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Macroeconomic Effects of the 2017 Tax Reform

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In December 2017, Congress enacted the most sweeping set of tax changes in a generation, lowering statutory tax rates for individuals and businesses and altering the tax base—in some cases to remove distortionary tax preferences and in some cases to create new ones. The law generated substantial debate on many issues, notably about its long-term impact on the capital-labor ratio, GDP per worker, real wages and, in the transition to the new steady state, economic growth. One of us (Robert) joined a group of economists (*Wall Street Journal*, November 26, 2017) to argue that the corporate-tax part of the tax reform would have substantially positive long-term effects in all of these dimensions. Another of us (Jason) was a consistent critic of the law.

Broadly speaking, we agree that a simple neoclassical model of the economy can provide useful insights in assessing the macroeconomic consequences of the tax changes. This paper is an attempt to provide a more thorough analysis of the macroeconomic impact of the tax changes based on this model. In addition, we develop estimates of the short-run impact of the tax changes based on calibrating previous regression-based models that link taxes to short-run economic growth. The bulk of the paper reflects a joint analysis, but we also have different interpretations of the results and their implications for public policy—which we discuss in separate concluding sections.

Our views on the specific question of the tax bill's effects on economic growth still do not completely converge and there are three sources of differences. First, different expectations for future tax and spending policy. For example, the long-term macroeconomic impact of the tax changes is considerably more positive if it is assumed that the equipment expensing provisions that are set to phase-out after 2022 are made permanent and any resultant cost of the bill is paid for with lump-sum taxes. Conversely, the macroeconomic impact of the tax changes is much less positive if the expirations are allowed to occur. Second, different views on whether and to what extent higher budget deficits result in crowding out, either through reduced domestic investment or more of that domestic investment being financed by capital inflows. Finally, both authors agree that the model we are working with is incomplete and does not capture potentially economically important aspects of the law but the authors differ on what direction that would push the estimates. For example, to the degree the law resulted in future spending cuts, would such cuts, at the margin, further boost growth by reducing distorting government programs or hurt growth by reducing investments in infrastructure and research?

It should be noted that this paper is focused solely on the macroeconomic impact of the tax changes. It does not address the welfare implications directly—for example, by allowing for offsetting reductions in leisure or consumption against the increases in output. Moreover, we do not address issues of the fairness of who should pay taxes or the impact of the tax legislation on the distribution of after-tax income. As such, this analysis is an input into a broader evaluation of the tax cut but not a full evaluation itself. We each provide some thoughts on these broader welfare issues in our separate concluding sections.

The paper is organized as follows. Section I describes the tax changes passed by Congress in 2017. Section II details the alternative scenarios about future tax policy that we analyze in the paper. The law itself is incomplete in two important respects. First, it contains a number of provisions that expire or are phased out. Second, the government’s intertemporal budget constraint will eventually have to be satisfied by future changes in government spending or revenues that were not specified in the legislation itself but which would have macroeconomic consequences themselves. The first scenario we consider is the tax law that Congress passed, which includes expensing of equipment investment being phased out, new and expanded offsets being phased in, and a sunset of most of the individual and pass-through provisions. We call this the "law-as-written" scenario. The second treats as permanent the features of the tax law in effect that are scheduled to be in effect in 2019. This scenario includes permanent expensing of equipment and research and development (R&D) investment, the individual and pass-through provisions, and cancels some delayed offsets in the law. We call this the "provisions-permanent" scenario. In both scenarios, we implicitly assume that any revenue losses due to the tax cuts are eventually paid for through non-distortionary lump-sum financing or by cuts in government expenditure that have no positive or negative economic impacts.

Section III is a neoclassical analysis of the long-run impact of the 2017 tax changes on the corporate and pass-through sectors. Our main approach involves calibrating effects on the user cost of capital. We then translate the changes in user costs into long-run impacts on capital-labor ratios, levels of real GDP, and the real wage. This translation considers five types of capital—equipment, structures, residential rental property, R&D intellectual property, and other forms of intellectual property—and uses reasonable parameter values within the context of a neoclassical model of production and investment. We analyze the law-as-written and provisions-permanent scenarios and compare them with a baseline of what the pre-2017 law would have implied in the long run—for 2027 and beyond. We show how the conclusions depend on assumptions about key parameters that enter into the neoclassical framework, and we evaluate hypothetical alternative tax reforms, including full expensing of all capital and elimination of the tax deductibility of bond interest payments. Although this study has a long-run focus, we also project shorter-run growth effects—out to the 10-year horizon emphasized by Congress—based on estimated convergence rates toward long-run or steady-state positions.

Section IV contains a discussion of the impact of crowding-out on the ten-year estimates, along with a sensitivity analysis of these effects. Crowding out is not considered over a longer period because the assumption of eventual lump-sum financing or equivalent cuts in government spending satisfies the government's budget constraint.

Section V provides a qualitative discussion of factors that are left out of the standard neoclassical analysis. These forces are hard to assess and are of varying sign. However, these effects may be important.

Section VI has an analysis of effects from the 2017 reductions in average marginal income-tax rates for individuals. We assess these effects using existing reduced-form empirical studies of the effects of changes in marginal income-tax rates. These regression-based estimates imply that these effects are important over a two-year horizon and, in fact, dwarf the estimated growth effects from the business tax changes over this period. However, the business tax changes analyzed in Sections III and IV are what matter for longer-term growth projections.

Section VII provides a brief comparison with other estimates. The final section offers a conclusion and implications for future tax and fiscal policy, including the different perspectives of the two authors.

A summary of the main results in this paper is in Table 1; the remainder of this paper provides the basis for these estimates and context for understanding them.

Table 1
Summary of the Major Macroeconomic Results for Featured Parameters
(percent change)

	Law as written	Provisions permanent
Long Run Results		
Corporate productivity	2.5%	4.7%
Pass-through productivity	-0.8%	3.1%
GDP per capita	0.9%	3.1%
10-year Results		
Level of output after 10 years	0.4%	1.2%
Change in annual growth rate	0.04 p.p.	0.13 p.p.
Financing Assumptions, 2018-2027		
Cost assuming JCT scoring and our dynamic feedback	$1.2 trillion	$1.7 trillion
Annual lump sum cost per household	$900	$1,400

I. The Tax Law

On December 22, President Trump signed Public Law 115-97, "An Act to provide for reconciliation pursuant to titles II and V of the concurrent resolution on the budget for fiscal year 2018," which was originally called the "Tax Cuts and Jobs Act" before that title had to be dropped due to procedural objections. The 2017 Tax Law made the most sweeping changes to individual and corporate tax law in decades and also reduced the estate tax. The Joint Committee on Taxation (JCT 2017b) estimated the law will cost $1.5 trillion in federal revenue, or $1.1 trillion after accounting for its impact on the economy (see the Appendix Table for a breakdown).

The 2017 tax law altered the individual rates and bracket structures, maintaining seven rates as in prior law but reducing several of them—including cutting the top rate from 39.6 percent to 37.0 percent. The full set of these changes for married couples in the first year are shown in Table 2.

Table 2
Individual Income Tax Brackets for Married Individuals Filing Jointly, 2018

Before 2017 Tax Law		After 2017 Tax Law	
Taxable Income	Marginal Tax Rate	Taxable Income	Marginal Tax Rate
$0 to $19,050	10%	$0 to $19,050	10%
$19,050 to $77,400	15%	$19,050 to $77,400	12%
$77,400 to $156,150	25%	$77,400 to $165,000	22%
$156,150 to $237,950	28%	$165,000 to $315,000	24%
$237,950 to $424,950	33%	$315,000 to $400,000	32%
$424,950 to $480,050	35%	$400,000 to $600,000	35%
Over $480,050	39.6%	Over $600,000	37%

In addition, the law nearly doubled the standard deduction, eliminated personal exemptions, reduced the individual Alternative Minimum Tax (AMT), and doubled the child tax credit from $1,000 to $2,000, providing $75 of additional refundability for households currently constrained by the refundable limit. The law also limited some tax benefits, most notably capping the deductibility of State and local taxes at $10,000 and lowering the cap on the mortgage interest deduction for new mortgages from $1,100,000 to $750,000. Finally, effective 2019 the law sets the Shared Responsibility Payment to zero, effectively repealing the individual mandate that was originally established by the Affordable Care Act.

The law established a new 20 percent deduction for certain pass-through income. The deduction applies broadly to individual filers making less than $157,500 and joint filers making less than $315,000. For individual filers making more than $207,500 and joint filers making more than $415,000 annually the pass-through deduction is limited by a set of guardrails, including that it does not apply to personal services firms and is limited by the amount of wages and potentially capital a firm has. The tax law also doubled the exemption for the estate tax from $5.6 million to $11.2 million in 2018, or from $11.2 million to $22.4 million for married couples.

All of the individual, pass-through and estate provisions sunset after 2025, with the exception of the shift to chained CPI and the de facto repeal of the individual mandate.

On the corporate side, the law cut the statutory corporate tax rate from 35 to 21 percent. It also allows businesses to fully expense investments in equipment for five years and then phases down that favorable treatment, returning to previous depreciation schedules starting in 2027. The law also includes a number of domestic offsets that pay for a portion of these costs, including repealing the domestic production deduction, limiting the deductibility of interest to 30 percent of earnings (defined as earnings before interest, tax, and amortization or EBITA before 2021 and earnings before interest or EBIT thereafter), requiring five-year amortization of research and experimentation expenditures starting in 2022, and limiting net operating loss carrybacks and carryforwards.

The law also made major changes to international business taxation including establishing a territorial system and reducing the tax rate on foreign intangibles associated with income derived in the United States. These costs are almost exactly offset within the ten-year budget window with two major new anti-abuse provisions, a minimum tax on Global Intangible Low-taxed Income (GILTI) that is 10.5 percent through 2025 and 13.125 percent thereafter and also a Base Erosion and Anti-abuse tax that functions like an alternative minimum tax on inbound investment. In addition, the law mandated a one-time payment on existing overseas earnings and allowed free repatriation of these earnings thereafter.

II. Modelling the Tax Law Along with Assumptions about Future Policy

Modelling the tax law requires analyzing not just what Congress passed but also making assumptions about future policy. Our analysis compares tax policies to a baseline that reflects what would have happened absent any legislation in 2017 or later, what is sometimes called a "current law" baseline.[1]

We focus on two scenarios. The first is the law as passed by Congress (henceforth, "law-as-written" scenario). This specification assumes that all of the tax cuts phase-out or expire as scheduled and all of the offsets come into effect as scheduled. This scenario is the one that has been the basis for widely cited cost and macroeconomic estimates by official agencies like the JCT and groups like the Penn Wharton Budget Model, the Tax Policy Center, and the Tax Foundation.

