Overview of the Tax Foundation's General Equilibrium Model

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The Tax Foundation has developed a General Equilibrium Model to simulate the effects of government tax and spending policies on the economy and on government revenues and budgets. The model can produce both conventional and dynamic revenue estimates of tax policy. The model can also produce estimates of how policies impact measures of economic performance such as GDP, wages, employment, the capital stock, investment, consumption, saving, and the trade deficit. Lastly, it can produce estimates of how different tax policy impact the distribution of the federal tax burden. The model can analyze the effects of most types of tax policy proposals. It can estimate the effects of changes to the rate and the base of the individual income tax, the corporate income tax, payroll taxes, estate and gift taxes, excise taxes, and other miscellaneous taxes.

The Tax Foundation model has three main components that work together to produce estimates. The first component is a tax simulator. This component produces conventional revenue and distributional estimates. The tax calculator also produces estimates of marginal tax rates on different sources of personal and business income. The second component of the model is a neoclassical production function. This component estimates long-run changes in the level of output based on changes in the capital stock and labor force in response to policy. The last component of the model is an allocation or demand function. This component estimates how tax changes alter people's choices between labor and leisure. In addition, it takes estimates of projected output from the production model and estimates how changes in income are allocated between saving and consumption, and how the economy's wealth is allocated between physical and financial capital. It predicts net exports and international capital flows, and the split of financial capital between domestic and foreign assets.

The Tax Foundation model produces estimates of the long-run impact of tax policy as well as the year-by-year path of the economic adjustment, and the impact of tax policy on the government budget over the usual 10-year budget window.

1.0 The Tax Simulator

The starting point for Tax Foundation estimates is the output from the tax simulator. The tax simulator includes a detailed individual income tax calculator and tax models for the corporate income tax, payroll taxes, value-added taxes, excise taxes, the estate tax, and miscellaneous taxes and fees. The tax model produces estimates of federal tax revenues, marginal and effective tax rates, and the distribution of the tax burden. The model produces long-run revenue estimates and annual estimates over a 10-year budget window.

1.1 The Individual Income Tax Calculator

The individual income tax calculator estimates individual income tax revenue changes and marginal tax rates on different sources of personal income by using a detailed tax calculator that captures most elements of the individual income tax. The current tax return simulator is coded in Visual Basic, and both baseline and simulation parameter inputs for the tax calculator are stored in an Excel spreadsheet. Currently, the model includes more than 150 individual income tax parameters from 1954 to the present. However, the tax return simulator is sufficiently modular that additional parameters can be created when needed.

The Public Use File

The main data source for the tax return simulator is the Internal Revenue Service's (IRS) 2011 Public Use File (PUF).[1] The PUF is a representative sample of U.S. taxpayers, which contains more than 150,000 sample tax returns that represent the population of more than 150 million tax returns. Each record has information provided by taxpayers on IRS forms 1040, 1040A, 1040EZ, and supporting tax forms. Each sample tax return includes information on sources of income, such as wages and salaries, capital gains, interest, dividends, and business income. It includes information on deductions, exemptions, credits claimed, and any alternative minimum tax liability. It also includes information on filing status and number of dependents.

While the PUF has a vast amount of data, it comes with limitations, as it does not include information that isn't reported on a 1040 or any of the supporting documents. The PUF does not include demographic information, such as the age of dependents, nor does it include detailed income splits between spouses.

Ideally, a PUF should correspond as closely as possible to the current year. However, the PUF usually takes the IRS several years to produce. As a result, we "age" the available PUF data to reflect the growth in various types of incomes projected by the Congressional Budget Office (CBO) and the growth in the aggregate number of tax returns by filing status projected by the IRS. We use these data to reweight the PUF through changing the sampling weights of sample filers without changing the total number of returns. The goal is to match the baseline tax revenue in our tax simulator to the baseline revenue projections from the CBO.

Tax Calculator Estimates

For baseline tax law and any given proposal, the tax calculator uses given tax policy parameters to estimate the tax burden for each sample taxpayer in the Public Use File, much like individuals would calculate their own tax liabilities. The calculator starts at the top of the IRS Form 1040 by summing adjusted gross income (AGI) for each sample taxpayer. Then it calculates taxable

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[1] "US Individual Income Tax Public Use Sample Documentation," NBER, http://users.nber.org/~taxsim/gdb/.

income, by considering personal exemptions and deductions. After applying the marginal tax rates in the various tax brackets to taxable income, the tax calculator subtracts out credits and adds in alternative minimum tax, to arrive at the final tax burden for each taxpayer.

The tax calculator does account for certain taxpayer behavioral responses, even when only producing conventional estimates. The tax calculator assumes that taxpayers choose whether to claim the standard deduction or itemized deductions based on which provides a larger tax benefit. When estimating the cost of expanding credits such as the Child Tax Credit and the Earned Income Tax Credit, we assume that not all newly eligible taxpayers will claim these credits, just as not all filers that are currently eligible for these credits make use of them. Lastly, we assume that taxpayers adjust their capital gains realization behavior when there are changes in the marginal tax rates on capital gains. We use the same realization elasticities as the Joint Committee on Taxation. In the short run, the elasticity of realizations with respect to the marginal rate is -1.1 and in the long run it is -0.7.[2]

Effective Marginal Tax Rates

An important output of the tax return simulator is effective marginal tax rates (EMTRs). These EMTRs are used in the production model to estimate changes in the price of labor (the after-tax wage) and the price of capital (the after-tax return on capital). Marginal tax rates represent the additional tax owed on an additional dollar earned. This includes not only incremental changes in tax burdens due to changes in the statutory tax rate but also incremental changes in tax burden due to changes in taxable income (the tax base), as when tax credits or deductions are changed, phased in, or phased out.

The effective marginal tax rate ($EMTR$) is equal to the statutory tax rate (t_{stat}) faced by a taxpayer plus the marginal tax impact of any changes in the tax base. The marginal impact of tax base changes is calculated by multiplying the statutory tax rate (t_{stat}) by the change of the tax base ($\Delta Tax\ Base$) over the change in income ($\Delta Income$). Lastly, we add the marginal rate effects of credit phase-ins and phaseouts.

$$EMTR = t_{stat} + t_{stat}\frac{\Delta Tax\ Base}{\Delta Income} + \frac{\Delta Credit}{\Delta Income}$$

The tax return simulator estimates the effective marginal tax rate for each taxpayer for several sources of income: wages, capital gains, dividends, business income, and interest income. These sources of income fall into three categories used in the production model: labor income, corporate capital income, and noncorporate capital income.

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[2] "Explanation of Methodology Used to Estimate Proposals Affecting the Taxation of Income from Capital Gains," Joint Committee on Taxation (March 27, 1990), https://www.jct.gov/publications.html?func=startdown&id=3157.

Along with estimating marginal tax rates, the tax calculator estimates the effective average tax rate for each type of income. Average tax rates represent the total amount of individual income taxes paid on each of these sources of income.

1.2 The Corporate Income Tax Model

The corporate income tax model can estimate changes to corporate income tax liability due to changes in the corporate tax rate and base. Unlike for the individual income tax return simulator, there is no publicly available micro-dataset of corporate tax returns. As such, we construct a corporate tax baseline using data from the Congressional Budget Office (CBO), the Bureau of Economic Analysis (BEA), and the Federal Reserve to make estimates.

The corporate income tax baseline starts with the CBO projection of corporate tax revenue. From there, we estimate an effective corporate tax rate on aggregate corporate net income. The effective corporate tax rate (ETR) is equal to projected corporate tax revenue divided by net corporate income. Net corporate income is equal to gross corporate income minus capital consumption allowances, or tax deductions for depreciation (*CCA*).

$$ETR = \frac{Corporate\ Tax\ Revenue}{Gross\ Corporate\ Income - CCA}$$

Changes to corporate tax revenue are estimated by rearranging the formula so that corporate tax revenue is a function of net income times the effective corporate tax rate.

$$Corporate\ Revenue = ETR * (Gross\ Corporate\ Income - CCA)$$

To estimate the impact of a change in the statutory corporate tax rate, we multiply the old effective corporate tax rate (ETR) by the ratio of the new statutory corporate tax rate to the old statutory corporate tax rate. The revenue impact of depreciation schedule changes is estimated by increasing or decreasing depreciation deductions, which are estimated in our depreciation model (described below).

