CBO's Policy Growth Model

April 2021

The Role of the Policy Growth Model

The Policy Growth Model (PGM) is one in a suite of models that the Congressional Budget Office uses to analyze how economic growth and the federal budget interact:

- How estimates of economic growth affect projections of federal budget variables, such as spending, tax rates, and deficits.
  - For example, more rapid growth of productivity leads to higher incomes and tax revenues.

- How changes in those federal budget variables, in turn, affect economic growth.
  - For example, increased marginal tax rates on labor income lead households to reduce their hours worked on net, lowering economic growth.
  - By contrast, reduced federal deficits lead to lower interest rates and, therefore, more private investment, boosting economic growth.

Recent CBO Analyses Using the Policy Growth Model

The Long-Term Budget Outlook (various years),
www.cbo.gov/about/products/major-recurring-reports#2

The Long-Term Budget Outlook Under Alternative Scenarios for Fiscal Policy
(August 2018), www.cbo.gov/publication/54325

The Deficit Reductions Necessary to Meet Various Targets for Federal Debt
(August 2018), www.cbo.gov/publication/54181

The Macroeconomic and Budgetary Effects of Federal Investment (June 2016),
www.cbo.gov/publication/51628

*Budgetary and Economic Outcomes Under Paths for Federal Revenues and
Noninterest Spending Specified by Chairman Price* (March 2015),
www.cbo.gov/publication/49977

The Structure of the Policy Growth Model

Variables and Parameters

PGM accounts for the effects of changes in the labor force, productive capital, and total factor productivity (or TFP, the residual growth not attributable to the growth of potential hours or capital services) on U.S. economic activity, or gross domestic product (GDP).

PGM includes parameters (variables that are typically fixed over time) that are used to estimate how the number of hours worked, saving, investment in productive capital, and GDP change in response to economic shocks and changes in fiscal policy:

- Some parameters in PGM are used to estimate how GDP changes in response to changes in inputs to production, such as labor and capital, as well as changes in productivity.

- Other parameters in PGM are used to estimate how people respond (in terms of the numbers of hours they work and the amounts they save, both domestically and abroad) when the federal government's tax rates, spending, and deficits change.

Potential Output in CBO's Modeling Framework

A major focus of CBO's analysis is potential (maximum sustainable) output.

- Potential output is CBO's primary measure of the economy's fundamental ability to supply goods and services.
- Labor and capital determine output, which affects federal taxes, spending, deficits, and debt; those, in turn, influence the supply of labor and accumulation of capital.
- Focusing on the relationship between potential output and inputs of labor and capital thus helps maintain consistency between CBO's projections of the supply of labor, capital accumulation, federal taxes, spending, deficits, and debt.

CBO's baseline projection of potential output is determined using the agency's macroeconomic forecasting model (CMAC), which includes representations of different productive sectors.

- The six sectors—nonfarm and farm business sectors, households and nonprofits, and the federal government and state and local governments—have different production functions.
- The nonfarm business sector (NFB) constitutes about 75 percent of potential output.

PGM reproduces CBO's economic baseline using a single economywide production function, simplifying the analysis of fiscal policy.

The Equation for Production in the Policy Growth Model

Production is characterized by an equation that describes how inputs can be transformed into output. Specifically, growth of real (inflation-adjusted) potential GDP ($QGDP_t^*$) is a log-linearized Cobb-Douglas production function:

$$dlog(QGDP_t^*) = dlog(A_t^*) + (1 - \alpha) \times dlog(H_t^*) + \alpha \times dlog(K_t)$$

H_t^* is an index of labor supply defined in terms of economywide potential hours.
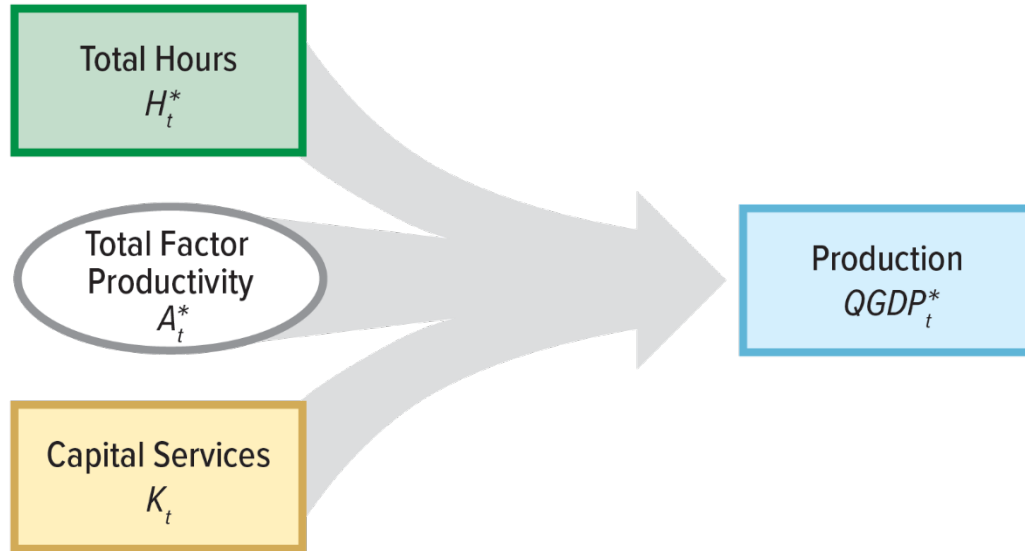
K_t is the flow of services from nonfarm business capital and owner-occupied residential housing.

