cost of capital translates into a 0.7 percent increase in investment.[5] CBO calculated the act's changes in the user costs of capital faced by C corporations and by pass-through businesses for 32 types of equipment, 23 types of nonresidential structures, 3 types of intellectual property products, 3 types of residential capital, and inventories. For each type of capital, the changes in user costs for C corporations and pass-through businesses were weighted by the shares of capital held by those types of businesses. For owner-occupied housing, the user cost is faced by homeowners. CBO used a moving average of changes in the user cost of capital to translate them into changes in investment for types of capital that take a long time to build (that is, structures and intellectual property products).

Effects of Location Decisions

The lower corporate income tax rate in the 2017 tax act also encourages some companies to locate in the United States rather than in other countries in CBO's estimates, boosting investment in the United States by businesses producing tradable goods. A 1 percentage-point decrease in the tax rate translates, in CBO's analysis, into an increase of about one-quarter of one percent in investment in the base production that CBO anticipates is most able to move from country to

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[4] For example, one study examines episodes when expectations of changes in fiscal policy have deviated from scheduled changes under current law. It also examines how those expectations have influenced household spending. See Lorenz Kueng, *Tax News: The Response of Household Spending to Changes in Expected Taxes*, Working Paper 20437 (National Bureau of Economic Research, August 2014), www.nber.org/papers/w20437. Another study makes clear that the user cost of capital depends not just on current tax policy but also on expected future tax policy, and it presents evidence of periods when investors predicted unannounced changes in future tax policy. See Alan J. Auerbach and James R. Hines, Jr., "Anticipated Tax Changes and the Timing of Investment," in Martin Feldstein, ed., *The Effects of Taxation on Capital Accumulation* (University of Chicago Press, 1987), pp. 163–200, www.nber.org/chapters/c11348.

[5] That value is CBO's own estimate, and it is near the middle of the range of values estimated by other researchers. For a review of that literature, see Kevin A. Hassett and R. Glenn Hubbard, "Tax Policy and Business Investment," in Alan J. Auerbach and Martin Feldstein, eds., *Handbook of Public Economics*, vol. 3 (Elsevier, 2002), pp. 1293–1343, https://tinyurl.com/ybhzd5md.

country.[6] That base is merchandise trade (exports plus imports) excluding trade of agricultural products and petroleum products—22 percent of output projected to be generated with business capital over the next 11 years.

Effects of Economic Activity

In CBO's analysis, the tax act increases demand for investment through two channels: increased labor supply and, during the first half of the projection period, an increase in output relative to potential output (primarily stemming from changes in consumption, which are discussed below). When labor supply increases, firms increase investment in order to outfit the larger labor force with business capital. In addition, when demand for their output increases, businesses invest in capital to meet that additional demand. The impact of higher demand for output on investment is greatest during the period in which demand is increasing, a phenomenon known as the accelerator. Once businesses have invested enough to meet the additional demand, the only further stimulus to investment is their need to gradually replace the additional capital.

CBO modeled those impacts on investment using the same equations that it used to forecast investment in its 10-year economic forecast.[7] The relevant inputs to those equations were the real output and potential output of the sectors using business investment, employment in those sectors, and productivity in those sectors.

Effects of Federal Borrowing

The federal borrowing resulting from the act tends to reduce investment by 33 cents for every dollar of increase in the deficit in CBO's estimates.[8] The effects of that crowding out phase in over four years in the agency's analysis, as interest rates and changes in the resources available for private investment gradually respond to larger federal deficits. CBO allocates the total

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[6] CBO's estimate of that responsiveness is derived from research on investment by foreign affiliates of U.S. multinational companies. For example, see Michael Devereux and Ben Lockwood, *Taxes and the Size of the Foreign-Owned Capital Stock: Which Tax Rates Matter?* (European Tax Policy Forum, April 2006), www.etpf.org/resphase1.html. The estimate was adjusted downward from the findings in the research literature to be applicable to the types of investment affected by the 2017 tax act for four reasons: The literature considers location decisions primarily among European countries, and locating in one of those countries rather than in another tends to be easier than locating in the United States rather than in one of those countries; base production in this analysis is broader than it is in the literature, which examines multinational corporations and not all businesses producing tradable goods; the literature does not consider the reduction in investment by establishments that lose workers to the arriving establishments; and the tax act gives multinational companies with certain taxable income an incentive to relocate tangible assets abroad that is not examined in the literature.