The corporate tax model can also incorporate estimates of interest deduction limitations. These limitations are estimated off-model, using Bureau of Economic Analysis data on interest paid and received by corporations. Based on the specifics of the proposal, we estimate the value of interest deductions that would be limited ($IntLimit$) under the proposal as a percent of corporate net income. This limit is used to gross up corporate net income: $(1 + IntLimit) * (Gross\ Corporate\ Income - Depreciation)$. In modeling proposed interest deduction limits, we usually assume that old loans are grandfathered unless otherwise specified. This means that interest on old loans is deductible as under previous law while new loans are subject to the new limitations.[3]

For the marginal tax rate on corporate income, we assume that the statutory tax rate is equal to the marginal tax rate.

The Depreciation Model

The depreciation model estimates annual depreciation deductions for both C corporations and pass-through businesses. It also produces estimates of the present discounted value of depreciation deductions, which are used in the production model as part of the determination of the cost of capital.

The core of the depreciation model is a detailed dataset of investment and the capital stock that we constructed from BEA and Federal Reserve data. This dataset contains the annual levels of investment and capital stock from 1954 to the present, and we have projected the series to 2028. The data is provided for more than 1,000 types of capital that fall into four main asset types: equipment and software, nonresidential structures, residential structures, and intellectual property. Investment and the capital stock in these assets for each year are broken down by business form (corporate versus noncorporate) and by depreciation asset classes (three-year, five-year, etc.). This is done for every single depreciation law from 1954 to present. The model is sufficiently modular that new depreciation proposals can be added when needed.

Using both investment and asset class weights, the depreciation model estimates the amount of depreciation deductions corporate and noncorporate businesses take on an annual basis. The model is set up to estimate both the steady-state value of depreciation deductions and depreciation deductions over a 20-year period, considering any transitions from one depreciation system to another. We use the CBO data to project the baseline growth of investment over the next two decades.

For corporations, the amount of depreciation deductions is used directly in the corporate income tax model to estimate changes in revenue by changing the size of net corporate income. For noncorporate businesses, changes in depreciation are converted into income factors, which are used to increase or decrease reported business income in the tax return simulator. The business income factors (BIF) are equal to income minus depreciation in simulation over income minus depreciation in baseline.

[3] The same method is used for interest deduction limitations that apply to noncorporate businesses. The interest deduction limitation $(1 + IntLimit)$ is used to gross up AGI for tax returns with business income in the tax calculator.

$$BIF = \frac{Gross\ Noncorporate\ Income_{simulation} - \text{CCA}_{simulation}}{Gross\ Noncorporate\ Income_{baseline} - \text{CCA}_{baseline}}$$

The depreciation model also estimates the present-discounted value of depreciation allowances for each asset type. These values are used in the service price of capital in the production model to estimate changes in the size of the capital stock. For any given depreciation regime, we estimate the present discounted value of each depreciation schedule in both the baseline and in a simulation, using a discount rate of 5 percent, which represents the long-run real rate of return on capital of 3 percent plus an assumed inflation rate of 2 percent, which is the Federal Reserve's stated target. These net present values are then weighted by the amount of the capital stock that falls into each asset class. The result is a weighted-average net present value for four assets: equipment and software, nonresidential structures, intellectual property, and residential structures.

1.3 Payroll Taxes

Ideally, payroll tax liability and the payroll tax marginal rate would be calculated using the tax return simulator. The IRS PUF includes information on wages and self-employment income, which are subject to payroll taxes. However, unlike the individual income tax, payroll taxes are levied on each worker rather than by tax filer. This presents a challenge, as tax returns do not contain detailed information on how income is split between married couples filing jointly, and the Social Security payroll tax is capped based on individual earnings.

We use a separate payroll tax model to estimate payroll tax liability and the effective marginal payroll tax rate. This model uses data from the Social Security Administration's Annual Statistical Supplement to estimate how different payroll tax proposals would impact federal payroll tax revenue.[4] This data includes information on the taxable base of both the Social Security and Medicare payroll tax and allows us to model changes in both the rate and base of the payroll tax.

In the Tax Foundation model, we treat payroll taxes as a tax wedge on labor income that reduces the after-tax returns to work. We approximate the marginal effective payroll tax rate used in the production model by dividing payroll tax revenue by total wages and self-employment income.[5]

$$Payroll\ Tax\ Rate = \frac{Payroll\ Tax\ Revenue}{Wages + \ Self\ Employment\ Income}$$

[4] "Annual Statistical Supplement, 2016," Social Security Administration, https://www.ssa.gov/policy/docs/statcomps/supplement/2016/index.html.

[5] Ideally, we would derive the marginal payroll tax rate in the same way in which we calculate individual income tax marginal rates.

The payroll tax model also accounts for the attribution of half of the payroll tax to the employer. The employer half of the payroll tax creates a tax wedge between the total amount employers pay their workers and what the workers receive as pretax taxable income. Thus, changes to the employer-side payroll tax alter the amount of compensation that workers report on their tax return and affect individual income tax revenue and employee-side payroll tax revenue.

The distributional impact of payroll tax changes is modeled using the tax return simulator. Employee-side payroll taxes are modeled by reducing taxpayer after-tax income by the size of the tax. Employer-side payroll taxes are modeled as changes in reported income, which allow us to take into account interactions with the individual income tax. To estimate the distributional impact of the Social Security payroll tax, we impute income splits between spouses in the tax return simulator. These income splits are used to estimate what portion of a married tax filer's income is above the Social Security payroll tax income threshold and which portion is below the threshold. The income splits are derived from IRS data.

1.4 Value-added Tax

The value-added tax (VAT) model allows us to model proposals to introduce VATs. Given no such tax currently exists in the U.S. federal tax system, we use outside data to estimate what a VAT in the United States would look like.

Estimates of the value-added tax start with construction of the tax base. We treat the value-added tax like a factor income tax or a subtraction-method value-added tax. The tax base is made up of three factors: labor income, corporate and noncorporate capital income (less investment, which is deductible under a VAT), and net imports. These data are derived from BEA and Federal Reserve figures.

Simply multiplying the VAT rate by the proper economic accounts would overstate the potential revenue impact of a value-added tax. This is because any tax will suffer from some tax avoidance. As such, the value-added tax base is reduced somewhat to account for potential tax avoidance. We assume that the value-added tax noncompliance rate would be 15 percent, which is what the U.S. Treasury assumed in its estimate of a U.S. value-added tax.[6] Overall, we estimate the initial value-added tax base, before any exemptions, to be 63.1 percent of GDP.

Exclusions to the value-added tax base are modeled by reducing the tax base by the estimated size of the exclusion. For example, Senator Ted Cruz (R-TX) proposed a value-added tax that would exclude from its base employer-sponsored health insurance premiums. These health

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[6] "Simple, Fair, and Pro-Growth: Proposals to Fix America's Tax System," Report of the President's Advisory Panel on Federal Tax Reform (November 2005), https://www.treasury.gov/resource-center/tax-policy/Documents/Report-Fix-Tax-System-2005.pdf.

insurance premiums equal approximately 11 percent of wage income. As such, the VAT base on wages would be reduced by 11 percent.