A_t^* is an index of economywide potential TFP.

The factor shares α and $(1 - \alpha)$ are derived from historical economywide average shares of labor and capital income.

$dlog$ is the growth rate expressed in logarithms.

Production in the Policy Growth Model

The Behavior of the Supply of Labor in the Policy Growth Model

In PGM, an increase in after-tax wage rates, relative to those in the baseline, induces an increase in potential employment and potential hours worked. A decrease in wage rates has the opposite effect.

After-tax wage rates are determined by the capital-labor ratio, TFP, and the marginal tax rate. A rise in the capital-labor ratio, an increase in TFP, or a decrease in the marginal tax rate will raise the after-tax wage rate.

In CBO's estimation, a 1 percentage-point increase in the after-tax wage rate results in a 0.2 percentage-point increase in hours worked. That is, the elasticity of hours worked with respect to the after-tax wage rate is estimated to be 0.2.*

That central estimate includes an effect of additional labor income on hours worked, which is roughly a 0.05 percentage-point decrease in hours worked for a 1 percentage-point increase in the wage rate. That is, the elasticity of 0.2 includes both the income effect and the substitution effects.

The Behavior of the Supply of Private Domestic Saving in the Policy Growth Model

In PGM, the response of private domestic saving is determined by a single parameter and the deviation of the after-tax 10-year interest rate from its baseline value.

The after-tax interest rate is determined by the capital-labor ratio, TFP, and the marginal tax rate on interest income.

- The 10-year interest rate has a one-to-one relationship with the return on capital.
- A fall in the capital-labor ratio makes capital scarce relative to labor, raising the return on capital and the 10-year interest rate.
- A rise in TFP raises the return on capital and the 10-year interest rate.
- Lower marginal tax rates on interest income raise the after-tax 10-year interest rate.

For every 1 percent increase in the after-tax interest rate, the private domestic saving rate increases by 0.2 percent in PGM. That is, the elasticity of the saving rate with respect to the after-tax interest rate is estimated to be 0.2.

The Supplies of Labor and Saving in the Policy Growth Model
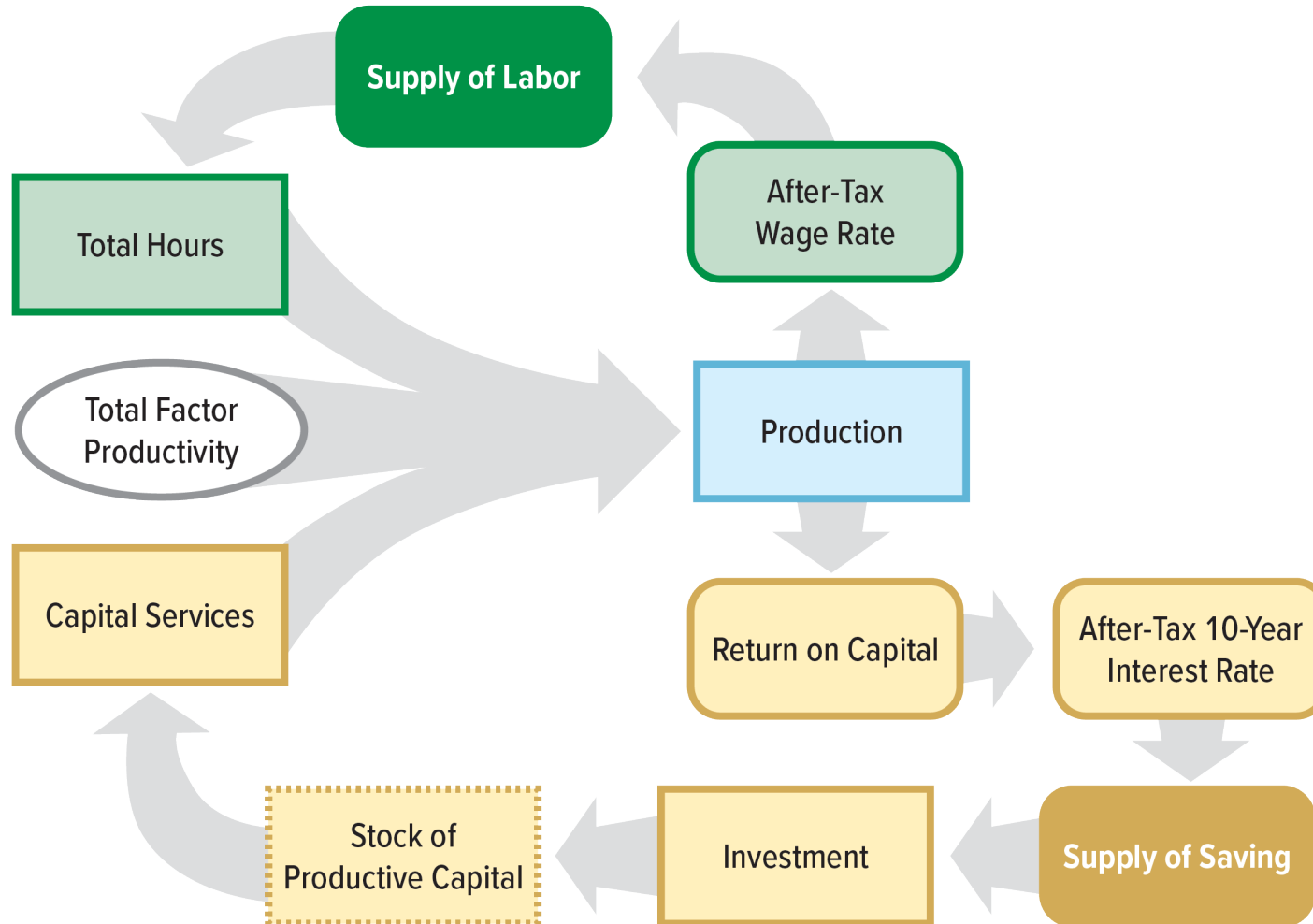
The Behavior of Net Foreign Investment in the Policy Growth Model