The second scenario takes the law that was passed by Congress and assumes that the major provisions are extended and the delayed offsets never happen (henceforth, "provisions-permanent" scenario). Most importantly, this scenario assumes that equipment expensing is expected to be and is actually made permanent after 2022 and that the individual, pass-through, and estate provisions that expire after 2025 are made permanent. We also assume that Congress cancels additional offsets that come into effect in 2022, including requiring the five-year amortization of research and experimentation (R&E) expenditures, tougher limits on interest deductibility, and tougher limits on international income shifting.[2]

Making economic predictions conditional on a given set of policy inputs is difficult. Making political predictions about those future policy inputs is considerably more difficult. The argument for focusing on the law as passed by Congress is that it is conceptually unambiguous, corresponds to what Congress actually passed, and is consistent with the prioritizations made by

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[1] We do not address the so-called "tax extenders" that were not addressed in the legislation as well as expiring energy provisions and delayed health provisions. Effectively, we are assuming these would have had the same set of expirations and extensions under the baseline and the policy and thus do not significantly affect our analysis.

[2] This choice of a "permanent" baseline differs from the permanent baseline concept advanced by the Office of Management and Budget which assumes the individual and estate tax provisions that expire after 2025 are made permanent but does not assume or propose to make expensing permanent or cancel the scheduled offsets.

Congress (e.g., prioritizing permanent corporate changes over permanent individual changes or phasing down bonus depreciation in a stated attempt to make it less likely that expensing is made permanent). Moreover, it is difficult to make predictions about the future of the tax law. The 1986 tax reform also incorporated many phase-ins and phase-outs, most of which actually happened. In addition, future tax policy will be shaped by developments in the path of the fiscal deficit and changes in the political system.

The argument for focusing on the law assuming all of the provisions are extended is that this best corresponds to "current policy" in the tax code, that is what is actually in place in the short run (say 2019) and what would happen economically in the long run if everything in place in 2019 continued. For many provisions in the tax code, assuming the continuation of current policy has been an accurate prediction of future practice. For example, the R&E tax credit was routinely extended on a temporary basis with virtually no lapses for more than three decades before being made permanent in 2015, and the alternative minimum tax (AMT) was routinely patched and extended on an annual basis until these fixes were made permanent in 2013. Moreover, about 80 percent of the Bush tax cuts were made permanent under a Democratic President with a Democratic Senate in early 2013 (Huang 2013).[3]

In addition, any long-run macroeconomic estimates require the government's intertemporal budget constraint to be satisfied. As such, the law that Congress passed was incomplete and will necessitate the passage of future laws (or changes in government spending) to satisfy this budget constraint. Our main analysis assumes that any effects on government

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[3] The same logic for applying a "current policy" concept to the tax law implies that a reasonable counterfactual would be to assume that provisions in the tax law that were phasing down or out in 2017 were made permanent—which in this case applies to the 50 percent bonus depreciation for equipment. Another argument for assuming that a counterfactual to the passage of the tax law was the extension of 50 percent bonus depreciation is that 50 percent or more bonus depreciation had been in effect continuously since 2008. Estimates for this scenario are presented in Section III and can be used as an alternative baseline if desired.

revenue will be financed later in a lump-sum, non-distortionary manner. This corresponds to the assumption that households will make payments that are not conditional on income or any economic choices and thus has no distortionary effects on the economy. It could be approximately translated into policy terms through, for example, reductions to Social Security or Medicare benefits or other government transfer programs. Lump sum financing is assumed to start after ten years so that it does not affect the estimates that incorporate an increase in the interest rate.

III. Neoclassical Framework

Our long-run estimates are based on a comparative statics exercise using a standard neoclassical framework in a Ramsey-style set up with Cobb-Douglas production functions, infinitely lived agents, and perfect foresight. We model different steady-state tax policies assuming they are fully anticipated and do not change.

Our analysis treats the expected real rate of return on capital, r^k, as given at least in the long run even when business tax structure changes. This result holds for the real interest rate in the steady state of the standard neoclassical growth model because of given values for the rate of time preference, the elasticity of intertemporal substitution, and the rate of exogenous technical progress (see Barro and Sala-i-Martin [2004, Ch. 2]). That is, the long-run supply of capital is horizontal in this model. We also present a more speculative analysis of what would happen if interest rates rose.

User Costs and Investment

We focus on user costs, which indicate the expected rate of return that an investor requires to invest in a certain form of capital. A reduction in taxes, for example, means that the user cost is reduced—which leads to increased investment until diminishing returns drive the expected rate of return back to indifference with alternative investments. The concept of user costs was used by Keynes (1936, Ch. 11) and has since been employed in public and corporate finance by many economists, including Hall and Jorgenson (1967), who do not use the explicit term. We base part of our conceptual framework on King and Fullerton (1984, Ch. 2). We initially ignore debt financing and therefore think of all financing as coming from owners; that is, from equity.

The after-tax expected cash flow for owners of a corporation in period t is given by:

(1) $$\Psi_t = (1-\tau_t)(Y_t - w_t L_t) - (1-\tau_t\lambda_t)(K_t - K_{t-1} + \delta K_{t-1}),$$

where Y is output, w is the real wage rate, L is labor, K is capital, τ is the tax rate on profits, λ is the effective expensing rate on purchases of capital goods, and δ is the true proportionate depreciation rate on capital. As we detail later, the expensing rate, λ, takes account of literal expensing, depreciation allowances, and investment tax credits. The tax rate is different across the two sectors we are analyzing: the “corporate sector” (by which we mean C corporations that pay taxes at the corporate rate) and the “pass-through sector” (by which we mean S corporations, partnerships and sole proprietors, who pay taxes at the individual level).

We assume that the corporation makes investment choices to maximize the expected present value of its net cash flows given in equation (1), where the present-value calculation uses as a discount rate the required after-tax expected rate of return on capital, r^k. In practice, we measure r^k after corporate taxes but before taxation at the individual level on dividends and (deferred) capital gains. Therefore, we are assuming that the relevant marginal tax rate at the individual level is negligible for the marginal investor.[4]

Our main analysis assumes a high value for r^k, around 8.2 percent per year, which is the average real rate of return on equity for the United States and also for a group of 11 OECD countries with long-term data at annual or higher frequency.[5] This rate has been roughly stable over long periods back as far as 1870.

The r^k of 8.2 percent in real terms is well above the risk-free rate. For example, the long-term average real rate of return on assets akin to short-term Treasury Bills for the 11 OECD countries was 1 percent in real terms, corresponding to an equity premium of about 7 percent.[6] Economists have advanced alternative explanations of this high equity premium, including the rare-disasters idea of Rietz (1988) and Barro (2006).

We use r^k=8.2 percent to discount all expected future corporate cash flows, although different discount rates may apply to different components. For example, Auerbach and Hassett (1992, p. 144) argue that the real value of future depreciation allowances is nearly known in advance (subject to minor uncertainty associated with inflation) and, therefore, should be discounted at a rate not much above the risk-free rate. However, Summers (1987) surveyed companies and found that they used an average nominal discount rate of 15 to 17 percent per year, compared to a 10-year Treasury rate at the time around 8 percent. This may be rational from a rare-disasters perspective—a possible explanation for why r^k is so high in the first place—where the critical question is what happens to the real value of depreciation allowances in

[4] The 2017 tax law did not change the tax treatment of dividends and capital gains.
[5] We use an updated version of the data in Barro and Ursua (2008, Table 5). The countries are Australia, Canada, Denmark, France, Germany, Italy, Japan, Norway, Sweden, United Kingdom, and United States. Most of the data on total real, arithmetic, annual returns are based on information from *Global Financial Data*.
[6] Duarte and Rosa (2015, Figure 1) infer from an array of empirical models that the U.S. equity premium has no clear long-term trend and is, if anything, above normal in recent years (up to 2014).

extremely bad states. Inability to recognize losses fully for tax purposes in such states is one consideration. Another is that, if assets are sold off, such as in bankruptcy, the value of depreciation allowances for the buyer could be reduced as a result without the seller being able to fully monetize the tax losses that it would be eligible for.

We assume now that the tax rate and expensing rate are constant over time, $\tau_t=\tau_{t+1}=\tau$ and $\lambda_t=\lambda_{t+1}=\lambda$. If we abstract from adjustment costs for investment and changes in the relative price of investment goods, we get the first-order condition for K_t by calculating derivatives of Ψ_t and Ψ_{t+1} in equation (1) with respect to K_t. We then set to zero the sum of the first expression and the discounted value of the second expression. The result, as the arbitrary length of the period approaches zero, is:[7]

$$\text{(2)} \qquad MPK_t = \Omega = \left(\frac{1-\tau\lambda}{1-\tau}\right) \cdot (r^k + \delta),$$

where MPK_t is the marginal product of capital and Ω is the user cost of capital. Because we are abstracting from adjustment costs for investment and changes in the relative price of investment goods, the left side of equation (2), MPK_t, is the expected marginal rate of return on investment at time *t*. We assume that the neglect of adjustment costs is satisfactory for analyses of long-run effects on capital-labor ratios, *K/L*.

The user cost of capital, Ω, on the right side of equation (2) includes r^k and δ. User costs depend also on features of the corporate tax system, summarized by τ and λ. As mentioned, the parameter λ incorporates literal expensing, depreciation allowances, and investment tax credits (in practice, the R&E credit associated with R&D investment).[8] Specifically, in calculating λ for

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[7]This neoclassical analysis neglects fixed costs, which were stressed by Devereux and Griffith (1998) in their analysis of international investment decisions. However, such costs could also be significant for domestic investment. A useful alternative model would have fixed costs and diminishing returns to scale at the firm level.
[8]An investment tax credit, c, enters as c/τ in the formula for λ. Therefore, with our definition, a change in τ affects λ for given c.

the old and new corporate tax systems, we estimate present values (using the nominal discount rate implied by r^k and the inflation rate, π) associated with depreciation allowances. We should stress that equation (2) holds for a tax system with permanently fixed values of τ and λ. More generally, there would be dynamic effects generated by anticipated changes in τ and λ over time.

Some properties of the user-cost formula are:

- $\lambda=1$ (full expensing) implies no effect of τ on Ω.
- $\lambda=0$ gives the formula $(1-\tau)\cdot MPK_t = r^k + \delta$.
- $0<\tau<1$ implies Ω falls with λ.
- $0\leq\lambda<1$ implies Ω rises with τ.
- $\lambda>1$ implies Ω falls with τ.
- If the tax system allows only for depreciation deductions corresponding to true deprecation at the rate δ, then $\lambda=\delta/(r^k+\delta)$. Correspondingly, the formula becomes $(1-\tau)\cdot(MPK_t-\delta) = r^k$.

Economists generally agree that permanent 100 percent expensing makes sense from an efficiency standpoint, because this approach matches deductions from corporate taxable income with cash flows for buying capital goods, effectively eliminating the tax on the normal rate of return and leaving corporate taxes to fall on rents, which is a non-distortionary form of tax.[9] With this system permanently in place, corresponding to $\lambda=1$ in equation (1), the tax rate, τ, does not influence the user cost, Ω. In effect, taxes are rebated through expensing at the time of investment at the rate τ. Then the government gets back this rebate over time by taxing future

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[9] In practice, there are a number of qualifications to this statement, especially for a tax system that does not fully and immediately refund losses and thus acts as a tax on risk—potentially discouraging entrepreneurship. In addition, statutory tax rates may matter for certain decisions, such as international shifting. And changes to the expensing rate or the tax rate can act as capital levies or windfalls, depending on how they are designed. These arguments do not overturn the case for expensing but point out that even in the presence of expensing the tax rate could matter.

returns on capital at the rate τ. The expected present value of these future flows (when discounted at the rate r^k) coincides with the initial rebate. Hence, the expected present value of taxes collected on the normal return to capital is zero, although they would be positive or negative if returns are better or worse than expected—essentially meaning the tax system is serving an insurance function.[10] In such a system taxes would still be collected on excess returns associated with rents, a category that Power and Frerick (2015) estimate has risen from 60 percent of returns to 75 percent of returns over the last two decades. In addition, if the government's discount rate is less than r^k it would also raise revenue in present value.