Table 1. Value-added Tax Base (Billions of Dollars), 2018	
Wages and Salaries	$10,352.03
Private Business	$7,544.13
Household and Institutions	$895.50
Government Enterprises, except Fed	$165.22
Fed	$2.86
General Government	$1,744.32
Capital Income (Net Investment)	$2,937.76
Corporate Business	$1,606.72
Noncorporate Business	$1,331.04
Net Imports	$501.25
Non-Compliance (15%)	-$2,068.66
Total Tax Base (Before Exemptions)	$11,722.38
GDP	$18,569.10
VAT Base (%-GDP)	63.1%
Source: Tax Foundation General Equilibrium Tax Model, March 2018	

Projected tax revenue is estimated by taking the projected value-added tax base and multiplying it by the tax inclusive VAT rate. The tax inclusive rate for a VAT is equal to the tax exclusive rate divided by one plus the tax exclusive rate.

$$VATRate_{inc} = \frac{VATRate_{Excl}}{1 + VATRate_{Excl}}$$

When a value-added tax is enacted, it creates an offsetting revenue loss for the individual income tax, the corporate income tax, and payroll tax. This is because the value-added tax is an indirect tax collected from sales before payments to the factor inputs. It reduces the post-VAT revenues to businesses that are then used to pay the incomes of labor and capital. Even in the static case, before economic reactions, this has the effect of reducing the returns to these sources of income and, in turn, shrinks the tax base for the individual income tax, the payroll tax, and the corporate income tax. To model these revenue offsets, we create income factors. These factors are used in the tax return simulator, corporate tax model, and payroll tax model to shrink factor income by the amount of the value-added tax. The value-added tax income factors for the three factor incomes (labor income, corporate income, and noncorporate income) are calculated by dividing posttax factor income by pretax factor income.

$$VAT\ Income\ Factor = \frac{Factor\ Income - VAT}{Factor\ Income}$$

In modeling the distributional impact of the value-added tax, we follow the modeling convention that prices remain constant and the tax is "passed back" to the factors of production by reducing labor and capital income.[7] We use the same income factors we use for the income and payroll tax offsets to shrink income in the tax calculator, which is then reflected in the distributional tables as lower after-tax income.

To estimate the economic impact of the value-added tax, we treat the value-added tax as a tax wedge on labor, which reduces labor supply and economic output. The marginal VAT rate is equal to the tax inclusive value-added tax rate reduced by any noncompliance and exemptions.

1.5 Estate and Gift Tax

The Tax Foundation uses a side-model to estimate changes to the estate tax. The Tax Foundation models the estate tax as a tax on wealth. The estate tax model is based on 2007 data on estates from the U.S. Treasury that have been extrapolated to match the current year economy. The dataset contains information on the size of estates and their estate tax liability. The estate tax model can estimate both the impact of changes in the estate tax rate and changes in the estate tax exemption amount.

There are two outputs from the estate tax model. First is the effective tax rate, which is the total estate tax revenue as a percent of wealth. This is used to gross up or down CBO projections of estate tax collections as wealth rises or falls in response to policy changes. Second is the ratio of the marginal tax rate to the average tax rate on estates owing some tax, which may be changed either by alterations in the statutory rates or the exempt amounts. The resulting marginal tax (ratio times the average rate on wealth) is modeled as increasing the required return on capital.

1.6 Other Taxes

Excise Taxes and Miscellaneous Taxes

The Tax Foundation model estimates the impact of excise taxes and miscellaneous taxes on revenue and economic output. Baseline excise and miscellaneous taxes are expressed as marginal tax wedges on labor and capital income that are equal to tax revenue over private business output.

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[7] Eric Toder, Jim Nunns, and Joseph Rosenberg, "Using a VAT to Reform the Income Tax," Tax Policy Center/The Pew Charitable Trusts (January 2012), http://www.taxpolicycenter.org/sites/default/files/alfresco/publication-pdfs/412489-Using-a-VAT-to-Reform-the-Income-Tax.PDF.

Changes to excises and miscellaneous taxes are all estimated off-model using supplementary data. Similar to JCT,[8] we model excise taxes as creating revenue offsets for the individual income, corporate income, and payroll taxes. This is because excise taxes are indirect taxes on sales, taken by the government out of business revenue before it is distributed as compensation to the factor inputs. They create a wedge between output (what workers and capital produce) and the amount they receive. This shrinks the tax base for the individual income taxes, the corporate income tax, and the payroll tax. We model these tax base offsets using the same procedure as for the value-added tax. That is, we use income factors to shrink or increase factor incomes by the projected tax change. These income factors are also used to distribute the excise and miscellaneous taxes as reductions or increases in labor and capital income in the individual income tax calculator.

State and Local Taxes

The Tax Foundation model accounts for state excise taxes, state and local income taxes, sales taxes, property taxes, estate and gift taxes, and state corporate income taxes. State and local taxes serve two functions in the model. First, they allow us to model the interaction among federal and state and local tax policy in determining taxable income. For example, the ability for taxpayers to deduct the first $10,000 in state and local income and sales taxes reduces the effective marginal tax rate of the federal individual income tax. Second, estimating state and local taxes allows us to fully account for the tax burden on individuals and businesses. Excluding state and local taxes would understate baseline marginal tax rates, overstate baseline after-tax returns to labor and capital, and understate the economic impact of federal tax changes.

The method by which we estimate state and local taxes differs depending on the tax. For state and local income taxes, we use the tax return simulator. For simplicity, we assume that state and local taxes have the same tax base as the federal tax code and that state tax bases remain unchanged when the federal tax base changes. We assume that each taxpayer faces a state tax rate that is equal to his or her marginal federal tax bracket rate times the ratio of state income tax revenue over federal individual income tax revenue.

For corporate taxes and estate taxes, we assume that the weighted average state tax rate is equal to the federal rate times the ratio of state corporate tax revenue over federal corporate tax revenue.

The remaining state taxes – state and local sales taxes, personal property taxes, real estate and other property taxes, payroll taxes, and miscellaneous state taxes – are modeled the same way as federal excise and miscellaneous taxes. They are treated as either tax wedges on labor or capital,

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[8] "New Income Income and Payroll Tax Offset to Changes in Excise Tax Revenues For 2018-2028," Joint Committee on Taxation, (March 2018) https://www.jct.gov/publications.html?func=startdown&id=5066.

and are equal to revenue divided by the appropriate tax base, usually private business output or the capital stock.

1.7 Miscellaneous Tax Expenditures and Policy Proposals

Every year, the federal government forgoes more than $1 trillion in revenue due to various credits, deductions, and income exclusions. Many tax expenditures are deductions and credits that are directly reported on an individual's tax return and can be estimated directly in the individual income tax calculator. However, many tax expenditures are income exclusions and are not reported to the IRS on tax returns, or are business expenditures, for which we lack micro data. To estimate the impact of such tax expenditures, we use supplementary data.

The method by which we estimate specific tax expenditures depends on the type of tax expenditure and the available data. For individual income exclusions, we use outside data to impute changes in reported AGI and taxable income in the tax return simulator. For personal tax expenditures with little available data and for business tax expenditures, we take revenue estimates directly from either the Joint Committee on Taxation[9] or the U.S. Treasury.[10] In simulations in which individual and business income tax rates change, we adjust the size of certain tax expenditures by the ratio of the new business tax rate over the old business tax rate. In dynamic analyses, we assume that the value of tax expenditures grows with the size of GDP.

To capture the economic effect of tax expenditures, we first separate expenditures into two groups: expenditures that fall on the margin of economic activity, which impact a taxpayer's incentive to work or invest, and those that do not. For example, Section 199 under previous law provided a deduction for income from domestic manufacturing. It acted like a reduced marginal tax rate for certain businesses and had an impact on incentives to earn additional income.

The tax revenue from tax expenditures that impact incentives to work or invest are transformed into marginal tax rate equivalents, which are used in the production model as either tax wedges on labor or capital income. The marginal tax rates are equal to the ratio of the expenditure's revenue over baseline revenue times the labor or capital marginal tax rate.

$$Expenditure\ Marginal\ Tax\ Rate = \frac{Expenditure\ Revenue}{Baseline\ Revenue} * Marginal\ Tax\ Rate$$

This same process of using outside, supplementary data is used when estimating the impact of new policy for which the PUF does not provide enough information or business proposals. For

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[9] "Publications on Tax Expenditures," Joint Committee on Taxation, https://www.jct.gov/publications.html?func=select&id=5.