Domestic investment is financed both by private domestic saving and the saving of foreigners. A portion of the productive domestic (within U.S. borders) capital stock is owned by foreigners.

- The return on foreign-owned capital generates a flow of payments to foreigners.
- As the return on domestic productive capital rises or falls, the payment to foreign owners of domestic capital does the same.

Meanwhile, U.S.-owned capital abroad generates income for U.S. nationals. The volume of and return on U.S.-owned capital abroad are fixed in the model and do not respond to economic or policy shocks.

Net foreign investment reflects whether the stock of foreign-owned domestic capital rises or falls relative to the stock of U.S.-owned capital abroad.

Gross national product (GNP), a measure of national income, is equal to GDP plus net income from abroad.

International Variables in the Policy Growth Model
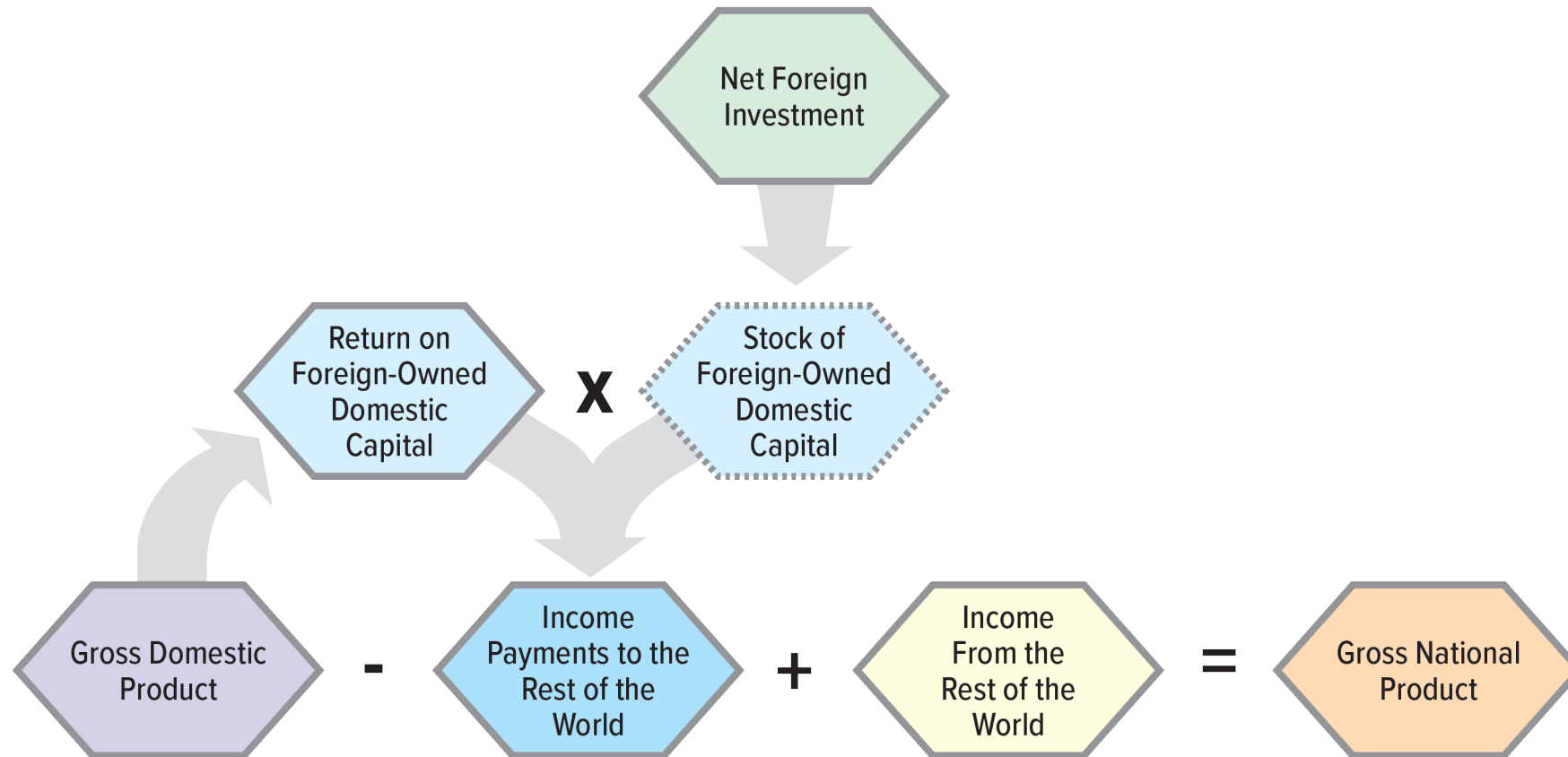
The Response of Private Investment to Federal Deficits in the Policy Growth Model

In PGM, changes in the federal deficit, relative to the federal deficit in the baseline, have a proportional effect on national saving (domestic private saving plus public saving), net foreign investment, and ultimately private investment.