The analysis can be extended more broadly to allow for changes over time in λ and τ. These changes would be subject to uncertainty and may feature feedback from the state of the economy. In analyzing the 2017 tax law, our main analysis treats the changes in λ and τ as unanticipated and permanent.

Debt Financing

We now expand the analysis to allow for bond/debt financing. We know from Modigliani and Miller (1958) that, if there were no corporate tax advantages for bonds, then, under reasonable conditions, the option to issue bonds would not matter for the overall value of the corporation and for investment choices. The core idea is that, if owners can also issue or hold bonds that pay the nominal interest rate, i (that is, borrow and lend at the same interest rate as the corporation), then leverage choices made at the firm level do not matter.

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[10] At the margin, the impact of a permanent increase in the capital stock by one unit at the current date on the expected present value of taxes is $\frac{1}{r^k} \cdot \frac{\tau(1-\lambda)}{(1-\tau)} \cdot (r^k + \delta)$. If $0<\tau<1$, this expression is positive if $\lambda<1$, zero if $\lambda=1$, and negative if $\lambda>1$.

When there are tax advantages at the corporate level from bond financing and no transaction costs associated with default/bankruptcy, all financing would optimally occur through bonds/debt, none through equity. The usual view, as in Kraus and Litzenberger (1973), Myers (1984), and Leland (1994), is that the optimal debt-equity mix trades off these tax advantages against costs implied by the positive effect of leverage on a corporation's probability of default/bankruptcy.[11] In our applied analysis, we use a simple model that captures this core tradeoff.

We introduce debt financing in a simple way by adding to the after-tax corporate cash flow, Ψ_t, in equation (1) the two critical terms: the tax deductibility of interest payments on debt and the transaction costs associated with default/bankruptcy. The new terms for period *t* are:

$$(3) \qquad \tau_t \cdot i_{t-1} \cdot \frac{B_{t-1}}{P_t} - \Phi\left(\frac{B_t}{P_t K_t}\right) \cdot K_t,$$

where B_t is the nominal quantity of the corporation's bonds, P_t is the price level, and i_t is the nominal interest rate on corporate bonds.[12] We adopt the convention that interest payments made in period *t* depend on i_{t-1} and B_{t-1}. The first term in equation (3) reflects the tax deductibility of these interest payments at the corporate level.[13]

The term $\Phi\left(\frac{B_t}{P_t K_t}\right)$ in equation (3) represents the cost associated with potential corporate default, whose probability is assumed to be an increasing function of the debt-asset ratio, B_t/P_tK_t.

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[11] Bondholders may also play a monitoring role with respect to corporate management.

[12] We can include in Ψ_t in equation (1) the flows associated with net bond issuance and interest payments, $\frac{B_t - B_{t-1}}{P_t} - \frac{i_{t-1}B_{t-1}}{P_t}$. However, when we consider the first-order condition associated with B_t, the effects from these additional terms is nil if we discount Ψ_{t+1} by the real interest rate on bonds, $(1+i_t)/(1+\pi_t)$, where $\pi_t = P_{t+1}/P_t - 1$ is the inflation rate. This discounting is appropriate when, as in Modigliani and Miller (1958), the firm's owners can borrow and lend at the same interest rate, i_t, as the corporation. This result works even when default/bankruptcy can occur because i_t will incorporate this probability.

[13] In the subsequent analysis, we allow for the limitations on deductibility of bond interest that were included in the new tax law.

We assume Φ'>0 and Φ''>0. These costs can involve transaction costs associated with default/bankruptcy. This expression multiplies the total assets at risk, K_t, in equation (3). We treat the overall term, $\Phi\left(\frac{B_t}{P_t K_t}\right)\cdot K_t$, as effectively a cost that subtracts from expected corporate cash flow in period *t*.

The first-order conditions for B_t (applying to Ψ_t and Ψ_{t+1} in the form of equations [1] and [3]) lead, as the length of the period goes to zero, to:

(5) $$\Phi'\left(\frac{B_t}{P_t K_t}\right) = \tau_{t+1} i_t.$$

The condition says that the marginal cost associated with potential default (per unit of assets) equals the tax savings per unit financed by bonds.

The presence of debt finance modifies the first-order conditions associated with investment. The new effects arise because K_t influences the term $\Phi\left(\frac{B_t}{P_t K_t}\right)\cdot K_t$ for a given real debt, B_t/P_t. The revised condition—an extension of equation (3)—can be written when τ, λ, and r^k are constant over time as:

(6) $$MPK_t = \Omega = \left(\frac{1-\tau\lambda}{1-\tau}\right)\cdot(r^k+\delta) - \left(\frac{1}{1-\tau}\right)\cdot\Phi\left(\frac{B_t}{P_t K_t}\right)\cdot(\theta-1),$$

where θ is the elasticity of Φ with respect to the debt-asset ratio, B_t/P_tK_t. If θ is constant (with $\theta>1$), we can use equation (5) to rewrite equation (6) as:[14]

(7) $$MPK_t = \Omega = \left(\frac{1-\tau\lambda}{1-\tau}\right)\cdot(r^k+\delta) - \left(\frac{\theta-1}{\theta}\right)\cdot\left(\frac{\tau}{1-\tau}\right)\cdot\left(\frac{B_t}{P_t K_t}\right)\cdot i.$$

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[14] If we write $\Phi = a\cdot\left(\frac{B_t}{P_t K_t}\right)^{\theta}$, then the optimal debt-asset ratio is $\frac{B_t}{P_t K_t} = (\frac{\tau i}{a\theta})^{1/(\theta-1)}$. If θ=2, the right side simplifies to $\tau i/2a$.

Note that the last term on the right side of equation (7) is decreasing in τ and *i*; that is, a higher *i* implies a lower cost of capital.[15] More specifically, if default probability depends as an approximation on the square of the debt-asset ratio (so that the marginal effect is proportional to the ratio), then $\theta=2$ and the final term in equation (7) simplifies to

$-(\frac{1}{2}) \cdot \left(\frac{\tau}{1-\tau}\right) \cdot \left(\frac{B_t}{P_t K_t}\right) \cdot i$. We use this specification in our calibration exercises—although the results change little for even large changes in this parameter.

Our explicit treatment of the potential cost of bankruptcy/default for bond financing differs from the standard cost-of-capital formula generally used in tax analysis (e.g., U.S. Department of the Treasury 2014 and Congressional Budget Office 2017). Our alternative has the effect of putting less weight on debt financing, which generally results in a higher cost of capital than is typically assumed when the real interest rate on bonds is well below the expected real rate of return on capital.

Production Function

Our main analysis assumes a Cobb-Douglas form of the production function, where expected output, Y_t, relates to capital, K_t, and labor, L_t, in accordance with:

(8) $$Y_t = AK_t^{\alpha} L_t^{1-\alpha},$$

where $0<\alpha<1$. We begin with one type of capital and broaden subsequently to distinguish among equipment, structures, residential rental property, R&D, and other intellectual property.[16] With that extension, the term K_t^{α} is replaced in equation (8) by $(K_{1t})^{\alpha_1} \cdot (K_{2t})^{\alpha_2} \cdot ... \cdot (K_{5t})^{\alpha_5}$, where each subscript corresponds to a type of capital, and the α_i add to the capital share, α.

[15] The negative effect of *i* on user cost when corporate interest payments are tax deductible was noted by Modigliani and Miller (1958, p. 296).

[16] We ignore land and inventories, effectively distributing them proportionately to the other forms of capital.

Returning to equation (8), if the marginal products of capital and labor, *MPK* and *MPL*, are equated to the respective real factor prices, then α equals the (gross) capital share of income. The marginal product of capital is the given by:

$$MPK_t = \alpha A(\frac{K_t}{L_t})^{-(1-\alpha)}. \quad (9)$$

This specification implies that the long-run elasticity of *K/L* with respect to *Ω* (given on the right side of equation [7]) is *-1/(1-α)*, which exceeds 1 in magnitude.[17]

As mentioned before, our analysis treats r^k as given; that is, the supply of capital is horizontal. In other models, such as the finite-horizon framework of Blanchard (1985),[18] the long-run supply of capital slopes upward, so that an increase in *K/L* (generated, for example, by a cut in τ or rise in λ) associates with a rise in the real interest rate. However, this effect is small quantitatively in the Blanchard model. Further, an opposing force on the real interest rate arises if the time-preference rate falls or the elasticity of intertemporal substitution rises when *K/L* increases. That is, individuals may become more patient or more willing to substitute intertemporally when they get richer.

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[17]As is well known, the Cobb-Douglas specification implies a unit elasticity of substitution between capital and labor; that is, $\sigma=1$. We can use instead a constant-elasticity-of-substitution (*CES*) production function with $\sigma \geq 0$. In this case, changes in *K/L* associate with changes in shares of income going to capital and labor. Karabarbounis and Neiman (2014) estimate $\sigma \approx 1.2$ in order to explain a rising trend of gross corporate capital-income shares in many countries from the observed reductions in real prices of capital. For general σ, the elasticity of *K/L* with respect to *Ω* is given by $\frac{d(\frac{K}{L})}{K/L} = \frac{-\sigma}{(1-s_k)} \cdot \frac{d\Omega}{\Omega}$, where s_k is the gross capital share of income (equal to α in the Cobb-Douglas case). Therefore, if σ is 1.2 or 0.8, our subsequent results on *K/L* (which assume $\sigma=1$) would be modified by ±20 percent.

[18] With respect to assessing effects from "finite horizons," this model is essentially a tractable version of the overlapping-generations (OLG) framework.

Table 3
Assumptions on Economic Parameters in Baseline Analysis

After-tax expected real rate of return on capital, r^k	8.2%	
Inflation expectations, π	2.3%	
Nominal interest rate on corporate bonds, i	4.0%	
Debt share of financing, B/(PK)	32%	
Share of value added		
C corporations	39%	
Pass-throughs	36%	
Government, Households, and Institutions	25%	
Payroll per worker (2015)		
C corporations	$60,000	
Pass-throughs	$41,000	
Economic depreciation rate, δ		
Equipment	8.8%	
Structures	2.0%	
Rental residential property	2.7%	
R&D intellectual property	12.3%	
Other intellectual property	19.5%	
	C corporations	**Pass-throughs**
Share of income		
Equipment	14.1%	12.2%
Structures	12.4%	12.8%
Rental residential property	0.8%	7.6%
R&D intellectual property	4.6%	2.3%
Other intellectual property	6.1%	3.1%
Overall capital share, α	38.0%	38.0%

We assume a capital share, α, of 0.38 to match the most recent value from an updated version of the data set described in Fernald (2014). This specification assumes that the capital share will neither revert to its pre-2000 value around one-third nor continue to rise as it did from 2000 to 2012. When we extend to multiple types of capital, we use individual α_i that add to α=0.38.[19] The full set of economic parameters we use is shown in Table 3.