[10] "Tax Expenditures," U.S. Treasury (October 2017), https://www.treasury.gov/resource-center/tax-policy/Pages/Tax-Expenditures.aspx.

example, former presidential candidate Hillary Clinton proposed an expansion of the Child Tax Credit for children under the age of five.[11] Since the Public Use File does not have information on the age of dependents, we used Census Current Population Survey data to impute the number of children that were under the age of five in the tax return simulator.

1.8 Distributional Tables

The Tax Foundation model produces distributional analyses of tax policies on both a conventional and dynamic basis. Both tables measure the distributional impact of tax proposals as changes in after-tax income, or the amount of income taxpayers have available to consume after taxes. However, the tables are constructed in slightly different ways.

The units of analysis for Tax Foundation tables are tax returns, and the definition of income is Adjusted Gross Income (AGI). In general, the Tax Foundation distributional tables break tax returns into five equal income buckets or quintiles. Each quintile (0%-20%, 20%-40%, 40%-60%, 60%-80%, and 80%-100%) contains an equal number of tax returns that are ordered by AGI. Before tax returns are ordered, however, each return's AGI is adjusted to control for the size of the household by dividing AGI by the square root of the number of exemptions. In addition to the five quintiles, we break down high-income tax returns into smaller buckets (80%-90%, 90%-95%, 95%-99%, and 99%-100%). This is because the distribution of income is unequal and a significant amount of total AGI is reported, and a significant amount of tax is paid, by high-income taxpayers.

[11] Kyle Pomerleau, "Details and Analysis of Hillary Clinton's Tax Proposals, October 2016," Tax Foundation (October 12, 2016), https://taxfoundation.org/details-and-analysis-hillary-clinton-s-tax-proposals-october-2016/.

Table 2. Income Quintile Break Points, 2018	
0%-20%	<$15,344
20%-40%	$15,344-$27,750
40%-60%	$27,750-$43,800
60%-80%	$43,800-$70,168
80%-100%	>$70,168
80%-90%	$70,168-$99,773
90%-95%	$99,773-$139,936
95%-99%	$139,936-$345,877
99%-100%	>$345,877
Source: Tax Foundation Model, March 2018 Note: AGI levels are adjusted for the number of exemptions reported on each return.	

Conventional Estimates

Our conventional (static) distribution tables estimate the long-run change in the distribution of the tax burden. Our conventional tables include all federal taxes: incomes taxes (corporate and individual), payroll taxes, excise taxes, miscellaneous taxes and fees, and the estate and gift tax.

In general, our conventional tables follow modeling conventions used by other groups (Joint Committee on Taxation,[12] the U.S. Treasury,[13] and the Congressional Budget Office[14]). The size of the economy is assumed to be held constant. The individual income tax is borne entirely by the individuals who pay them. Payroll taxes (both employer and employee-side) are fully borne by workers. The value-added tax and excise taxes are passed back to factors of production (capital and labor) in the form of lower income. In our conventional distributional tables, we

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[12] "Methodology and Issues in Measuring Changes in the Distribution of Tax Burdens," Joint Committee on Taxation (June 14, 1993), https://www.jct.gov/publications.html?func=startdown&id=4471.

[13] Julie-Anne Cronin, "U.S. Treasury Distributional Analysis Methodology," U.S. Department of the Treasury (September 1999), https://www.treasury.gov/resource-center/tax-policy/tax-analysis/Documents/WP-85.pdf.

[14] "The Distribution of Household Income and Federal Taxes, 2013," Congressional Budget Office (June 2016), https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51361-householdincomefedtaxes.pdf.

assume that the corporate income tax is borne by both capital and labor and split evenly (50/50).[15]

As does the U.S. Treasury, our conventional table distributes the long-run burden of a tax change rather than changes in tax liabilities on an annual basis.[16] As such, we focus on the tax burden of the law when it is fully phased in, ignoring phase-ins and phaseouts of provisions that may occur over the budget window. We also ignore transitory revenue impacts. For example, changes in depreciation schedules can create temporary, large changes in corporate tax revenue, which disappear in later years. Our model ignores these short-run changes in the timing of deductions and focuses on the long-run change in the burden of the corporate tax caused by the increased or decreased present value of corporate tax deductions.

Dynamic Estimates

The Tax Foundation dynamic table also estimate the long-run change in after-tax incomes, but it includes the impact of changes in the size of the economy due to tax policy. As such, we distribute both the change in tax liabilities to taxpayers plus any changes in income that arise from a change in economic output. Our dynamic table uses the same assumptions as the conventional table for most taxes: the individual income tax, the payroll tax, the value-added tax, and excise taxes.

In our dynamic distributional table, changes in corporate tax liability is not passed to taxpayers. Rather, the corporate income tax is passed to taxpayers through its impact on economic output. In the production model, changes to the corporate income tax impact the after-tax rate of return on capital. An increase (or decrease) in the after-tax rate of return to capital will drive an increase (or decrease) in the capital stock. A change in the level of the capital stock permanently changes output, which increases (or decreases) the incomes for both owners of capital and workers.

Economic changes from the production model are distributed to taxpayers through income growth factors. These factors gross up individual income and tax items in the tax return simulator

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[15] We derive our corporate tax distribution by following a similar methodology used by the U.S. Treasury. Under the Treasury approach, the corporate tax is split into two parts: a tax that falls on the normal returns to investment, which ends up falling on labor and capital through reduced output, and a tax that falls on supernormal returns, or rents, which is a tax fully borne by shareholders. See Julie-Anne Cronin, Emily Y. Lin, Laura Power, and Michael Cooper, "Distributing the Corporate Income Tax: Revised U.S. Treasury Methodology," U.S. Department of the Treasury (May 2012), https://www.wsj.com/public/resources/documents/May2012corptaxpaper.pdf. We believe the calculation of supernormal returns is overstated in the Treasury work, and choose a split with more of the tax borne by labor. For our reasons explained, see Stephen J. Entin, "Labor Bears Much of the Cost of the Corporate Tax," Tax Foundation (October 24, 2017), https://taxfoundation.org/labor-bears-corporate-tax/.

[16] Julie-Anne Cronin, "U.S. Treasury Distributional Analysis Methodology."

based on changes in income estimate in the production model. The production model produces income factors for five income categories: labor income, corporate capital income, noncorporate capital income, interest income, and other income. The labor income, corporate capital income, and noncorporate capital income growth factors are equal to their respective simulation values divided by their baseline values. The interest income and other income growth factors are equal to simulation GDP over baseline GDP. These five growth factors are matched with income and tax items in the Public Use File.

Table 3. Growth Factors and Associated Income in the Public Use File		
Growth Factor	**Growth Factor Calculation**	**Scaled Income and Tax Items**
Labor Income	Percent change in labor compensation	Wages and salaries, self-employment income, state and local taxes
Corporate Capital Income	Percent change in corporate capital income (net of depreciation)	Ordinary dividends, qualified dividends, short-term capital gains, long-term capital gains, capital losses, capital gains distributions, and other capital gains
Noncorporate Capital Income	Percent change in noncorporate capital income (net of depreciation)	Schedule C, E, F income, rent and royalty income, businesses' losses, partnership and S corporation income
Interest Income	Percent change in GDP	Taxable interest, tax-exempt interest, investment interest expense, and deductions for interest paid
Other Income	Percent change in GDP	Taxable refunds, credits, offsets of state and local income taxes, alimony received, other income on schedule E, miscellaneous income, Social Security received, IRA distributions, taxable pension and annuity income, unemployment compensation

Like our conventional distributional tables, our dynamic distribution tables measure the long-run percent-change in taxpayers' ability to purchase goods and services. And much like the conventional tables, our dynamic tables do not include transitory revenue changes. In addition, they do not capture transitory economic effects that may impact incomes in the short run. For example, a reduction in the corporate income tax rate will not only change the tax burden on new capital, increasing the willingness to invest, but it also cuts taxes on existing capital, or investments made in the past. In the long run, the lower corporate tax rate will result in higher output and high incomes for both owners of new capital and workers. However, in the short run, owners of existing capital will capture a larger share of the tax cut. This means that the distribution of the gains will be different in the short run than the long run.