An increase in the deficit initially reduces national saving in PGM by the same amount.

However, CBO estimates that part of the change in the deficit is financed by increases in private domestic saving and net foreign investment.* An increase in the federal deficit of one dollar leads to:

- An increase, or offset, in private saving of 43 cents (so national saving falls by 57cents) and
- An increase, or offset, in net foreign investment of 24 cents.

Taken together, those estimates generate a 33-cent decrease in private investment.

Deficits and Private Investment in the Policy Growth Model

The Policy Growth Model
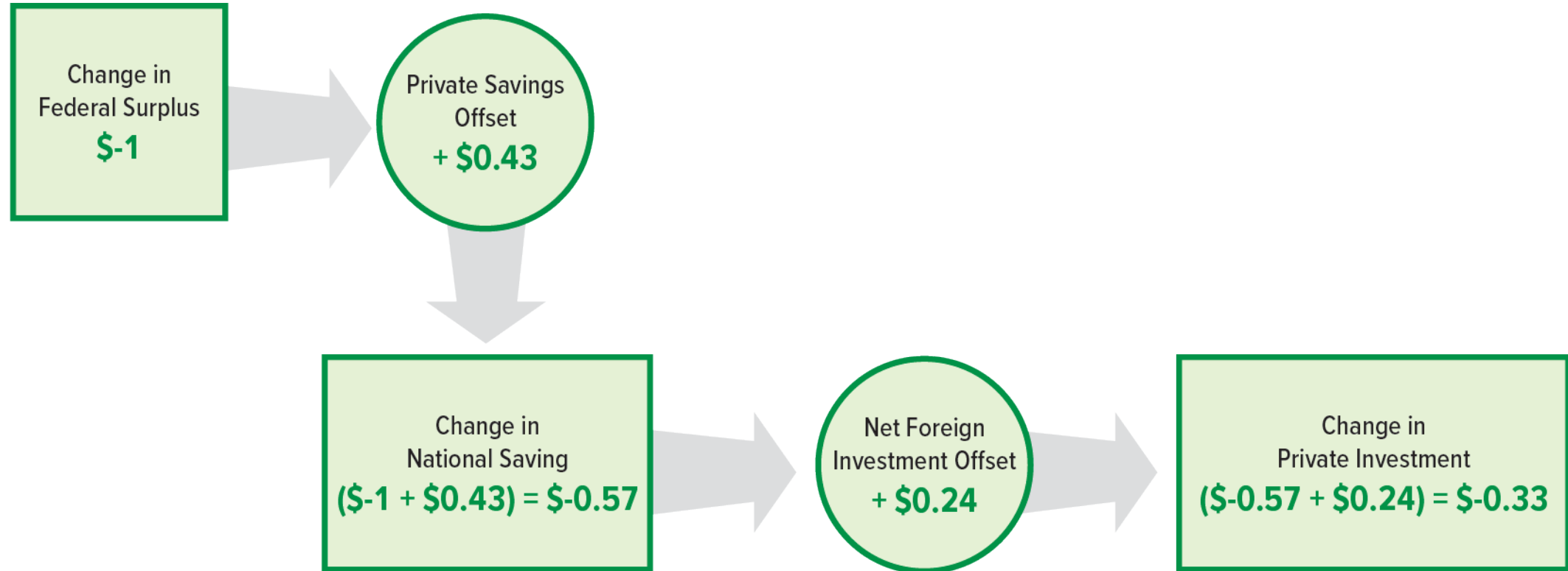
Analyzing Economic and Budgetary Effects of Fiscal Policy Changes

Macroeconomic Analysis of Fiscal Policy

Short Term: Changes in fiscal policies affect the overall economy primarily by influencing the demand for goods and services by consumers, businesses, and governments, which leads to changes in output relative to potential output.

Long Term: Changes in fiscal policies affect output primarily by altering national saving, federal investment, and people's incentives to work and save, as well as businesses' incentives to invest, thereby changing potential output.

# Creating a Simulation in the Policy Growth Model

Policy analyses, or simulations, in PGM are carried out relative to the baseline. A simulation might be used to investigate a variety of economic or budgetary questions related to fiscal policy:

- How the federal debt changes in response to different projections of economic growth.
- How economic growth changes in response to changes in fiscal policy or exogenous variables (those not determined within the model) from their baseline values.
  - How changes to marginal tax rates on interest income would affect the level of capital and, therefore, total output.
  - How changes to federal spending would affect output, interest rates, and federal debt.

Each simulation specifies values for all the parameters governing behavior in the model, including the response of:

- The supply of labor to changes in the after-tax wage rate,
- Private domestic saving to changes in the after-tax return on capital,
- Net foreign investment to changes in national saving, and
- Private domestic saving to changes in the deficit.