[19] We calculate capital shares of income (Table 3) based on information from the Bureau of Labor Statistics (BLS); specifically the BLS Multifactor Productivity Capital Tables, available at bls.gov/mfp/mprdload.htm, and B-Tax.

Effects of the 2017 Tax Law on User Costs

We begin the empirical exercise by calibrating the effects of the 2017 tax changes on the user cost of capital, Ω, for the corporate sector on the right side of equation (7). This user cost involves the tax rate, τ, the effective expensing rate, λ, and the treatment of interest deductions. Our calibration requires one set of tax parameters for the baseline and two for the different concepts of the law-as-written case and the provisions-permanent case. These parameters are shown in Table 4.

Table 4
Modeled Tax Policy Parameters

	Baseline	**Law as written**	**Provisions permanent**
Corporate tax rate, τ_c	38.0%	27.0%	26.0%
Corporate R&E Credit rate	5.0%	6.1%	5.0%
Pass-through tax rate, τ_p	35.2%	35.5%	31.1%
Effective limitation on debt	0%	15%	5%
Expensing of equipment	No	No	100%
Expensing of R&D intellectual property	100%	No	100%

Note: Baseline refers to law in place before the enactment of the 2017 law. "Law as written" reflects long-run changes in 2017 law as specified in the law. "Provisions permanent" treats changes in effect for 2019 in 2017 law as permanent. In the baseline and law as written, equipment has double-declining depreciation over 5 or 7 years. In the baseline, we treat bonus depreciation as zero because this allowance was set to expire after 2019. In all systems, structures have 20- or 39-year straight-line depreciation, and residential rental property has 27.5-year straight-line depreciation. In the law as written, R&D intellectual property has 5-year straight-line depreciation. We treat the R&E credit as zero for pass-throughs. In all systems other intellectual property is treated as having double-declining depreciation over 5 years.

For the baseline specification, we use parameters consistent with the tax law as it existed in 2017. The federal statutory tax rate was 35 percent but about one-third of corporate income received a 9 percent domestic production deduction and was thus taxed at 31.85 percent. Therefore, we use a federal rate of 34 percent and add to this 4 percent for state corporate-profits tax (net of the associated deduction in federal liability) to get a baseline tax rate of 38 percent.

We assume normal depreciation schedules for the five types of capital, because the bonus depreciation in effect in 2017 was scheduled to expire after 2019. Our modelling of the R&E credit follows U.S. Department of the Treasury (2016) and is built into our λ's for R&D.

For the law-as-written scenario (applicable as of 2027), we use a statutory federal tax rate of 21 percent but adjust it to reflect limitations on net operating losses and some smaller offsets that are not lump sum in nature.[20] We end up with a tax rate inclusive of state corporate-profits taxes of 27 percent (Table 4); that is a cut by 11 percentage points from the baseline. We also model the shift to five-year amortization of R&D expenses (scheduled to start in 2022) and the associated interactions with the R&E credit. Finally, we assume that 85 percent of investment is unconstrained by the limit on interest deductions.

The provisions-permanent scenario, applicable as of 2019, differs in assuming that expensing of investment in equipment and R&D are both permanent. In addition, the offsets noted above are smaller, resulting in a tax rate inclusive of state corporate-profits taxes of 26 percent (Table 4). That is, the rate cut in this scenario is 12 percentage points. Finally, because of the weaker limitations on interest deductions, we assume that 95 percent of investment is unconstrained by the limit on interest deductions.

[20] Specifically, we assume that half of the cost of these offsets is counted as an adjustment to the tax rate—which works out to about 1.5 percentage points in the law-as-written scenario and about 0.25 percentage point in the provisions-permanent scenario. This is an imperfect back-of-the-envelope way of modelling these provisions. Limitations on net operating losses, for example, might be more properly modelled as an increase in the discount rate on depreciation allowances because it increases the riskiness of this delayed tax benefit.

Table 5
Estimated Effects on C Corporations from 2017 Tax Law

	Baseline	Scenario I Law as written	Scenario II Provisions permanent
Corporate-profits tax rate, τ	38%	27%	26%
Effective expensing rate, λ			
Equipment	0.812	0.812	1.000
Structures	0.338	0.338	0.338
Rental residential property	0.336	0.336	0.336
R&D intellectual property	1.132	1.011	1.192
Other intellectual property	0.842	0.842	0.842
User cost of capital, Ω (% change from baseline)			
Equipment	0.186	0.180 (-3%)	0.168 (-10%)
Structures	0.139	0.125 (-10%)	0.124 (-11%)
Rental residential property	0.149	0.134 (-10%)	0.132 (-11%)
R&D intellectual property	0.185	0.202 (+10%)	0.189 (+2%)
Other intellectual property	0.300	0.291 (-3%)	0.290 (-3%)
Average		*(-4%)*	*(-8%)*
Percent change in capital-labor ratio, K/L			
Equipment		5.6%	14.3%
Structures		12.9%	16.1%
Rental residential property		13.0%	16.2%
R&D intellectual property		-7.1%	2.3%
Other intellectual property		5.4%	8.0%
Average		*6.6%*	*12.5%*
Percent change in output per worker, Y/L		2.5%	4.7%

Notes: The effective expensing rate, λ, is calculated as a present value, including tax credits. The economic and tax law parameters were listed in Tables 3 and 4 and are described in the text where appropriate. Averages reflect the average percent changes for each type of capital, weighted by the capital income shares.

Table 5 shows that the 2017 tax reform raises the effective expensing rate, λ, for equipment from 0.81 to 1.0 in Scenario II (provisions permanent) but leaves it unchanged in Scenario I (law as written). The implied reduction in user cost, Ω, in equation (7) is from 0.186 to 0.180 in Scenario I (because of the cut in τ) or by 3 percent. In Scenario II, the user cost falls to 0.168 or by 10 percent. Note that, with $\lambda=1$, the cut in τ matters only in a minor way (and in a direction to raise user costs) because of the bond interest deductions.[21]

For structures, λ is unchanged in both scenarios at 0.34. Correspondingly, the user cost, Ω, falls from 0.139 to 0.125 (10 percent) in Scenario I and to 0.124 in Scenario II (11 percent). Since λ is unchanged, these effects reflect entirely the reductions in τ. Surprisingly—despite the move toward full expensing of equipment in Scenario II—the proportionate reduction in Ω is greater for structures. The reason is that equipment is already heavily expensed in the old tax system, with λ=0.81. Results for residential rental capital, a minor component, are similar to those for non-residential structures.

For R&D intellectual property, the full expensing of investment in the baseline is maintained in Scenario II but is replaced in Scenario I by straight-line balance depreciation. The calculations take account of the R&E credit, which we factor into the effective expensing rates, λ. The expensing rate, λ, falls in Scenario I (mostly because of the dropping of full expensing) and rises in Scenario II (because the R&E credit is more valuable with the reduced τ). The user cost, Ω, rises by 10 percent in Scenario I, mostly because of the fall in λ. The user cost rises by 2 percent in Scenario II because a cut in τ raises Ω when $\lambda>1$ and also because a cut in τ lowers the value of the bond interest deduction.

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[21] The cut in τ from 0.38 to 0.26 provides a substantial benefit for the after-tax returns on old equipment. Our prediction is that this reduction in τ would not have much effect on investment in new equipment (because $\lambda=1$). Instead, the "windfall" cash would be expected to go to retained earnings, dividend payments, share repurchases, and, perhaps, bonuses for workers. In one respect, this tax windfall could be viewed as undesirable because it loses tax revenue and has no direct allocative effects. However, this perspective would suggest that a surprise increase in τ—a capital levy with regard to old capital—would be desirable. In fact, a key element in the government's credibility is some form of commitment not to engage "regularly" in these types of capital levies—because, once they are anticipated, these levies can substantially curtail investment. From this perspective, the occasional realization of tax windfalls might help to strengthen the government's credibility.

For other intellectual property, λ is unchanged in both scenarios at 0.84. The user cost, Ω, falls by 3 percent in both scenarios.

From User Costs to Capital-Labor Ratios

Converting the changes in user costs, Ω, into long-run changes in capital-labor ratios, K/L, requires an estimate of the relevant elasticity; that is, the proportionate sensitivity of K/L to Ω. With a Cobb-Douglas production function and a single type of capital, equations (1) and (3) imply that this elasticity is $-1/(1-\alpha)$, where α is the gross capital share of income (see n.17). Since we use $\alpha=0.38$, the magnitude of the elasticity is 1.6.[22]

As mentioned before, we extend to multiple types of capital by assuming that each type, *i*, enters into an expanded Cobb-Douglas production function with exponent α_i. For illustrative purposes, suppose there were two types with exponents α_1 for equipment and α_2 for structures.[23] Given the first-order conditions for choices of K_1 (equipment) and K_2 (structures), we can show that the proportionate response of K_1/L to changes in the two user costs, Ω_1 and Ω_2, is given by

$$(10) \qquad \frac{\Delta(\frac{K_1}{L})}{K_1/L} = -\frac{1}{(1-\alpha_1-\alpha_2)} \cdot \left[(1-\alpha_2)\cdot\frac{\Delta\Omega_1}{\Omega_1} + \alpha_2 \cdot \frac{\Delta\Omega_2}{\Omega_2}\right].$$

That is, on the right side, the term outside the brackets is analogous to that from the case with one type of capital, and the term inside the brackets is a weighted average of the proportionate changes in the two user costs.

[22] This number is at the high end of directly estimated elasticities for investment, as surveyed by Hassett and Hubbard (2002) and Council of Economic Advisers (2017). However, these estimates apply to investment, not directly to (long-run) capital-labor ratios.

[23] As discussed in n.17, we could instead have a C.E.S. production function that has an elasticity of substitution σ between labor and a Cobb-Douglas aggregate of capital. Alternatively, we could bring in elasticities of substitution differing from one among the types of capital. We are unaware of studies of these elasticities among types of capital.

An analogous expression gives the proportionate change in K_2/L:

(11) $$\frac{\Delta(\frac{K_2}{L})}{K_2/L} = -\frac{1}{(1-\alpha_1-\alpha_2)} \cdot \left[(1-\alpha_1) \cdot \frac{\Delta\Omega_2}{\Omega_2} + \alpha_1 \cdot \frac{\Delta\Omega_1}{\Omega_1}\right].$$

Equations (10) and (11) imply that the resulting proportionate change in output per worker, *Y/L*, is given by:

(12) $$\frac{\Delta(\frac{Y}{L})}{Y/L} = -\frac{1}{(1-\alpha_1-\alpha_2)} \cdot \left[\alpha_1 \cdot \frac{\Delta\Omega_1}{\Omega_1} + \alpha_2 \cdot \frac{\Delta\Omega_2}{\Omega_2}\right].$$

Thus, if there is only one form of capital, so that $\alpha_1=\alpha$ and $\alpha_2=0$, the expression on the right side in front of the brackets is the usual elasticity, and this elasticity is multiplied by α to get the proportionate response of *Y/L* to the proportionate change in *Ω*.