Table 4. Main Tax Model Baseline Parameters, 2018	
Federal Individual Income Tax	
Wages	19.8%
Dividends	17.4%
Interest Income	23.1%
Business Income	25.6%
Capital Gains	22.2%
State and Local Income Tax	
Wages	4.4%
Dividends	6.5%
Interest Income	5.9%
Business Income	6.3%
Capital Gains	8.8%
Payroll Tax	
Federal	11.9%
State and Local	0.2%
Corporate Income Tax	
Federal	21%
State and Local	2.3%
Present-Discounted Value of Depreciation Deductions	
Corporate	
Equipment and Software	100%
Nonresidential Structures	67%
Intellectual Property	100%
Residential Structures	55%
Noncorporate	
Equipment and Software	100%
Nonresidential Structures	69%
Intellectual Property	100%
Residential Structures	55%
Estate Tax	
Federal	0.04%
State and Local	0.01%
Excise and Other Taxes	
Personal Property taxes	0.1%

Other Taxes	1.6%
Federal Excise Taxes	0.7%
Customs Duties	0.3%
State and Local Sales Taxes	4.1%
Other State and Local Excise Taxes	0.8%
Real Estate Property Tax on Homeowners	0.7%
Real Estate Property Tax on Corporations	1.0%
Real Estate Property Tax on Noncorporate Businesses	1.1%
Subsidies for Business	-0.4%
Subsidies for Homeowners	-0.0%

Note: All values are marginal tax rates except for the present-discounted value of depreciation deductions.

2.0 Production Model

The production model uses marginal tax rates calculated by the tax model to estimate changes in long-run output. The estimate of economic output includes GDP, compensation of employees, the labor supply (in hours worked), and the capital stock. The outputs of the production model are also used to produce income growth factors, which are used in the tax model to produce both dynamic revenue and distributional estimates. Lastly, outputs from the production model are used in the allocation model to estimate changes in consumption, investment, and the trade balance.

The production model is constructed by separating the economy into four production sectors: private business, households and institutions, government enterprises, and general government. This division aligns output according to how products are distributed and how the income generated is taxed. Private businesses (Sector 1) produce the largest share of output. Institutions and households (Sector 2) do not sell their products in the market as private businesses do. The output from Sector 2 includes household production, including housekeeping, gardening, home health care, and other services, plus imputed rent on owner-occupied housing, and production of nonprofit organizations. Government enterprises (Sector 3), unlike general government, do sell their product in the market. General government (Sector 4) output is measured at cost, which is compensation of government workers and government consumption of fixed capital.

All four sectors have employees that pay taxes through the individual income tax and the payroll tax. We divide the private business sector into the corporate sector and the noncorporate sector due to their different tax statuses. The corporate sector is subject to two layers of taxation: one at the entity level when the corporation earns income, and a second tax at the individual level when that income is passed to its shareholders as dividends or capital gains. The noncorporate sector includes S corporations, partnerships, and sole proprietors. Their income is passed through to individuals and only taxed once at the individual level.

The production model employs four underlying assumptions:

1. The real after-tax rate of return on physical capital is constant in the long run. This means that when effective marginal tax rates decline and push the after-tax return up, businesses will invest more and increase the size of the capital stock until the after-tax rate of return is driven back to its original level. Likewise, if effective marginal tax rates increase, investment will decline and the capital stock will shrink until the after-tax rate of return rises back to its original level.

2. Labor's share of factor income is assumed to be constant in the long run. We also assume that shares of market GDP by sector are constant.

3. The supply of labor is somewhat inelastic. In modeling the response of workers to changes in their after-tax wage, we assume a labor supply elasticity of 0.3. This elasticity is well-supported in the economic literature, and similar to the price elasticity employed by the Congressional Budget Office in its analyses.[17]

4. We assume that the Federal Reserve holds the price level constant. This allows us to focus on the effect of tax policy rather than some combination of tax policy change with an accompanying monetary change.

2.1 Cobb-Douglas Production Function

The production model is based on a Cobb-Douglas production function with constant returns to scale. Each non-general government sector mentioned above has its own production function. The production function uses labor and capital as inputs and assumes the change in output is proportional to the changes in the input. The construction provides us estimates for output and the compensation of capital and labor for each sector.

The production function for three non-general government sectors can be formulated as follows,

$$Y_i = \mathrm{F}_i(K_i, L_i) = a_{i1} * {K_i}^{a_{i2}} * {L_i}^{1-a_{i2}},$$

where a_{i1} is the total factor productivity coefficient for sector i; K_i is capital input, in dollars, for sector i; L_i is labor input, in hours, for sector i; a_{i2} is the output elasticity of capital for sector i; and $(1 - a_{i2})$ is the output elasticity of labor for sector i.

An economy in perfect competition seeks to maximize its profit for each sector. Based on the first-order condition for maximum profits, given the price level P_i for Sector i, we estimate the parameters α_{i1} and α_{i2} and distribute factor income from labor and capital in fixed ratios for different sectors as follows,

$$S_i * K_i = \alpha_{i2} * P_i Y_i,$$

$$w * L_i = (1 - \alpha_{i2}) * \; P_i Y_i,$$

where S_i is the gross return to capital observed in Sector i, also known as the observed service price for capital input; and w is the overall before-tax wage rate for all three sectors combined.

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[17] "How the Supply of Labor Responds to Changes in Fiscal Policy," Congressional Budget Office (October 2012), http://www.cbo.gov/sites/default/files/cbofiles/attachments/10-25-2012-Labor_Supply_and_Fiscal_Policy.pdf.

2.2 Service Price

Our simulation of the economy and revenue changes starts from the service price of capital. The service price is the expected rate of return that an investment must attain to cover all taxes, economic depreciation, and the opportunity cost.[18] Each sector has a different service price because the tax regimes vary by sector.

The discussion on how service prices are calculated for the corporate sector and noncorporate sector is elaborated in a previous publication.[19] Given the same after-tax real rate of return r for these two sectors, we create formula (2) for the service price for the noncorporate sector($S_{nc,\mathrm{j}}$) and formula (3) for the corporate sector ($S_{\mathrm{c,j}}$) as follows:

$$S_{nc,j} = \frac{(r+\delta_j)*(1-itc-t_{nc,f}*z_{j,f}-t_{nc,s}*(1-t_{nc,f})*z_{j,s})+t_e+(t_{p,nc}*(1-t_{nc}))}{(1-t_{nc})} \qquad (1)$$

where j is an indicator for capital asset j; itc is the rate of any investment tax credit taken against all capital assets; $t_{nc,f}$ is the noncorporate income tax rate at the federal level; $z_{j,f}$ is the net present value of cost recovery for asset j at the federal level; $t_{nc,s}$ and $z_{j,s}$ are the corresponding values for the state level; $t_{p,nc}$ is the property tax rate for the noncorporate business; and t_e is the estate tax rate. The term t_{nc} is the combined business income tax rate at the federal and state level and can be expressed as $t_{nc} = t_{nc,f} + t_{nc,s} - t_{nc,f} * t_{nc,s}$.

$$S_{c,j} = \frac{\left(\frac{r}{(1-t_{ic})}+\delta_j\right)*(1-itc-t_{c,f}*z_{i,f}-t_{c,s}*(1-t_{c,f})*z_{j,s})+t_e+(t_{p,c}*(1-t_c))}{(1-t_c)} \qquad (2)$$

where t_{ic} is the combined federal and state personal income tax rate on corporate income; $t_{p,c}$ is the property tax on corporate capital assets at the state and local level; $t_{c,f}$ is the corporate income tax rate at the federal level; $z_{j,f}$ is the net present value of cost recovery for asset j at the federal level; $t_{c,s}$ and $z_{j,s}$ are the corresponding values for the state level; and $t_{p,c}$ is the property tax rate for the corporate business. The term t_c is the combined corporate income tax rate at the federal and state level and can be expressed as $t_c = t_{c,f} + t_{c,s} - t_{c,f} * t_{c,s}$.