How the Policy Growth Model Creates a Simulation Relative to the Baseline
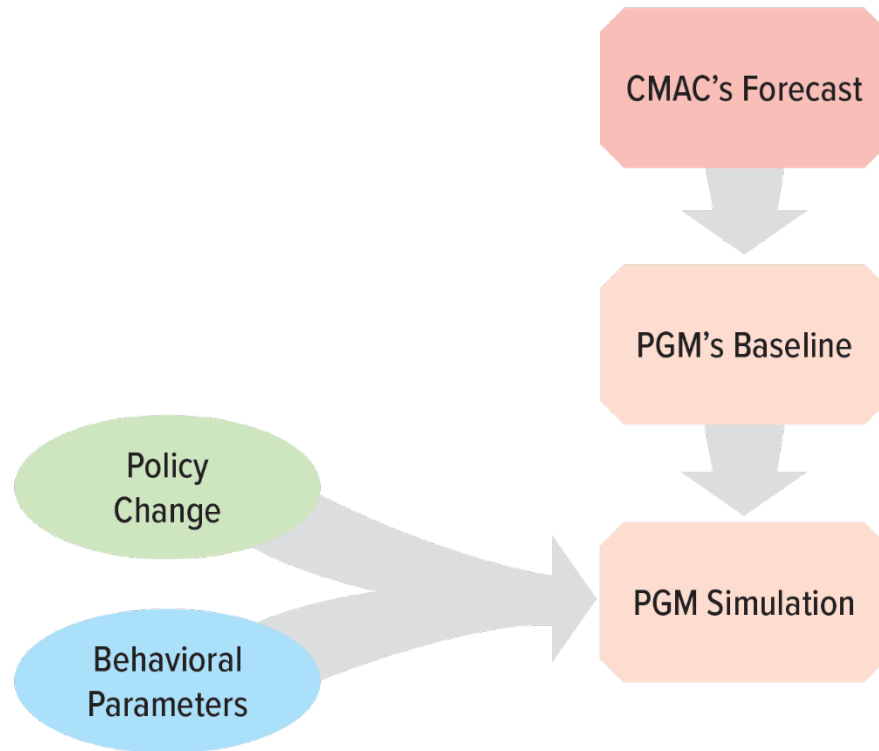
Examples

Sensitivity of Economic Growth and Federal Debt to Productivity Growth in the 30-Year Projections

In *The 2021 Long-Term Budget Outlook*, CBO used PGM to examine the economic and fiscal implications of slower or faster TFP growth.
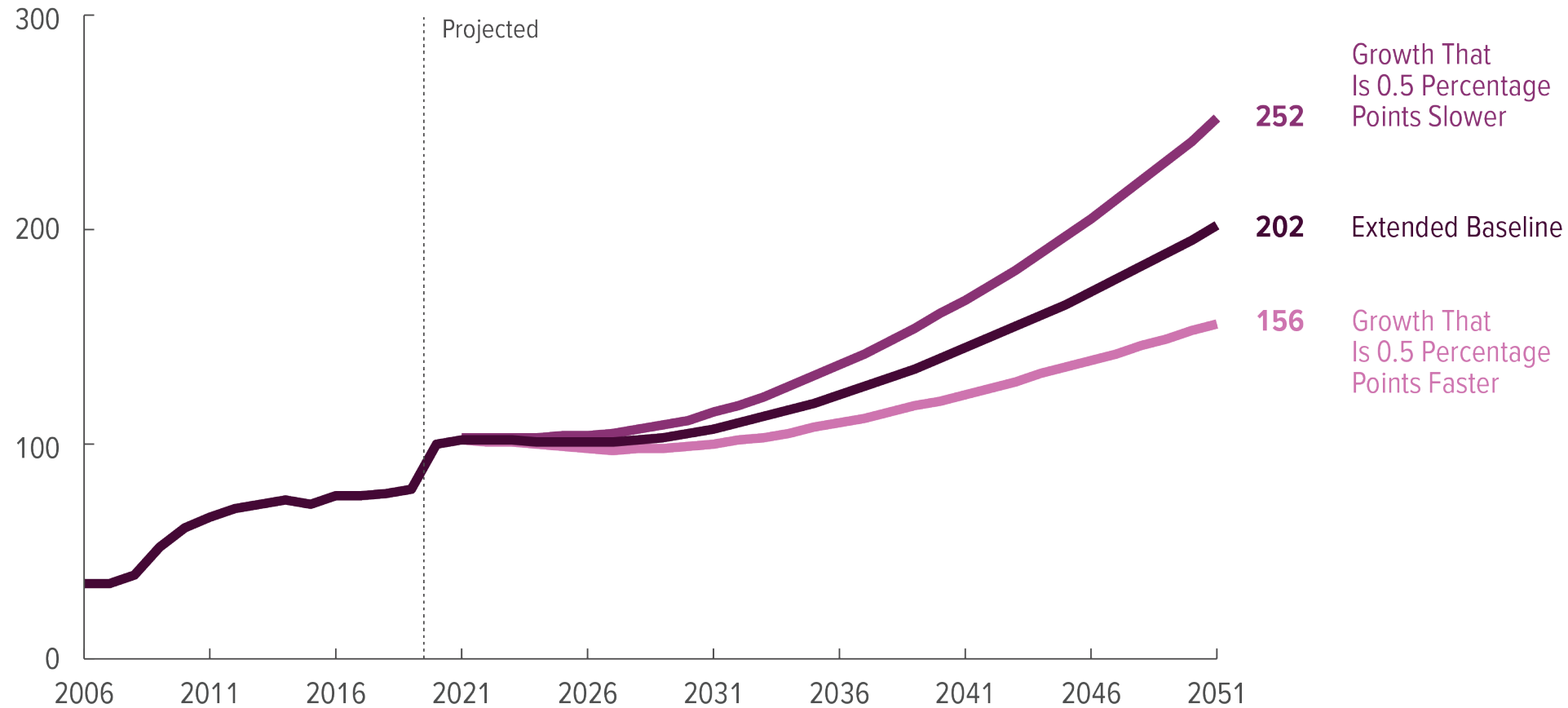
Percent