We can readily extend equations (10-12) to our case with five types of capital—where type 3 corresponds to residential rental property, type 4 to R&D intellectual property, and type 5 to other intellectual property. In this case, what matters for the change in *Y/L* in an extension of equation (12) is a weighted average of the proportionate changes in the Ω_i, where the weights are the α_i (and then the whole object is divided by α to get an average).

Effects on Capital-Labor Ratios and Output per Worker

Table 5 shows that, in the law-as-written scenario, the user cost for equipment falls by 3 percent, user costs for structures and residential rental fall by 10 percent, the user cost for R&D rises by 10 percent, and the user cost for other intellectual property falls by 3 percent.[24] We can then calculate from an extension of equation (10) the changes in the various capital-labor ratios. The result is that *K/L* rises by 6 percent for equipment, rises by 13 percent for structures and

[24] As discussed earlier, all of these estimates are relative to a "current law" baseline. Measured relative to the 50 percent bonus depreciation that was in the law for the year 2017, it would be a 2 percent increase in the user cost for equipment because the shift to normal depreciation in the law-as-written case outweighs the lower statutory tax rate.

residential rental property, falls by 7 percent for R&D intellectual property, and rises by 5 percent for other intellectual property. The resulting rise in long-run corporate output per worker, *Y/L* or corporate productivity, is given from an extension of equation (12) as 2.5 percent.

Correspondingly, for the provisions-permanent scenario, we get larger proportionate increases in capital-labor ratios—*K/L* rises by 14 percent for equipment, 16 percent for structures and residential rental property, 2 percent for R&D intellectual property,[25] and 8 percent for other intellectual property. The resulting rise in long-run corporate *Y/L* is 4.7 percent.

The results show that the predicted effect on long-run output per worker in the corporate sector, *Y/L*, is about twice as large in the provisions-permanent case (4.7 percent) as in the law-as-written environment (2.5 percent). The main reason for the difference is the inclusion of full expensing of investment on equipment and R&D in the provisions-permanent scenario.

Sensitivity to Parameter Values

Tables 6 and 7 show how the results in Table 5 change when we alter two key underlying parameters. Table 6 uses a lower overall capital share—we shift to the commonly used value of $\alpha=1/3$, which generally prevailed prior to 2000. This change shifts the magnitude of the central elasticity of the various *K/L* with respect to user costs, $-1/(1-\alpha)$, from 1.6 to 1.5. Correspondingly, the predicted proportionate responses of long-run corporate *Y/L* are reduced. The changes in long-run corporate output per worker are 2.0 percent for the law-as-written scenario and 3.9 percent for the provisions-permanent scenario, as compared to 2.5 percent and 4.7 percent respectively in our featured estimates in Table 5.

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[25] This capital-labor ratio rises despite the small increase in the associated user cost because of the cross effects from the other forms of capital on the *MPK* for *R&D* capital.

Table 6
Estimated Effects with α=1/3

	Baseline	Scenario I Law as written	Scenario II Provisions permanent
User cost of capital, Ω (% change from baseline)			
Equipment	0.186	0.180 (-3%)	0.168 (-10%)
Structures	0.139	0.125 (-10%)	0.124 (-11%)
Rental residential property	0.149	0.134 (-10%)	0.132 (-11%)
R&D intellectual property	0.185	0.202 (+10%)	0.189 (+2%)
Other intellectual property	0.300	0.291 (-3%)	0.290 (-3%)
Average		*(-4%)*	*(-8%)*
Percent change in capital-labor ratio, K/L			
Equipment		5.2%	13.4%
Structures		12.4%	15.2%
Rental residential property		12.5%	15.3%
R&D intellectual property		-7.5%	1.4%
Other intellectual property		4.9%	7.1%
Average		*6.1%*	*11.6%*
Percent change in output per worker, Y/L		2.0%	3.9%

Note: Specifications as in Table 5, except that α=1/3.

Table 7 shifts to a lower expected real rate of return on capital, r^k. We now assume 6 percent (corresponding to an estimated historical average for returns on unlevered equity), rather than 8.2 percent. This change substantially raises the effective expensing rate, λ, particularly for structures and other intellectual property and for equipment in the absence of full expensing. Correspondingly, the changes in λ (starting from higher baseline values) and the proportionate changes in Ω are smaller than those in Table 5. The result in Table 7 is smaller proportionate responses of *Y/L*—these are now 2.1 percent in the law-as-passed scenario and 4.0 percent in the provisions permanent scenario.

Table 7
Estimated Effects with r^k=6.0%

	Baseline	Scenario I Law as written	Scenario II Provisions permanent
User cost of capital, Ω (% change from baseline)			
Equipment	0.158	0.154 (-2%)	0.146 (-8%)
Structures	0.106	0.096 (-9%)	0.095 (-10%)
Rental residential property	0.115	0.104 (-9%)	0.103 (-10%)
R&D intellectual property	0.164	0.178 (+8%)	0.168 (+3%)
Other intellectual property	0.271	0.265 (-2%)	0.264 (-3%)
Average		*(-3%)*	*(-7%)*
Percent change in capital-labor ratio, K/L			
Equipment		4.4%	11.8%
Structures		11.4%	14.2%
Rental residential property		11.5%	14.3%
R&D intellectual property		-6.0%	1.5%
Other intellectual property		4.4%	6.5%
Average		*5.6%*	*10.5%*
Percent change in output per worker, Y/L		2.1%	4.0%

Note: Specifications as in Table 5, except that r^k=6.0%

Hypothetical Alternative Tax Systems

Table 8 considers three alternative tax systems, some elements of which have been considered during the Congressional deliberation over the 2017 tax law or at other times. In the column labeled "permanent bonus," the new tax law is the same as the old one (including $\tau=0.38$ and full expensing for R&D intellectual property), except that 50 percent bonus depreciation applies permanently to equipment. The idea of this scenario is that it amounts to keeping the corporate tax provisions that were in effect for the year 2017 (and most of the period since 2008), specifically 50 percent bonus depreciation for equipment. When compared to the two scenarios in Table 5, the user cost for equipment is lower than that in the law-as-written scenario but higher than that in the provisions-permanent scenario. The user cost for structures is much higher than that for the law-as-written and provisions-permanent cases. The user cost for R&D intellectual property is lower than that in the law-as-written scenario because expensing of R&D is retained in the hypothetical case. Finally, the user cost for other intellectual property is well above that for the law-as-written and permanent-provisions scenarios because τ is not reduced. Overall, we predict smaller increases in the various *K/L*, and the proportionate increase in long-run corporate *Y/L* is by 1.2 percent, half the 2.5 percent rise in the law-as-written scenario and about one-quarter of the 4.7 percent in the provisions-permanent scenario. Making bonus depreciation permanent also has implications for the pass-through sector and GDP that differ from these, as discussed below and shown in Table 12.

The column labeled "full expensing" in Table 8 applies $\lambda=1$ permanently to all forms of capital and assumes a tax rate of $\tau=0.32$. (This tax rate, which matters little for the results when most of the λ's equal 1, corresponds to a federal rate of 28 percent plus the net effect from State income taxes.) When compared to the law-as-written scenario in Table 5, the important differences in user-cost reductions are for structures, R&D and other intellectual property. Correspondingly, the increases in *K/L* are much larger for structures and other intellectual property but smaller for R&D. Overall, the resulting proportionate increase in long-run corporate *Y/L* is by 8.2 percent in the full-expensing scenario—more than the rise by 4.7 percent in the scenario with provisions permanent (in Table 5). This scenario may even have raised more money than the law Congress passed, especially outside of the ten-year budget window.

Table 8

Responses under Hypothetical Tax Systems

	Permanent Bonus	**Full Expensing**	**Eliminate Interest Deduction** Law as written	Provisions permanent
Corporate-profits tax rate, τ	38%	32%	27%	26%
Effective expensing rate, λ				
Equipment	0.906	1.000	0.812	1.000
Structures	0.338	1.000	0.338	0.338
Rental residential property	0.336	1.000	0.336	0.336
R&D intellectual property	1.132	1.156	1.011	1.192
Other intellectual property	0.842	1.000	0.842	0.842
User cost of capital, Ω (% change from baseline)				
Equipment	0.176 (-5%)	0.170 (-8%)	0.182 (-2%)	0.170 (-8%)
Structures	0.139 (0)	0.102 (-27%)	0.127 (-9%)	0.126 (-10%)
Rental residential property	0.149 (0)	0.109 (-27%)	0.136 (-9%)	0.134 (-10%)
R&D intellectual property	0.185 (0)	0.190 (+3%)	0.204 (+11%)	0.191 (+4%)
Other intellectual property	0.300 (0)	0.277 (-8%)	0.293 (-2%)	0.292 (-3%)
Average	*(-2%)*	*(-13%)*	*(-3%)*	*(-7%)*
Percent change in capital-labor ratio, K/L				
Equipment	6.5%	16.6%	3.9%	12.4%
Structures	1.2%	35.0%	10.8%	13.8%
Rental residential property	1.2%	35.2%	10.9%	14.0%
R&D intellectual property	1.2%	5.3%	-8.8%	0.4%
Other intellectual property	1.2%	15.8%	4.0%	6.5%
Average	*3.1%*	*21.5%*	*4.7%*	*10.5%*
Percent change in output per worker, Y/L	1.2%	8.2%	1.8%	4.0%

Notes: See notes to Table 5. Parameters for the old system are shown in the first column of Table 5. Hypothetical systems are as follows. For permanent bonus, only change from baseline is 50% bonus depreciation for equipment. Full expensing has λ=1 for all capital (the R&E credit is retained so the λ for intellectual R&D is greater than 1) and no deductions for bond interest. Eliminate debt deduction matches scenarios I and II in Table 5 (law as written and 2019 provisions treated as permanent) but with elimination of tax deduction for interest.

The columns labeled "eliminate debt deduction" in Table 8 are the same as the two scenarios in Table 5, except for the removal of the deduction for bond interest. This change raises user costs when compared to those for the law as written and provisions permanent scenarios in Table 5. Therefore, the proportionate increases in long-run corporate *Y/L* are smaller—1.8 percent for the law as written in Table 8, compared to 2.5 percent for the corresponding scenario in Table 5, and 4.0 percent for provisions permanent in Table 8, compared to 4.7 percent for the corresponding setting in Table 5.

Effects on Pass-Through Businesses

So far, our estimates apply to C-corporate businesses, which pay taxes through the corporation income tax. C corporations, however, represent only 49 percent of total business employment, 71 percent of business wages, and 36 percent of business net income.[26] Overall, C Corporations represent 52 percent of gross value added in the business sector.