As stated above, the model assumes the long-term after-tax return r remains constant in the long run. A change in the marginal tax rate on capital income may alter r for a short period, until investors respond to a tax policy change by investing more or less. A change in taxation of labor may also alter returns on capital in the short run as workers choose to work more or less. An

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[18] Dale Jorgenson, "Capital Theory and Investment Behavior," *American Economic Review* 53, no. 2 (1963), https://scholar.harvard.edu/jorgenson/publications/capital-theory-and-investment-behavior

[19] Huaqun Li, "Measuring Marginal Tax Rate on Capital Assets," Tax Foundation (December 12, 2017), https://taxfoundation.org/measuring-marginal-tax-rate-capital-assets/.

increased after-tax return on capital will cause the capital stock to expand and thereby reduce the rate of return on capital until it goes back to its baseline level.

Under our comparative statics framework, we use $S_{,j}$ and $S_{c,j}$ to indicate the minimum required long-run service price which will ensure investors attain the same r as in the baseline level following a tax change. The long-run simulation requires that the size of the capital stock adjusts to satisfy that minimum required service price and after-tax return. The decrease of the required pretax service price due to, for example, a corporate tax cut, will increase the capital stock and expand the whole economy, including wages and employment, compared to the baseline.

The government enterprises are largely exempt from most taxes, so the minimal required service price is the sum of the long-term after-tax return r and economic depreciation, which can be written as $_{g} = r + \delta$.

The institution and household sector includes part of the economy that is either tax-exempt or services not usually subject to a business-level tax. The service price for this sector is generally calculated the same way as that for the government enterprises due to their tax-exempt status. The only difference is that we add an adjustment factor to reflect the change in the capital return for owner-occupied residential structures due to any tax credits available for homeowners.

2.3 Labor Supply Function

The price of leisure is the after-tax wage foregone by not working. We assume that people choose between leisure and work based on the real after-tax wage. The labor supply is therefore determined by the real after-tax wage rate and the wage elasticity of the labor supply. The model assumes one homogeneous labor pool for all sectors, with the same wage and supply responses across the economy. All sectors have an equal before-tax wage rate, indicated as w in the production function for each sector. As stated previously, the assumed elasticity of labor supply in this model is 0.3, which means that a 10 percent increase in real after-tax compensation gives rise to a 3 percent increase in hours worked. The labor supply function can be formulated as

$$lnL = ln\alpha_4 + \alpha_5 \cdot \ln(w * (1 - t_l))$$

where α_4 is a calibration constant; α_5 is the elasticity of labor supply; and t_l is the marginal tax rate on labor income across all sectors, which is calculated from the tax simulator.

The production model assumes that the hours of labor input in the government sector and government consumption of fixed capital are exogenous. It assumes that government workers are paid the same wage as workers in the nongovernment sector. Changes in wages in the nongovernment sector affect total labor compensation for government employees, which defines the contribution of the general government sector to GDP.

2.4 Growth Factors

As policy changes alter service prices and tax rates, the Cobb-Douglass production function generates the new level of production in the economy. The new level of output grows or shrinks various tax bases, such as capital income, wage income, and other income. The percentage shift in these tax bases provides income growth factors, which interact with the tax simulators to scale up or down the individual income items for each tax filer in PUF dataset. Income growth factors are defined to track how different income levels from the new output have changed from the previous income levels in the production model. These growth factors act as a conduit between the production model and the tax simulator. Growth factors defined in the production model are used to change individual income levels in the tax simulator. Thus, tax filers are moved to new tax brackets and the weighted-average marginal tax rate for labor income changes accordingly.

The marginal rate changes for labor income cause further changes in the supply of labor and generate a new level of output in the economy, at which taxes and tax rates are recalculated.

The growth factors measure the income level change from different runs during the process of reaching equilibrium. They are calculated by dividing the new income levels by the old income levels. As mentioned in section 1.8 (Distribution Tables), five income growth factors, including growth factors for labor income, corporate capital income, noncorporate capital income, interest income, and other income, are defined. The growth factor for labor income in the production model is based on the compensation of employees for all sectors combined. The growth factor for corporate/noncorporate capital income is based on net corporate/noncorporate capital income after economic depreciation in the private business sector. Growth factors for interest and other income are assumed to equal the percentage change in the nongovernment production level.

3.0 Allocation Model

The allocation model attempts to forecast and report on more features of the economy than a simple production model. It puts production into a broader context, beginning with a starting endowment of time, valued at the after-tax wage, and initial wealth. Each period, people choose to allocate time between labor and leisure. They choose to increase or reduce wealth by consuming or saving, and they decide whether to hold wealth as physical assets such as equipment and real estate, or as financial wealth as government debt or domestic or foreign stocks and bonds.

Determining these behaviors helps to answer questions such as: "How will changes in the government deficit and private investment be funded?" "What will happen to consumption and saving?" "What will be the effect of the policy changes on the trade and current account balances, and international capital flows?" "Given the availability of and demands on domestic saving and foreign capital flows to fund the government deficit and investment, how fast will the changes to capital formation occur, and how long will it take to complete all the economic adjustments to the changes in tax and spending policies?"

3.1 The Structure of the Allocation Model

The allocation model is based on the economy's endowment of wealth and time. The full endowment ($FEnd$) is hours available (T) valued at the after-tax wage rate (pLa) plus beginning-of-period wealth (W_0). (Here, pLa is the after-tax "price" of labor," which is the pretax price times $1 - tLa$, where tLa is the marginal tax rate on labor.)

$$FEnd = pLa * T + W_0$$

Current earnings are adjusted to include exogenous income (TR) consisting of transfer payments from government.

$$FEnd = pLa * T + W_0 + TR$$

Time may be allocated to labor (La) or leisure (Le).

$$T = La + Le$$

Work yields output and income. Thus, time used for work is part of the production process. The narrower production-related endowment (End) is based on hours worked, after subtracting leisure.

$$End = pLa * (T - Le) + \ W_0 + TR = pLa * (La) + \ W_0 + TR$$

This start-of-period endowment may be used either for consumption or additions to wealth. Labor income may be consumed or saved. Existing wealth may be sold off or added to. Changes in wealth alter the end-of-period endowment.

Any wealth devoted to production during the period will earn a return. Any return not used for consumption will add to wealth over the period. End-of-year wealth is W_1. The beginning of period "price" of obtaining an additional unit of wealth at the end of the period is the future unit discounted by the after-tax return on wealth (much like the price of a Treasury bill issued at discount): $pwd = \frac{1}{(1+rwd)}$. This formula uses the rate of return measured against the discounted wealth, the earning of which increases the discounted value to W_1 at the end of the period. (Here, r is the after-tax return, which is the pretax return on wealth times $1 - tw$, where tw is the marginal tax rate on wealth.)

For the sake of computational convenience, we use the closely equivalent measure:

$$pwd = (1 - rwd).$$

Here, the after-tax rate of return is measured against the final end-of-period wealth ($\frac{W_0 - W_1}{W_1}$).

Tax changes can affect the endowment by altering the marginal tax rates on labor and capital, thereby altering the prices of labor and leisure. The values of time and wealth move accordingly, and affect the decisions of individuals on how to allocate time, how much wealth to hold, and in what form to hold it. Knowing the amount of capital and labor employed, we can calculate output, wealth, and the new level of the endowment.