Scenario	TFP Growth in NFB, 2021-2051	Economywide TFP Growth, 2021-2051	Real GDP Growth, 2021-2051	Debt-to-GDP Ratio, 2051
Slower Growth	0.6	0.5	1.3	252
Baseline	1.1	0.8	1.8	202
Faster Growth	1.6	1.1	2.2	156

Slower growth of TFP in the NFB sector and its economywide equivalent reduces overall economic growth, and the ratio of federal debt to GDP grows more quickly. That reduction lowers the rate of return on capital, decreasing interest rates (and interest payments) on federal debt. That feedback partly offsets the more rapid growth of the debt-to-GDP ratio.

Faster growth of TFP in the NFB sector has the opposite effect on federal debt and interest payments on the debt.

Congressional Budget Office, *The 2021 Long-Term Budget Outlook* (March 2021), www.cbo.gov/publication/56977.

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Federal Debt If TFP Growth in the Nonfarm Business Sector Differed From the Values Underlying CBO's Projections

Percentage of GDP

Projected

Growth That Is 0.5 Percentage Points Slower — 252

Extended Baseline — 202

Growth That Is 0.5 Percentage Points Faster — 156

Congressional Budget Office, *The 2021 Long-Term Budget Outlook* (March 2021), www.cbo.gov/publication/56977.

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The Scenarios CBO Used to Examine the Sensitivity of Budget Projections to Interest Rates

Also in 2021, CBO projected economic and budgetary outcomes under two scenarios in which interest rates on federal debt are higher and lower by a differential that increases by 5 basis points per year (before accounting for macroeconomic effects) relative to the rates underlying the agency's extended baseline.

CBO's analyses of sensitivity to interest rates started with a change in the average rate on federal debt while using the same 10-year Treasury rate. Then, the analyses accounted for the effects on capital and other macroeconomic factors in the alternative projections, which affected both rates.

Sensitivity of Economic Growth and Federal Debt to Interest Rates in the 30-Year Projections

CBO then examined the effect of higher or lower interest rates on federal debt.

Percent

Scenario	Interest Rate on Federal Debt (After accounting for macroeconomic effects), 2051	Real GDP Growth, 2021-2051	Debt-to-GDP Ratio, 2051
Higher Rates	6.6	1.7	260
Baseline	4.6	1.8	202
Lower Rates	2.7	1.8	160

Higher interest rates on federal debt result in larger deficits and a larger stock of debt, causing the debt-to-GDP ratio to grow more quickly. Rising debt crowds out private investment, slowing GDP growth and causing the debt-to-GDP ratio to grow even more quickly.

Lower interest rates on federal debt result have the opposite effect on deficits and the stock of debt.

Congressional Budget Office, *The 2021 Long-Term Budget Outlook* (March 2021), www.cbo.gov/publication/56977.

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Federal Debt If Interest Rates Differed From the Values Underlying CBO's Projections

Percentage of GDP
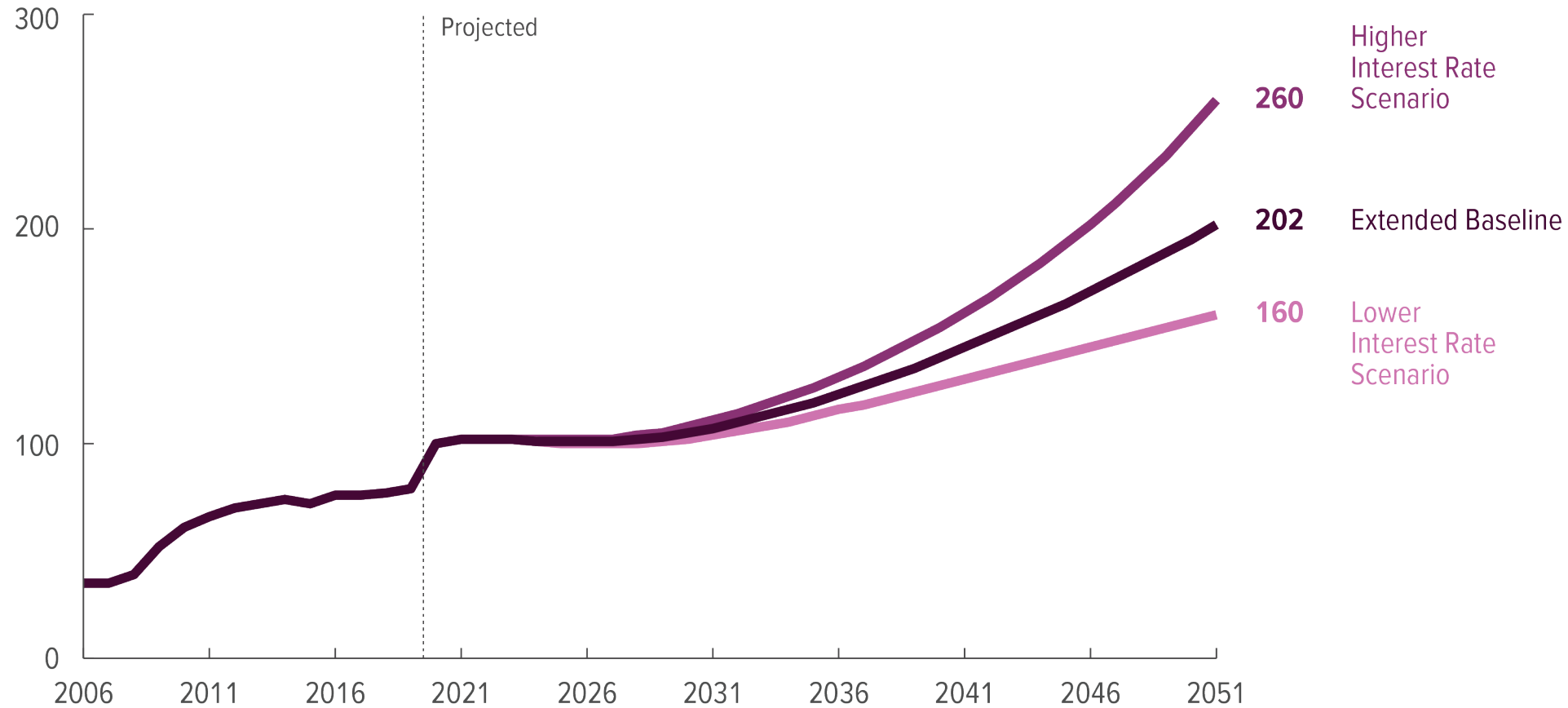
The Extended Alternative Fiscal Scenario