Table 9 applies our previous approach to estimate effects of the tax changes on pass-through businesses. For pass-throughs, we use the same depreciation rules as for corporations (except we assume they do not receive the R&E credit, which is generally but not universally the case). For tax rates, τ, we assume for the baseline that the average marginal tax rate for owners of non-C-corporate businesses is 35.2 percent.[27] In the law-as-written scenario this rises slightly to 35.5 percent, reflecting the elimination of the domestic production deduction and some bracket creep associated with shifting to chained CPI. In the provisions-permanent scenario, the tax rate is 31.1 percent, which reflects a combination of the reduction of individual tax rates and the allowable part of the 20 percent pass-through deduction, partially offset by the higher marginal tax rates associated with capping the State income tax deduction.[28]

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[26]The employment and wage statistics are based on the Census County Business Patterns data for 2015, adjusted to include railroad workers and the full set of sole proprietors and government workers based on the Current Employment Statistics Current Population Survey. The shares of net income are based on Pearce (2015) and are for the year 2012. We combine the wages and profits data in proportion to these categories in the Bureau of Economic Analysis National Income and Products Table 1.13 for National Income in order to get the sectoral shares.

[27]We thank the Tax Foundation for providing the base rates. We altered these somewhat to reflect self-employment taxes and the repeal of the domestic production deduction.

[28] We use the 2019 value for the tax rate in the provisions-permanent case, effectively assuming that the chained CPI is turned off in that year. Without this assumption the tax rate would gradually drift up over time.

Table 9

Estimated Effects on Pass-through Businesses from 2017 Tax Law

	Baseline	Law as written	Provisions permanent
Pass-through tax rate, τ	35.2%	35.5%	31.1%
Effective expensing rate, λ			
Equipment	0.812	0.812	1.000
Structures	0.338	0.338	0.338
Rental residential property	0.336	0.336	0.336
R&D intellectual property	1.000	0.785	1.000
Other intellectual property	0.842	0.842	0.842
User cost of capital, Ω (% change from baseline)			
Equipment	0.184	0.185 (0)	0.167 (-9%)
Structures	0.135	0.136 (+1%)	0.130 (-4%)
Rental residential property	0.145	0.146 (+1%)	0.139 (-4%)
R&D intellectual property	0.202	0.226 (+12%)	0.202 (0)
Other intellectual property	0.297	0.298 (0)	0.294 (-1%)
Average		*(+1%)*	*(-5%)*
Percent change in capital-labor ratio, K/L			
Equipment		-1.2%	12.2%
Structures		-1.5%	7.2%
Rental residential property		-1.5%	7.2%
R&D intellectual property		-13.1%	2.8%
Other intellectual property		-1.0%	4.2%
Average		*-2.1%*	*8.3%*
Percent change in output per worker, Y/L		-0.8%	3.1%

Note: Uses pass-through tax rates as shown. R&E credit assumed to be zero in all cases. See Tables 3, 4 and 5 on other aspects.

In the law as written, the minor rise in τ and the elimination of expensing for R&D combine to generate small increases in the various user costs, *Ω,* thereby causing reductions in the various *K/L*, especially for R&D intellectual property. Correspondingly, long-run pass-through *Y/L* falls by 0.8 percent. In contrast, for the provisions-permanent scenario, the *Ω* fall (except for R&D), leading to increases in the various long-run *K/L*. The corresponding rise in long-run pass-through *Y/L* is by 3.1 percent.

The bottom line is that, in the law-as-written case, the predicted proportionate change in long-run *Y/L* in the pass-through sector is -0.8 percent, compared to +2.5 percent for corporate business. In the provisions-permanent scenario, the proportionate rise in long-run *Y/L* for pass-through businesses is 3.1 percent, not far below the rise by 4.7 percent for corporate businesses.

From Business Sectors to Economy-wide estimates

We model the economy as having three sectors: a corporate sector initially with 39 percent of value added, a pass-through sector with 36 percent of value added, and a non-business sector (government, households, and institutions) with 25 percent of value added (see Table 3).[29] Our analysis in Tables 5 and 9 predicts how the tax law affects the various *K/L* and, thereby, *Y/L* in the long run in the corporate and pass-through sectors. We assume that the long-run change in *Y/L* in the non-business sector is zero.

If we ignore shifting of labor and businesses across sectors—particularly from pass-throughs to C corporations—then the economy-wide change in *Y/L* is the sum of the share-weighted changes in *Y/L* by sector. Standard macroeconomic analyses of tax changes make this assumption.

Shifting between the corporate and pass-through sectors, however, could have an impact on our estimates that would depend on the magnitude of the shifting and its impact on productivity. We discuss these two issues in turn.

From the perspective of labor, a key factor is that the changes in *Y/L* by sector would be accompanied by changes in wages. (In our specification, the wage equals the marginal product of

[29] The division between business and non-business is from Bureau of Economic Analysis National Income and Product accounts Table 1.3.5, Gross Value Added. The division within the business sector was described earlier in the text.

labor, which moves along with the average product.) Hence, in our cases, the tax changes would raise wages paid by C corporations compared to those paid by pass-throughs. Labor would, therefore, be predicted to migrate toward C corporations. In our setting, C corporations would pair the added labor with additional capital, which is assumed to be available at constant cost in the long run.[30] It is also likely that the tax changes will cause businesses to migrate in terms of legal form from the pass-through to the corporate sector.

The first question is how large this shift would be. Recent history suggests it could be substantial. C corporations have gone from 80 percent of net business income in 1980 to 47 percent in 2012. Three sets of factors have played a role in this change. The first is the evolution of the economy away from manufacturing and toward services like health, given that manufacturing is dominated by C corporations, whereas services—especially health—are dominated by pass-throughs (CBO 2014). More generally, the C corporate form is more attractive for businesses with larger scale (partly because of the option of public trading of shares) and higher risk (because of limited liability).[31] The second factor is a set of legal changes, including loosening shareholder rules for S corporations and the creation of Limited Liability Corporations (LLCs) in many U.S. States. These changes mean that limited liability is less of a consideration that favors the C corporate form. Finally, in the words of Smith et al. (2017, p. 9), "The Tax Reform Act of 1986 reduced the top ordinary personal income tax rate below the top

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[30]The numbers in Table 3 indicate that payroll per worker in the C corporate sector in 2015 was about 46 percent higher than that in the pass-through sector, although this comparison does not factor in differences in human capital of workers by sector. In addition, our simple model has to be extended to explain why not all labor would work in the corporate sector. Some workers could have a non-pecuniary preference for one sector over the other (or for working at businesses that are typically in one sector or the other). And C corporations would produce types of goods and services that differ from those produced by pass-through businesses.

[31]Corporations also facilitate a legal identity for a business that extends readily beyond the lifetimes of its owners; this durability is more difficult to ensure for sole proprietorships and some partnerships. Kuran (2004) stresses this idea in arguing that the lack of legal recognition of corporate structure was a key impediment to economic development in Muslim countries, particularly after the Industrial Revolution made economies of scale in production more important.

corporate income tax rate for the first time in the post-war era, unleashing a dramatic rise in business activity conducted in 'pass-through' business form." Disentangling the effects is difficult; for example, the pass-through share grew from 1990 to 2000 despite the raising of individual marginal tax rates, and thus taxes on pass-throughs, in 1990 and 1993.

An indication of the magnitude of the potential shifting due to tax changes comes from Mackie-Mason and Gordon (1997), Goolsbee (1998), and Prisinzano and Pearce (2017), who do regressions of the corporate share on the tax differential between C corporations and pass-throughs. Based on the changes in the tax rate differential between C corporations and pass-throughs (11 percentage points in the law-as-written scenario and 8 percentage points in the provisions-permanent scenario), Goolsbee's estimate implies a 0.2 to 3.4 percentage point of GDP shift in the law-as-written scenario and a 0.2 to 2.4 percentage point shift in the provisions-permanent case. Prisinzano and Pearce's central estimate is the same as the upper bound of Goolsbee's estimate.

Because our modelling is focused on long-run comparative statics, we double the upper bound and assume a 6.8 percentage point of GDP increase in the corporate sector in the law-as-written case and a 4.7 percentage point of GDP increase in the corporate sector in the provisions permanent case, or 19 and 13 percent of the pass-through sector shifting respectively.

A second issue is modelling any changes in productivity associated with the shift from the pass-through sector to the corporate sector. One source of higher productivity in the long run is changes in capital-labor ratios generated by reductions in the user cost of capital because of the changes in the tax system. We make the upper-bound assumption that pass-throughs that shift get the same proportionate reduction in the user cost as corporations do.[32]

The results for long-run GDP per worker are in Table 10. These calculations reflect a weighted average of the proportionate changes in output per worker in each sector weighted by their shares—assuming the shifting from corporate to pass-through sectors as described above. The results are that long-run GDP per worker increases by 0.9 percent in the law as written scenario and 3.1 percent in the provisions permanent case.

Table 10
Estimated Effects on Economy-wide Output per Worker

		Percent change in output per worker, Y/L	
	Initial share	**Law as written**	**Provisions permanent**
C corporations	39%	2.5%	4.7%
Pass-throughs	36%	-0.8%	3.1%
Government, Households, and Institutions	25%	0.0%	0.0%
Percent change in overall output per worker		**0.9%**	**3.1%**
<u>Sensitivity analysis when productivity rises by 10% for switchers</u>			
Percent change in overall output per worker		*1.6%*	*3.5%*

Notes: The initial shares in value added are in Table 3. Values of change in output per worker for law-as-written and provisions-permanent scenarios are from Table 5 for C corporations and Table 9 for pass-through businesses. These values reflect changing capital-labor ratios within sectors. The change in output per worker is assumed to be zero for government, households, and institutions. The percent change in overall output per worker is the sum of the changes by sector weighted by the final shares, which are assumed, because of shifting across sectors, to be 45.8 percent for C corporations and 29.2 percent for pass-throughs in the law-as-written case and 43.7 percent for C corporations and 31.3 percent for pass-throughs in the permanent case. The last row assumes that the shifters also experience a 10 percent rise in output per worker for a given capital-labor ratio.

[32] To understand why this is an upper bound, assume hypothetically that corporations have an effective tax rate of 25 percent and pass-throughs have an effective tax rate of 20 percent. In this case cutting the effective corporate rate to 15 percent would result in a tax change for past-throughs that was half as large as it was for corporates. We are effectively assuming that pass-throughs would also see a reduction in their tax rate from 25 to 15 percent.

As a sensitivity analysis we also consider level differences in *Y/L* between C corporations and pass-throughs—that is, higher output per worker in the corporate sector for given capital per worker. This difference could reflect net productivity benefits from the C-corporate form of legal organization. If this difference applies at the margin to the shifting firms (and is not just a compositional effect related to which companies choose to be C corporations), then there is an additional boost to economy-wide *Y/L* from the change in business form. If the productivity advantage for C-corporate form is 10 percent, we find that long-run GDP per worker rises by 1.6 percent in the law-as-written case and by 3.5 percent in the provisions-permanent case.

This alternative perspective also implies that the partly tax-induced movement away from C-corporate status since 1986 would have contributed to lower economy-wide productivity. More generally, there might be good reason to support the proposal from the 2006 Tax Reform Panel that would require pass-through businesses effectively to become C corporations. Also, it would suggest that cutting individual income tax rates or pass-through tax rates could reduce long-run productivity by causing shifting to the less efficient pass-through sector.