3.2 The response of wealth to tax changes

Physical capital and financial capital constitute total wealth: $W_K + W_F = W$. We assume that returns on financial wealth reflect the returns on physical capital (as they are close substitutes), and that people choose to maintain constant shares of W_K and W_F in their total asset holding. Some of financial wealth is held in foreign assets, and foreigners hold some domestic assets. In equilibrium, W less government debt less net foreign holdings equal the physical capital stock.

The production function and the required after-tax rates of return found in the TAG model are part of this general equilibrium framework. The production function tells us how the gross return on capital varies as the quantity of capital rises or falls. The quantity chosen will earn a gross return (equilibrium service price) high enough to cover taxes and depreciation and still yield the required after-tax return to the owners. In equilibrium, the after-tax rate of return equals the long-run normal return on capital observed over the last roughly 60 years. Given the tax system and depreciation, the public will acquire the amount of K that can meet the desired return.

3.3 Determining consumption and saving

Earnings from labor and wealth must be used to increase wealth (via saving, S) or for consumption (C). The decision alters the endowment over time. We need to determine these numbers to derive the international accounts and calculate the adjustment path of the economy following a policy change.

We designate pc as the price of a unit of consumption. Therefore:

$$pw * W1 + pc * C = End = pLa * (La) + W0 + TR$$

We use consumption as the numeraire, setting $pc = 1$:

$$pw * W1 + C = End = (pLa) * (La) + W0 + TR$$

We estimate consumption as a function of the endowment using quarterly data out of the Commerce Department national income and product accounts from 1964 to 2012.

Consumption moves with the endowment (rising as it rises, falling as it falls), but more slowly. Its elasticity is derived from historical relationships as revealed in the data.

$$\frac{C(End_0)}{(End_0)} = a1 + Bc * \ln(\frac{End_0}{P'}) = sc,$$

Here, sc is the estimate of the share of C in the endowment, and P' is a composite (divisia) index of the prices of wealth and leisure. This reveals consumption to be:

$$C = (a1 + Bc * ln(\frac{End_0}{P'})) * End_0$$

We assume, as conjectured in Milton Friedman's permanent income hypothesis, that consumption is a slow-moving function of permanent income, which is expected earnings from labor and wealth. Consumption is unlikely to vary by a large amount in the short run to accommodate large changes in desired capital formation. Knowing consumption can help to determine the extent to which saving, net exports, and international capital flow can change as GDP is altered by the policy shifts.

3.4 Determining net exports and the international capital flows

GDP is the production of final goods and services. It consists of consumption goods and services, investment goods, government services, and net exports of goods and services (NX, or the trade balance):

$$GDP = C + I + G + NX$$

If we know GDP, C, I, and G, we can determine NX:

$$GDP - C - I - G \ = \ NX$$

The current account balance (CAB) adds other current earnings to net exports. The additions are net income from abroad (the net of foreign wages paid to domestic residents less wages paid to foreigners, and earnings by domestic residents on foreign assets versus wage payments foreigners' earnings on domestic assets), and net taxes from abroad. Net remittances, donations, and foreign aid are subtracted. These adjustments to net exports are exogenous capital income and transfers ($EKTR$).

$$CAB = NX + EKTR$$

A net current account surplus lets Americans buy more assets from abroad than we sell to foreigners. These purchases constitute net foreign investment, NFI. NFI is the excess of domestic residents' investment abroad over foreigners' investment in domestic assets. A positive NFI represents a net capital outflow, meaning that, on balance, there is some domestic saving flowing out of the country. This is called a capital account deficit. Negative NFI represents a net capital inflow, a net flow of some foreign saving into the country. This is called a capital account surplus. For the foreign exchange markets to clear, the current account balance and the net foreign investment plus $EKTR$ must be equal in dollar value. Changes in the exchange rate ensure the balance by altering the value of domestic versus foreign assets and products.

$$CAB = NX + EKTR = NFI$$

Assuming $EKTR$ is exogenous and known, we can determine the CAB. We then note that the CAB must equal NFI. Obtaining NFI gives us the net flow of saving out of or into the country. When the country runs a current account deficit, NFI is negative, and the country is borrowing from abroad. Some foreign saving is being made available for domestic use.

3.5 Determining funding for the government budget deficit and investment

It is easy to show that domestic saving and the net capital inflow from abroad must equal the funding for the government deficit and private investment. Or to put it another way, investment is limited to domestic saving and inflowing foreign saving less the amount absorbed to fund the government deficit. (In what follows, we omit $EKTR$ for simplicity. When added to both the production and income sides of the equations, it transforms the equations into GNP, rather than GDP. The equalities still hold.)

Production equals income. People are paid for producing GDP. Therefore, GDP is a measure of income as well as production. Income may be used to pay taxes, consume, and save:

$$GDP \ = \ C \ + \ S \ + \ T$$

Equating the two formulas for GDP:

$$C + I + G + NX \ = \ GDP \ = \ C + S + T$$

Subtract C from both sides to get:

$$I + G + NX \ = \ S + T$$

Rearrange terms to get:

$$(G - T) + I = \ S - NX$$

This is equal to:

$$(G - T) + I = \ S - NFI$$

where the negative NFI equals the net capital outflow and $(G-T)$ is the government budget deficit.

Let D equal the government deficit:

$$D + I = S - NFI$$

Or:

$$I = S - NFI - D$$

This says that private investment is limited to domestic saving and the net capital inflow less the government deficit.

In the long term, the economy adjusts capital, labor, and output to be consistent with the long-run return on capital, to accommodate the assumed level of government spending less taxes, maintain required investment to sustain the capital stock, desired consumption, desired wealth and associated saving behavior, and net foreign investment to balance net exports, plus the endowment. These determine a unique level of GDP, physical capital, and financial wealth; a unique division of financial wealth between domestic and foreign assets; and a unique level of foreign ownership of domestic assets and the resulting annual balance of interest and dividends flowing in and out of the country.

4.0 Producing Estimates

The three main components of the Tax Foundation General Equilibrium Tax Model work iteratively to produce revenue and economic estimates. The Tax Foundation model can produce two types of estimates: comparative statics, or long-run estimates, and estimates over a 10-year budget window.

4.1 Comparative Statics

The comparative statics model estimates the long-run impact of tax policy by comparing a baseline tax policy to a simulation tax policy. The comparative statics model does not attempt to model economic and budgetary transitional impacts. It essentially estimates what the economy would look like today if an alternative tax policy had always been in place.