[7] For related discussion, see Mark Lasky, *Complementary Putty-Clay Capital and Its Implications for Modeling Business Investment and Measuring Income from Intangible Capital*, Working Paper 2014-03 (Congressional Budget Office, May 2014), www.cbo.gov/publication/45317.

[8] For the basis of that estimate, see Jonathan Huntley, *The Long-Run Effects of Federal Budget Deficits on National Saving and Private Domestic Investment*, Working Paper 2014-02 (Congressional Budget Office, February 2014), www.cbo.gov/publication/45140.

amount of crowding out among the components of investment by the inverse of the user cost of capital—thus allocating more crowding out to long-lived capital, for which depreciation, a key factor that increases user costs, is smaller.

Labor Supply

In CBO's projections, increases in the supply of labor stemming from the 2017 tax act increase potential output. To estimate the effect on total hours worked, CBO mainly used simulations of the changes in after-tax wage rates and annual income for a representative sample of taxpayers and projections of average responses in hours worked to those changes for taxpayers in each decile of income.[9] In those simulations, a 1 percent increase in the after-tax wage rate increases hours worked by an average of 0.27 percent, because work becomes more valuable in relation to other uses of a person's time (which is known as the substitution effect). A 1 percent increase in after-tax annual income decreases hours worked by an average of 0.05 percent, because it lets people maintain the same standard of living while working fewer hours (which is known as the income effect).

In CBO's projections, it takes time for people to respond to the act; specifically, changes in taxes scheduled to occur in one year affect the supply of labor over three years. The agency also adjusted the responses in some years to account for its projection that 20 percent of people expect some of the tax changes to expire in 2025 as scheduled and therefore supply more labor before then, while they expect tax rates to be temporarily low. Furthermore, CBO adjusted the responses by smoothing them over several years to account for people's difficulty in making large adjustments in working hours from one year to the next. CBO made the adjustments using estimates from its life-cycle model and its dynamic stochastic general equilibrium model.

Consumption

In CBO's projections, unexpected increases in consumption raise actual output. Getting additional income has significantly different effects on the consumption of low-income people and high-income people, so in considering how the tax act would affect people's income, the agency built its estimates on separate analyses for each third of the income distribution. Drawing on research about how changes in income have been spent in the past, CBO estimated that a onetime increase of a dollar in income would result in 84 cents, 57 cents, and 30 cents of increased consumption for the lower, middle, and upper thirds of the income distribution,

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[9] For details about how the projections of responses differed by income group, see Congressional Budget Office, *How the Supply of Labor Responds to Changes in Fiscal Policy* (October 2012), www.cbo.gov/publication/43674; and Robert McClelland and Shannon Mok, *A Review of Recent Research on Labor Supply Elasticities*, Working Paper 2012-12 (Congressional Budget Office, October 2012), www.cbo.gov/publication/43675.

respectively.[10] The reason for the variation is that a greater percentage of the lower- and middle-income groups are constrained in their ability to borrow.

People's responses to changes in income in a given year and over a lifetime were estimated separately. Households constrained in their ability to borrow were estimated to spend the change in income that they experienced in a given year. Households unconstrained in their ability to borrow were estimated to spend roughly the annuitized value of any change in lifetime income. CBO estimated that change in lifetime income using a discount rate of 5 percent and using the estimate that 80 percent of people would expect the act's individual income tax provisions to be permanent.

CBO estimated the changes in a given year's income and in lifetime income for the three income groups. The agency then combined that information with the aforementioned estimates of consumption per dollar of income to calculate the total effects on consumption. CBO estimates that each unexpected one-dollar increase in consumption in a given calendar quarter, all else being equal, increases output by a total of 50 cents after eight quarters if the Federal Reserve responds typically, that is, by raising the short-term interest rate to prevent inflation from rising above the central bank's long-term goal.[11]

Inflation

CBO's approach to forecasting inflation and estimating changes in inflation relies on three key inputs: people's expectations of inflation, the gap between the projected unemployment rate and the estimated natural rate of unemployment, and changes in the prices of imported goods in