Because there is a lot of uncertainty in these conclusions and also potential for helping to explain movements in economy-wide productivity, we think that the impact of changing organizational form of business on productivity is an important area for macroeconomic research.

In this preliminary version of the paper we present estimates for GDP only. National income—which subtracts depreciation and net payments to the rest of the world—has long been standard in much of the literature on dynamic scoring (e.g., Altig et al. 2001 and U.S. Department of the Treasury 2006, also CBO consistently presents GNP for all of its dynamic analysis which adjusts partway to a national income concept). The advantage of using national income is that it is somewhat closer to a welfare measure because it subtracts depreciation and adds the net factor income from abroad. Such an adjustment generates lower percentage growth than we are showing for GDP. For depreciation, a rise in *K* implies that depreciation increases as a share of GDP. In addition, as we borrow more from foreigners to finance the higher *K*, the magnitude of the net factor income from abroad (a small positive number in recent U.S. history) is likely to fall as a ratio to GDP or even turn negative (see Huntley 2014).

Ten-year Changes and Convergence rates

Our assessment of the dynamic response of real per capita GDP comes from estimated convergence rates, which determine how rapidly the economy approaches its long-run or steady-state position. Some previous research on cross-country and cross-regional growth regressions, such as Barro and Sala-i-Martin (1992), estimated a convergence rate around 2 percent per year. However, recent estimates, such as those in Barro (2015), are closer to 3 percent.

A convergence rate of 3 percent per year implies a half-life of 23 years. This slow process is consistent with the underlying neoclassical growth model only if diminishing productivity of capital sets in slowly. This condition requires a broad view of capital to include human along with physical capital, so that the capital share of income is high, around 75 to 80 percent. This environment seems appropriate if one thinks about convergence associated with broad development of institutions, accumulation of human capital (including education and health), and so on.

However, the 2017 tax law directly affects the incentives to accumulate physical capital. One would expect a higher convergence rate here, akin to that in a recovery from a war that mostly destroys physical capital. In the neoclassical growth model, if one assumes a physical capital share around 40 percent, the implied convergence rate is about 5 percent per year.

Under this convergence rate, the economy would move 40 percent of the way to its long-run level after 10 years, an assumption that is around the mid-point that has been assumed or found in previous dynamic analyses. For example, Égert and Gal (2017) and U.S. Department of the Treasury (2006) model a corporate tax cut as getting the economy 30 percent and 65 percent, respectively, of the way to its steady state by year 10.

If we apply a 5 percent per year convergence rate to the long-run rises in economy-wide *Y/L* reported for the various cases in Table 10, we get the 10-year level and growth-rate effects shown in Table 11. This table also incorporates an unchanged ratio of employment to population because of roughly offsetting substitution and income effects on labor supply.

The result is that GDP would rise by 0.4 percent in the law-as-written case and by 1.2 percent in the provisions-permanent case. These results imply that the annual GDP growth rate over the 10-year horizon rises by 0.04 percentage point in the law-as-written case and 0.13 percentage point in the provisions-permanent case.

Table 11
Estimated Effects over 10-year Horizon

	Law as written	**Provisions permanent**
Change in GDP: Long-run	0.9%	3.1%
Change in GDP: 10 years out	0.4%	1.2%
Change in 10-year annual growth rate	0.04 p.p.	0.13 p.p.

Note: The proportionate changes in GDP over the long run come from Table 10, with the employment-population ratio unchanged. The proportionate changes in GDP after 10 years come from applying a convergence rate of 5 percent per year to the long-run results.

Finally, Table 12 uses the same methods described here to show GDP and growth rates for the different parameter and policy scenarios described earlier. One of the interesting results of this table is that the scenario that made bonus depreciation permanent without making any other changes raises the long-run level of GDP by 0.8 percent, nearly the same as the 0.9 percent increase under the law as written. The reason these estimates are much closer than the corporate productivity differential shown in Tables 5 and 8 is that this scenario raises productivity in the pass-through sector by 0.9 percent because the bonus depreciation for equipment would apply to the pass-through sector, whereas the law as written would reduce productivity in the pass-through sector by 0.8 percent, largely by ending expensing of R&D. Bonus depreciation permanent would result in a little over one-quarter of the increase in long-run GDP as the provisions-permanent scenario. We do not model revenues in this paper but based on JCT conventional scoring that does not reflect any dynamic feedback from growth this scenario would have cost $250 billion over ten years, which is about one-sixth of the conventional cost of the law as written and one-ninth of the cost of the law with provisions permanent.

Table 12
Macroeconomic Effects of Alternative Policies

	Permanent Bonus	**Full Expensing**	**Eliminate Interest Deduction**	
			Law as written	Provisions permanent
Change in GDP: Long-run	0.8%	6.7%	0.3%	2.4%
Change in GDP: 10 years out	0.3%	2.7%	0.1%	1.0%
Change in 10-year annual growth rate	0.03 p.p.	0.27 p.p.	0.01 p.p.	0.10 p.p.

Note: See Tables 8 for descriptions of these scenarios. Shifting from the pass-through to the corporate sector is assumed to be zero in bonus permanent, 3.6 percentage points in the expensing scenario (consistent with the methodology described in the text for the two main scenarios), 6.8 percentage points in the law as written scenario and 4.7 percentage points in the provisions permanent scenario.

The other policy alternatives shown in Table 12 follow basically the same pattern as they did for corporate productivity as discussed in the context of Table 8, with the scenario with permanent expensing, no interest deductions, and a 28 percent federal rate (for a $\tau=0.32$ after taking into account State taxes) adding 0.3 percentage point to the annual growth rate over the next decade. This scenario would likely raise revenue relative to current law over the long run, and possibly over the budget window as well due to the higher rates and ending interest deductions.[33]

IV. Financing and Crowding Out

All of the estimates above assume that the government was satisfying its intertemporal budget constraint and doing it in a manner that has no additional positive or negative economic effects beyond what we modelled. Specifically, this approach is consistent with lump sum financing—where every household pays a fixed amount or, alternatively, pays an amount that is not conditional on it economic choices. The macroeconomic estimates are joint estimates of the specific policy and the assumed course of future fiscal policy.

Magnitude of the financing

The growth effects estimated above can be used to produce estimates of the additional revenue that would be raised through dynamic scoring that would offset part of the conventional estimate of the tax cut. An approximate version of this can be generated by assuming that the initial level of GDP is 1 percent above baseline and then moves in a linear fashion to our 10th year estimate combined with the assumption that taxes as a percent of GDP match the conventional revenue score over the ten year window, which averages about 17 percent of GDP. In the law-as-written case, the dynamic feedback is about $250 billion, while in the provisions-permanent case it is about $450 billion.

[33] We do not fully develop the Office of Management and Budget baseline—which is the law as written plus the assumption that the individual and estate tax provisions are made permanent. That scenario, which could be modelled as the law as written except with the same pass-through tax rate as in the provisions-permanent scenario, would result in a 1.4 percent increase in long-run GDP, which would be a 0.6 percent increase in year ten—a 0.06 percentage point increase in the annual growth rate over the next decade.

Our model does not allow us to estimate the revenue impact of the myriad provisions in the tax law. A number of estimates are available for the cost of the law assuming no macroeconomic feedback. The Joint Committee on Taxation (JCT 2017a) estimated the law will cost $1.5 trillion in federal revenue over the ten-year budget window. Our estimate is that if the JCT estimate was adjusted to reflect making the 2019 provisions of the law permanent the cost would be $2.2 trillion (see Appendix for some details of the difference).

Other estimates of the cost have been similar or higher. The Tax Foundation also estimated the static cost of the law as actually passed at $1.5 trillion and the Tax Policy Center estimated $1.4 trillion (Tax Foundation 2017 and Page et al. 2017). The Administration estimated the reduction in revenues at “roughly $1.8 trillion,” ascribing the higher number to a different assumption about the repeal of the individual mandate (Mulvaney 2018). The Penn-Wharton Budget Model estimated a $2.2 trillion reduction in revenue without macroeconomic feedback largely because they believe more income could circumvent the “guardrails” to benefit from favorable pass-through treatment (Penn Wharton Budget Model 2017). Finally, a set of tax law professors have argued that the costs could be higher than expected as behavior adjusts to take advantage of the new law, for example alterations in State and local tax policy to protect the deductibility of taxes (Avi-Yonah, et al. 2017).

Combining the JCT estimate with the macroeconomic feedback generated by our model yields a revenue reduction for a dynamic score of the tax cut of $1.2 trillion (0.5 percent of GDP) over ten years for the law as passed and $1.7 trillion (0.7 percent of GDP) for the law with provisions permanent. If the tax cuts were financed with equal lump-sum payments, the law as passed would require about $900 per household per year, while the law with provisions permanent would require about $1,400 per household per year, with these payments starting in 2018. To the degree the financing was delayed it would need to be larger.

Note that these estimates only consider revenue, implicitly assuming that the higher *level* of GDP does not affect the *level* of spending. In reality, the higher level of GDP would automatically trigger higher levels of spending—for example, initial Social Security benefits grow with economy-wide wages, much of the cost of Medicare rises with economy-wide productivity growth, and the discretionary baseline is linked to "current services" inflation, which goes up with the level of productivity. As a result, over the longer term to a first approximation a reduction in revenue as a share of GDP will not reduce spending as a share of GDP by very much and thus regardless of how much it raises the level of output it will still result in a long-run increase in the primary deficit in dollar terms and as a share of GDP (see Barro 2012 for a fuller discussion).

The possibility of crowding-out through higher interest rates

If financing was delayed, the fiscal deficit and debt would rise in the interim. To use the JCT estimates as adjusted for our estimates of macroeconomic feedback as indicative, the unified deficit would rise by about 0.6 percent of GDP over the next decade under the law-as-passed scenario and 0.8 percent of GDP under the provisions-permanent scenario—leaving the debt/GDP ratio after 10 years 4.8 and 6.0 percentage points higher respectively.

One view, termed "Ricardian equivalence," is that these additional deficits would have no macroeconomic effects because forward-looking households would raise their personal savings in anticipation of the larger lump-sum repayments they would be required to make in the future (Barro 1974).

An alternative view is that, if personal saving did not fully adjust and capital was not supplied perfectly elastically internationally, then the result of increased investment demand and reduced savings would be a higher interest rate. Laubach (2009) estimated that this interest rate effect was 25 basis points for a 1 percentage point increase in the unified deficit as a share of GDP and 30 to 40 basis points for a 10 percentage point increase in the debt-to-GDP ratio. Engen and Hubbard (2005) had smaller estimates, finding that a 10 percentage point increase in the debt-to-GDP ratio would make interest rates 20 to 30 basis points higher.

To motivate our sensitivity analysis of the possible impact of crowd-out through higher interest rates we apply the Laubach estimate to the rough, indicative increase in the unified deficit we estimated by combining the JCT score with our macro estimates. The result is an increase in interest rates of 14 basis points in the law-as-written scenario and 20 basis points in the 2019 provisions-permanent scenario.