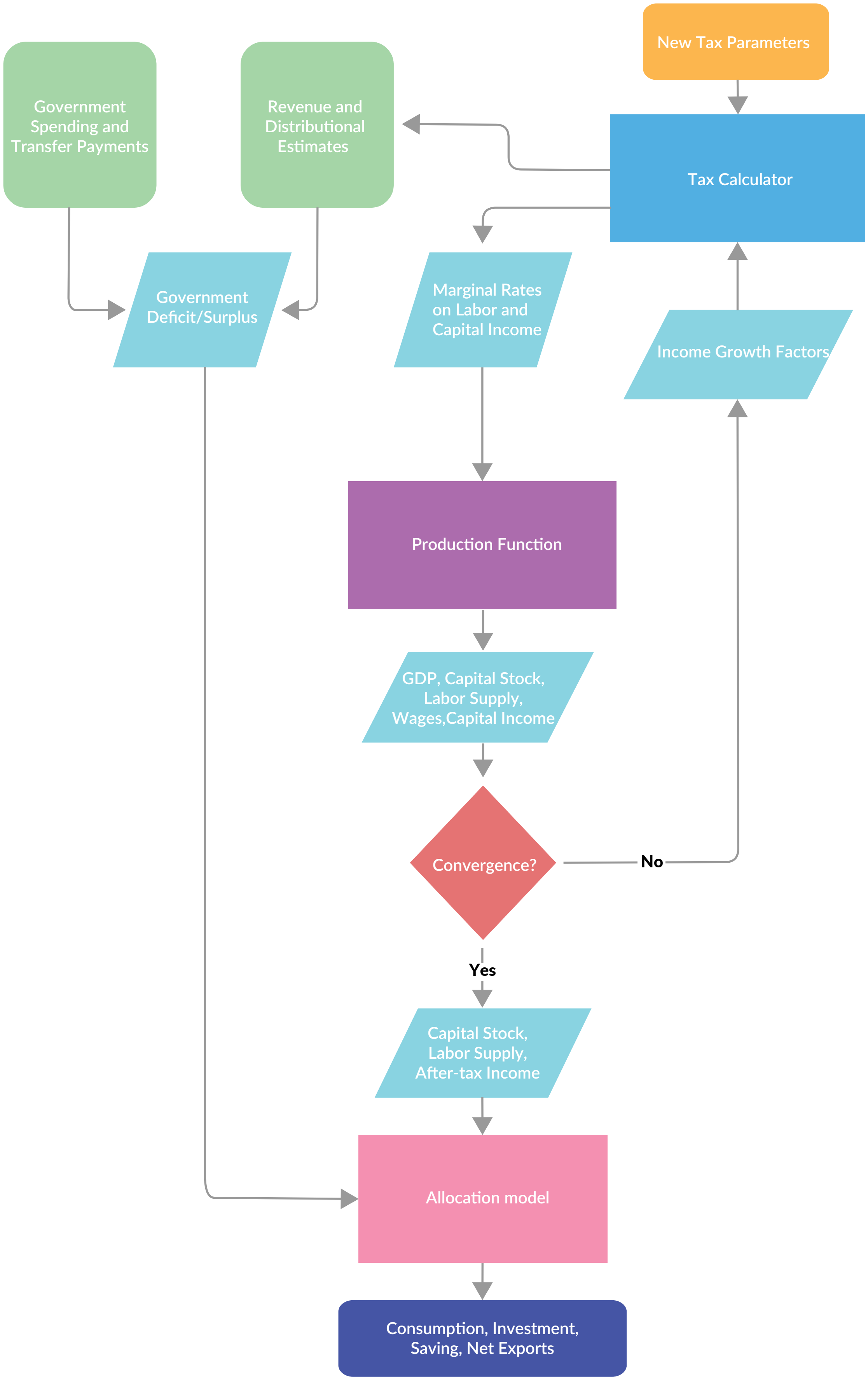
The three main components of the Tax Foundation model work iteratively to produce estimates of the long-run impact of tax policy on federal revenues and the economy. Estimates begin with the input of new tax parameters into the tax model. The new parameters are used immediately to produce conventional estimates of revenue, the government deficit, government debt, and the distribution of the tax burden. At the same time, the tax model produces estimates of new marginal tax rates on labor and capital.

The marginal tax rates on labor and capital produced in the tax model are used to recalculate after-tax wages and the service price of capital in the production model. This then produces estimates of a new desired level of the capital stock, wages, hours worked, and capital income. To account for the effect of real bracket creep, the phenomenon by which taxpayers fall into higher tax brackets due to higher incomes, the model calculates income growth factors. These income factors are used in the tax model to gross up or down incomes. With new incomes, we rerun the tax model and produce new estimates of the capital stock, wages, hours worked, and capital income. It also recalculates estimates of federal revenue, the government deficit, and the distribution of the tax burden given the new income level.

The model repeats this process of estimating output, marginal rates, and the tax burden until it hits a convergence in which incomes and marginal rates hit equilibrium. Convergence is defined as a point where two consecutive iterations yield near-zero changes in the growth factors. In practice, the model usually cycles about five times before it reaches an equilibrium. Once the tax and production model have converged, the production model has produced its final estimates of the long-run changes to the economy, federal revenue, and the tax burden.

Once the production model and the tax model have hit equilibrium, the estimated level of the capital stock, the budget deficit and after-tax income are fed into the allocation or demand model. This model uses those inputs to estimate consumption, investment, savings, and net exports.

Structure of the General Equilibrium Model



4.2 Ten-Year Estimates

In addition to long-run estimates, the Tax Foundation model can create estimates of federal revenues, GDP, wages, investment, capital stock, employment, consumption, and other measures of economic output for each year over a 10-year period. The procedure for estimating policies over the 10-year budget window is similar to the procedure for comparative statics estimates. We compare baseline economic and tax parameters to simulation economic and tax parameters to estimate changes in economic output and tax revenue. However, rather than comparing baseline and simulation parameters for two periods (current year and simulation year), we compare baseline and simulation parameters for each year over the budget window. We also account for transitional revenue and economic impacts that would occur over a 10-year period.

Each year over the 10-year budget window starts with baseline estimates of marginal tax rates, federal revenue, and economic projections. We produce baseline marginal tax rates with the tax calculator for every year over the budget window. For baseline revenue and economic projections, we use the most up-to-date CBO Budget and Economic Outlook. The CBO outlook provides estimates of federal revenues by major source, projected federal debt, and GDP and its major components over the next 10 years. Our baseline projections conform to CBO's "current law" definition and include any temporary policies that are set to expire over the budget window.

For conventional revenue estimates, we reestimate tax liability for each year depending on the specifics of the tax proposal. For economic projections and dynamic estimates, we start by estimating changes in marginal tax rates for each year. Much like in the comparative statics model, we estimate how a tax or spending change alters the current rate of return (r) on physical capital (K) and how it affects the after-tax wage rate. The adjustment to these shocks restores the rate of return on capital to normal levels by altering the capital stock, which determines the ultimate changes in capital formation, wages, labor supply, and output.

We start with the initial policy-induced deviation in r from its normal level. The model begins with an initial approximation as to how much of the deviation is adjusted away in the first year by picking a new target r' and corresponding target K' that move r and K a bit in the expected long-run direction. Achieving the new K' would require enough new investment, I', to cover depreciation of the starting capital stock plus the desired change in K $(= K' - K0)$.

The new r' and K' will determine productivity of labor and a new pretax wage. Any tax changes on labor income will then generate a new post-tax wage, which will give a new supply of labor (La). The new K' and La yield a new trial GDP' and aggregate income, which alters consumption, saving, and the budget deficit, and projects net exports and an associated net capital flow from abroad (net foreign investment, NFI). Using the new trial GDP, we determine C, NX, and NFI as described above.

The question then becomes, will the domestic saving and NFI expected at the trial GDP be sufficient to fund the associated budget deficit and leave enough saving to cover the assumed amount of required private investment? If the amount of available saving provides for enough investment (I) and the resulting capital stock (K) to match the assumed I’ and K’ consistent with the forecasted r’, the model concludes its estimated outcome for year one. If not, the model alters its initial assumption for r’, K’, and the required I’ to bring them more into line with the forecasted result, then recalculates. This iterative process continues until the guess and the outcome converge. At that point, saving and the net capital flow equal investment and the government deficit, and the domestic and international accounts are all in balance.

For example, suppose the forecasted saving and NFI are too small, after funding the trial deficit, to provide as much additional I and K as first assumed. I would fall short of I’, the target K’ would not be reached, and the resulting r would remain higher than our initial guess of r’. If so, the model would make a second pass at the solution, choosing something closer to the higher r from the first pass as the new starting r’. With a higher assumed return on capital, the new assumed K’ would be smaller, and less foreign financing would be needed. The change in assumptions would reduce the gap between estimated saving and the amount required. We re-iterate as needed until the guess and the outcome are equal.

Once the first year’s results are determined, the model turns to the second and subsequent years by assuming further movements in r toward its long-run normal level. In each period, the iterative process is repeated to determine how far the adjustment in r, K, I, and GDP can proceed. The result is an adjustment path to a new equilibrium.