CBO used a suite of models to analyze an alternative fiscal scenario in *The 2019 Long-Term Budget Outlook*.

Under current law, several federal tax and spending provisions expire over the next 10 years.

In the alternative fiscal scenario, CBO estimated the effects of extending those provisions relative to the amounts in the current-law baseline.

- Policies included postponing scheduled cuts in discretionary spending and increases in taxes, which raised deficits and lowered marginal tax rates relative to amounts in the baseline.

- To consider the short-run effects of the increases in spending and taxes, the agency used its short-term model.* Those results were merged with the results of PGM.

- In CBO's analysis, higher federal deficits decreased investment and GDP.
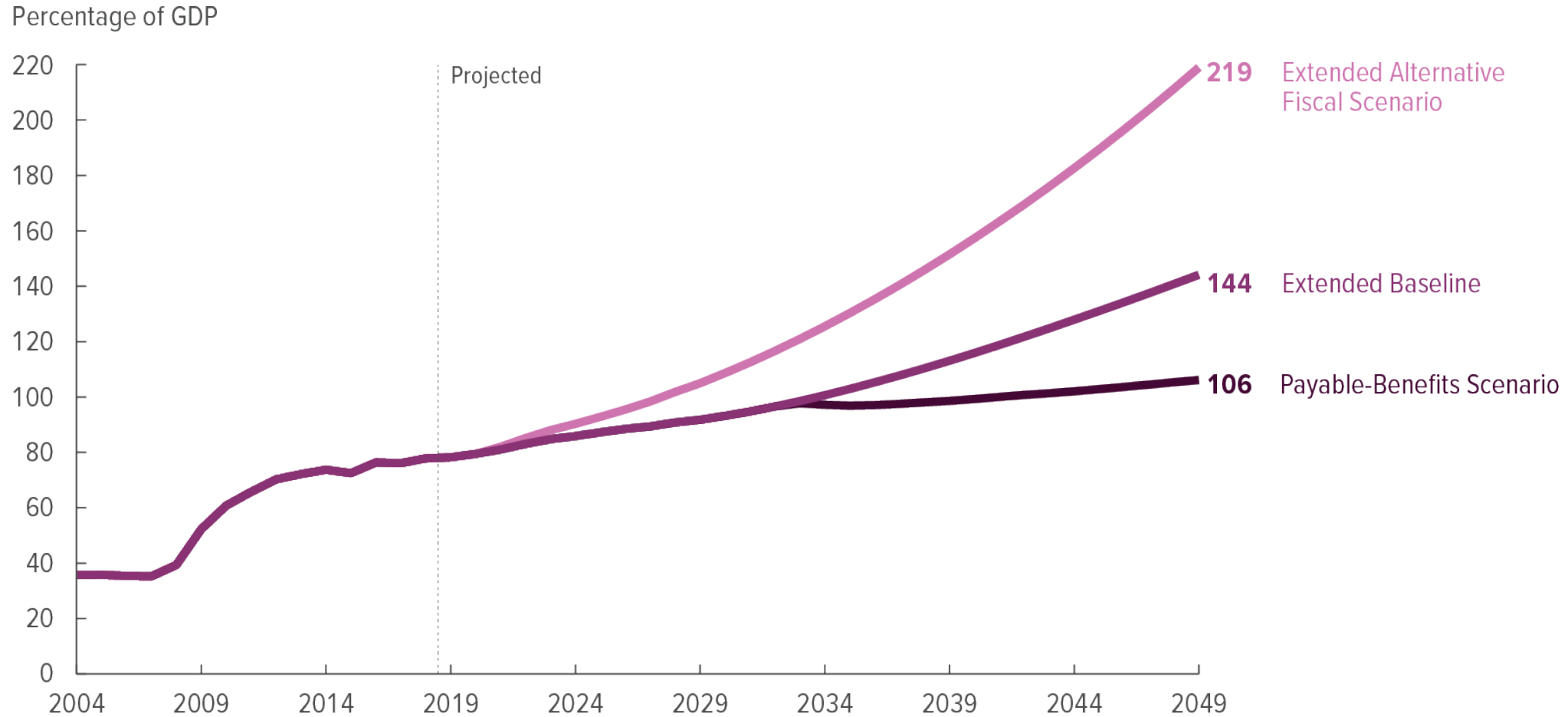
The Payable-Benefits Scenario

In *The 2019 Long Term Budget Outlook,* CBO also analyzed a payable-benefits scenario for Social Security, under which benefits were limited to the amounts payable from revenues received by the program's trust funds.