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[10] CBO used estimates from a study that separately analyzed three income groups. See Jonathan A. Parker and others, "Consumer Spending and the Economic Stimulus Payments of 2008," *American Economic Review*, vol. 103, no. 6 (October 2013), pp. 2530–2553, http://dx.doi.org/10.1257/aer.103.6.2530. CBO's estimates are generally consistent with estimates from several other studies that provided less information about separate income groups. See Greg Kaplan and Giovanni L. Violante, "A Model of the Consumption Response to Fiscal Stimulus Payments," *Econometrica*, vol. 82, no. 4 (July 2014), pp. 1199–1239, http://dx.doi.org/10.3982/ECTA10528; Claudia R. Sahm, Matthew D. Shapiro, and Joel Slemrod, "Check in the Mail or More in the Paycheck: Does the Effectiveness of Fiscal Stimulus Depend on How It Is Delivered?" Finance and Economics Discussion Series Paper 2010-40 (Board of Governors of the Federal Reserve System, July 2010), www.federalreserve.gov/pubs/feds/2010/201040; and Matthew D. Shapiro and Joel Slemrod, "Did the 2008 Tax Rebates Stimulate Spending?" *American Economic Review*, vol. 99, no. 2 (May 2009), pp. 374–379, http://dx.doi.org/10.1257/aer.99.2.374.

[11] CBO's central estimate is 50 cents, and the likely range is from 20 cents to 80 cents. For discussion of the basis of that estimate, see Charles Whalen and Felix Reichling, *The Fiscal Multiplier and Economic Policy Analysis in the United States*, Working Paper 2015-02 (Congressional Budget Office, February 2015), www.cbo.gov/publication/49925.

relation to the prices of domestically produced goods.[12] For example, for the core PCE price index—that is, prices for personal consumption expenditures excluding those for food and energy—CBO modeled inflation expectations by taking into account the Federal Reserve's target rate of 2 percent and the four most recent quarters of data about inflation. When the labor market is tighter and the projected unemployment rate is lower than the estimated natural rate of unemployment, inflation is estimated to be slightly higher (and the sum of the coefficients of four lagged terms of that unemployment gap to equal 0.08). And when the relative price of imported goods is projected to be lower, inflation is estimated to be slightly lower. The 2017 tax act leads to tighter labor markets and lower import prices; those two effects generally work in opposite directions, dampening the overall effect on inflation.

Interest Rates

CBO projected changes in the nominal federal funds rate on the basis of changes in the inputs to the agency's model for that rate that are expected to result from the 2017 tax act. The model uses an equation known as the Taylor rule. Specifically, in CBO's projections, the Federal Reserve raises the rate by one-half of a percentage point for each percentage point that actual GDP rises in relation to potential GDP or that the core PCE price index rises in relation to the Federal Reserve's target.[13] Increases in that rate, along with effects from increased federal borrowing, are projected to cause increases in interest rates on short- and long-term Treasury securities.[14]

In the second half of the coming 11-year period, the agency accounted for several additional factors that tend to boost interest rates, on net. On the one hand, the tax act is expected to raise the after-tax rate of return on capital and boost the share of income paid to capital, both of which tend to push interest rates up. In addition, as a result of the projected rise in inflation, demand for long-term Treasury securities (as a hedge against unexpected low inflation) falls in the second half of the projection period, the term premium rises, and long-term interest rates rise in CBO's projections. On the other hand, the act is expected to increase net foreign investment, which tends to push interest rates down.

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[12] See Robert W. Arnold, *How CBO Produces Its 10-Year Economic Forecast*, Working Paper 2018-02 (Congressional Budget Office, February 2018), www.cbo.gov/publication/53537, pp. 17–18. The approach uses CBO's own estimates, which are based on statistical analysis of changes in data over time, and is informed by a substantial body of research. The approach and that literature are described in greater detail in a forthcoming working paper.

[13] In CBO's projections, such a change takes years to be fully implemented as the Federal Reserve moves gradually toward its targets; about three-quarters of the change occurs over a year and half. CBO uses an inertial rule with a speed of adjustment of 0.8—that is, CBO puts a weight of 0.8 on the federal funds rate in the previous calendar quarter and a weight of 0.2 on the rate estimated on the basis of the output gap and inflation.

[14] For discussion of how those interest rates are linked in CBO's analysis, see Robert W. Arnold, *How CBO Produces Its 10-Year Economic Forecast*, Working Paper 2018-02 (Congressional Budget Office, February 2018), www.cbo.gov/publication/53537, pp. 18–20.