CBO estimated the effects of reducing benefits upon the then-projected exhaustion of the trust fund for the Old-Age, Survivors, and Disability Insurance program in 2032.

- To consider the effects of reduced benefits on retirement decisions (perhaps to increase saving or retire at an older age), the agency used its life-cycle model.* To analyze the effects of the unanticipated drop in spending in 2032, the agency used its short-term model. Results from both models were merged with results from PGM to create projections of the debt-to-GDP ratio and GNP per capita.

- In CBO's analysis:
  - Lower federal spending and higher saving raised investment and GDP. The effect of workers' retiring later also raised the supply of labor and GDP.
  - The debt-to-GDP ratio was significantly lower than its baseline value because of lower deficits and higher GDP.
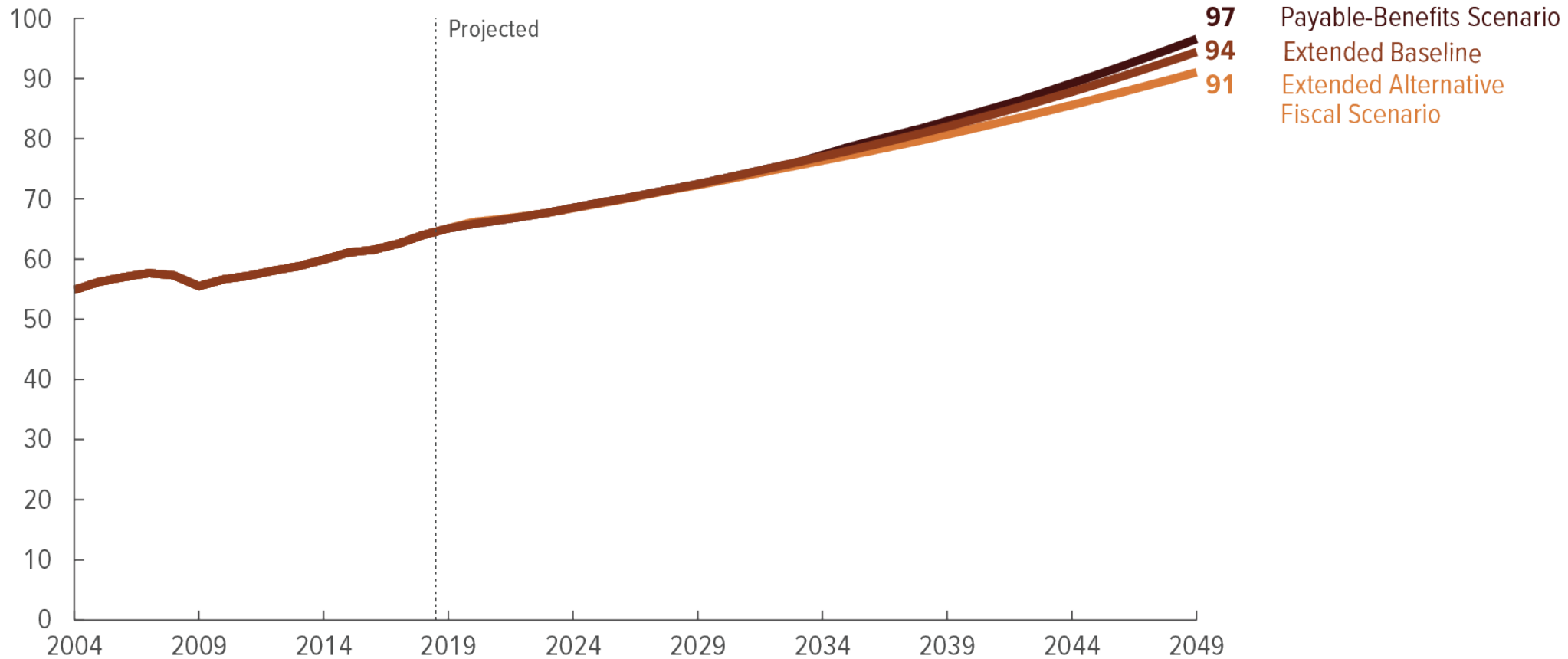
Federal Debt Under Three Fiscal Scenarios

Percentage of GDP

Projected

219 — Extended Alternative Fiscal Scenario

144 — Extended Baseline

106 — Payable-Benefits Scenario

2004 2009 2014 2019 2024 2029 2034 2039 2044 2049

Output per Person Under Three Scenarios

Thousands of 2019 Dollars, by Calendar Year

97 Payable-Benefits Scenario
94 Extended Baseline
91 Extended Alternative Fiscal Scenario

About This Document

This document was prepared to enhance the transparency of CBO's work and to encourage external review of that work. In keeping with CBO's mandate to provide objective, impartial analysis, the document makes no recommendations.

Aaron Betz and Robert Shackleton prepared the document with guidance from Jeffrey Werling and Devrim Demirel.

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