Modelling crowding out

In the analysis thus far, we assumed that the various tax changes had no long-run impact on rates of return—the expected real return on capital, r^k, and the nominal interest rate on bonds, i—or on the inflation rate, π. As mentioned before, the constancy of rates of return holds in some models. Other researchers think that enlarged stocks of real public debt—influenced by the alternative tax plans through their effects on the path of fiscal deficits—could raise the rate of return. The plans may also affect the inflation rate, especially through interactions with monetary policy.

Table 13 provides an assessment of crowding-out effects associated with increases in long-run rates of return. In the law-as-written scenario, we assume that r^k and i each rise by 0.14

percentage point compared to the baseline values. In the provisions-permanent scenario, we assume instead that r^k and i each rise by 0.20 percentage point. The increases in r^k have small downward effects on the effective expensing rates, λ. These changes in λ and the direct effects from a higher r^k raise the user costs, Ω, though there is an offsetting effect because the benefit from the interest deduction is heightened.

Table 13

Estimated Effects from Crowding Out

	C corporations		**Pass-through Businesses**	
	Scenario I Law as written	**Scenario II Provisions permanent**	**Scenario I Law as written**	**Scenario II Provisions permanent**
User cost of capital, Ω (% change from baseline)				
Equipment	0.181 (-2%)	0.170 (-9%)	0.186 (+1%)	0.169 (-8%)
Structures	0.127 (-9%)	0.126 (-10%)	0.138 (+2%)	0.132 (-2%)
Rental residential property	0.136 (-9%)	0.135 (-10%)	0.148 (+2%)	0.142 (-2%)
R&D intellectual property	0.204 (+10%)	0.191 (+3%)	0.228 (+13%)	0.204 (+1%)
Other intellectual property	0.293 (-2%)	0.292 (-2%)	0.300 (+1%)	0.296 (0)
Average	*(-3%)*	*(-6%)*	*(+2%)*	*(-4%)*
Percent change in capital-labor ratio, K/L				
Equipment	4.2%	12.5%	-2.8%	10.2%
Structures	11.0%	13.5%	-3.7%	4.3%
Rental residential property	11.2%	13.7%	-3.6%	4.4%
R&D intellectual property	-8.4%	0.6%	-14.6%	0.9%
Other intellectual property	4.3%	6.4%	-2.3%	2.6%
Average	*5.1%*	*10.4%*	*-3.9%*	*5.9%*
Percent change in output per worker, Y/L	1.9%	4.0%	-1.5%	2.2%

Note: See Notes to Table 5. Compared to results in Table 5, the only difference in Scenario I is that r^k and i (interest rate on bonds) are assumed to rise by 0.14 percentage point. In Scenario II, r^k and i are assumed to rise by 0.2 percentage point. These changes reflect estimated crowding-out effects on rates of return.

For C corporations, the crowding-out effects shown in Table 14 lead to smaller increases in the various *K/L* than those shown in Table 5. Through these channels, the proportionate rise in *Y/L* is less than otherwise. For the law-as-written case in Table 14, the rise in *Y/L* is 1.9 percent, compared to 2.5 percent in Table 5. For the provisions-permanent case, the rise in *Y/L* in Table 13 is 4.0 percent, compared to 4.7 percent in Table 5.

Similarly, for pass-through businesses, the crowding-out effects lead to lower proportionate increases in the various *K/L* and, thereby, to lower proportionate changes in *Y/L*. For the law-as-written case, the proportionate change in *Y/L* in Table 14 ends up as -1.5 percent, compared to -0.8 percent in Table 10. For the provisions-permanent case, the proportionate increase in *Y/L* in Table 14 is 2.2 percent, compared to 3.1 percent in Table 9. Thus, overall, the assumed amounts of crowding-out have significant negative effects on the predicted long-run changes in corporate and pass-through output per worker.

We can enter the estimates inclusive of crowding-out effects into the analysis of economy-wide output in Table 10. The result for the law-as-written case is that the proportionate rise in overall *Y/L* is 0.4 percent and 1.1 percent when there is also a 10 percent level difference in productivity between the two business sectors. For the provisions-permanent case, the results for overall *Y/L* become 2.4 percent and 2.9 percent when there is also a 10 percent level difference in productivity between the sectors.

Finally, following the methodology and assumptions described above, Table 14 provides estimates of GDP and GDP growth in the case of crowd out. Overall in this case GDP after a decade would be 0.2 percent higher in the law-as-written scenario—corresponding to a growth rate of 0.02 percentage point. In the provisions-permanent case GDP would be 1.0 percent higher after a decade, as compared to a 1.2 percent higher in the case without crowd out. For comparison, and not shown in Table 14, if the 50 percent bonus depreciation in effect in 2017 had been made permanent GDP after ten years would have been 0.3 percent higher, which is larger than under the law as written because there is would not be crowd out through higher interest rates from bonus depreciation being made permanent.

Table 14
Cost of the 2017 Tax Law with Conventional and Dynamic Scoring ($ billions), 2018-2027

	Law as written	**Provisions permanent**
JCT Conventional Score	$1,500	$2,200
Dynamic Feedback	-$250	-$450
Net Cost (assuming JCT conventional score)	**$1,200**	**$1,700**
Annual Cost per Household	$900	$1,400
Increase in r^k and i in crowd out scenario (bp)	14	20
GDP after 10 years w/o crowd out	0.4%	1.2%
GDP after 10 years w/ crowd out	0.2%	1.0%
Change in annual growth rate w/ crowd out	0.02 p.p.	0.10 p.p.

Cost per household is per year for 10 years. Assumes payments start in 2018. Detail does not add to total because of rounding.

V. What is Missing from the Long-run Neoclassical Analysis

The neoclassical model captures many of the important and well understood effects from the tax changes. But it also misses several that could be economically important that we discuss in qualitative terms here.

The Allocation of Capital

This model misses potential improvements in the quality of capital at a more granular level. Under prior law investments in different types of capital and different types of industries were sometimes taxed at very different rates, leading to distortions in the allocation of capital with too much investment in tax favored industries and too little investment in tax disadvantaged industries. By reducing tax rates and reducing or eliminating some tax preferences, the new tax law *may* reduce some of these differentials in a way that would lead to a better allocation of capital. A more granular analysis than just our five categories of investment would be needed to assess how important this effect would be.

The model may miss the potentially special role of research and development in endogenous growth. R&D may have substantial spillovers that play a role in the level and possibly even growth rate of output. In the law as written, R&D falls while in the law with provisions permanent it only increases by a small amount. This could potentially have consequences beyond just entering into a Cobb-Douglas production function as we have modelled it.

International Considerations

A big wild card in this analysis is international considerations, including shifting both real and reported income. Like Tax Foundation (2017), our analysis effectively assumes that the international provisions of the legislation have no macroeconomic impact—that investment is determined by marginal tax rates in the United States and not by relative tax rates with other countries or average tax rates. Nevertheless, there is evidence that these channels operate as well (Devereux and Griffith 1998).

The sign of the international effects, however, is not clear. At a first pass, the legislation both lowers the average tax rate on domestic investment but it also lowers the tax rate on overseas investment by shifting to a territorial system that would no longer tax profits of foreign subsidiaries of U.S. corporations. As a result, the impact of tax changes even on the large, lumpy location decisions emphasized by other researchers (Mathur and Kallen 2017) are ambiguous in the face of these competing incentives. The ambiguity is compounded to the degree that the U.S. legislation induces rate reductions in other countries, undoing some of the transitory advantage it created for U.S. based firms. (These average tax rate considerations could also apply to domestic investment.)

The international effects are further complicated by two significant new base erosion provisions, both of which are likely to have heterogeneous impacts on different types of businesses and different activities within businesses. The first provision is a new Global Intangible Low Tax Income (GILTI). The provision would immediately tax low taxed foreign income at a reduced rate—10.5 percent initially rising to 13.125 percent starting in 2026. Low-taxed foreign income is defined as total global returns in excess of 10 percent of the tangible capital located overseas. GILTI creates two different incentives. It raises the tax on overseas production, discouraging companies from shifting income and potentially activity overseas. On the other hand, it creates more of an incentive to locate tangible capital overseas to generate a higher threshold before returns on intangible capital become subject to GILTI. This is especially true because GILTI is assessed on a global basis so additional factories located in Germany can be used to offset royalty income booked in the Cayman Islands. The net effect of these two on economic activity is unclear although the provision overall likely raises revenue and reduces income shifting.

The other major new international base broadener is the Base-Erosion Anti-Abuse tax (BEAT) that functions as a minimum tax on foreign direct investment into the United States, with a minimum tax rate of 10 percent on a base that is adjusted in a variety of complicated ways including not deducting payments back to parent companies. This could potentially deter FDI into the United States, specifically encouraging foreign-headquartered multinationals not to set up tangible investments in the United States. On the other hand, it helps prevent the erosion of the U.S. tax base, which would require higher tax rates to raise a given amount of income.

The impact of all these changes on reported income is less ambiguous and likely to be positive as reported income is shifted back to the United States. This, however, would not be associated with any actual activity—just effectively correcting a measurement error that has led to increasing underreporting of actual GDP (Guvenen et al. 2017).

Other important issues not addressed by the neoclassical model we use

The model we use is a comparative statics exercise that compares two steady states with an essentially ad hoc adjustment for how much of the transition to the new steady state occurs over ten years. This misses much of the richness of the short-run dynamics, effects of expectations, and effects of shifting provisions. Modelling all of these, however, would require a much more complicated and opaque model.

The model we are using also does not have any explicit model of the consumer—nothing about how consumption patterns change over time, how savings responds to the new tax incentives, and the like. Instead, we assume that the supply of capital is infinitely elastic either because of the Ramsey-model properties of our setup or because of a small open economy assumption. To the degree, however, that savings does not respond on any reasonable timeline as is assumed in this model then it is possible that—for example—instead of the capital to finance equipment and structures coming from investment it could come from other sectors, like residential capital. These effects, however, do not occur in our model which has an infinitely elastic supply of capital but could occur in other modelling frameworks, like an Overlapping Generations model.

Finally as discussed in the financing section, this model is as much an estimate of the financing assumed for the tax cuts as it is of the tax cuts themselves. We have assumed lump sum spending reductions or tax increases. If instead the government budget constraint is closed by reduced government spending this could have a positive or negative effect on growth. In the extreme case of setting the tax rate to zero and eliminating government spending our model would presumably give the wrong prediction—finding that this would greatly increase growth when in fact the absence of laws or institutions would devastate it. At the margin, however, the evidence is much less clear-cut and one of the authors would argue that this would provide an additional impetus to growth while the other author would point to the potential reduction in government capital in R&D, infrastructure and other areas as reducing growth.

VI. The Individual Income Tax in the Short Run

The final form of the 2017 legislation on individual income taxes is complex, but we focus here on the change in the labor-income-weighted average marginal income-tax rate. The Tax Policy Center calculated a reduction in this average marginal tax rate by 3.2 percentage points for 2018 relative to the baseline.[34] However, this estimate does not factor in the reduced federal deductibility of State and local taxes. Our estimate is that an allowance for the reduced federal deductibility of State income taxes means that the cut in the average marginal income-tax rate for 2018 would be around 2.3 percentage points. This reduction in marginal tax rates is

[34] In the prior history (Barro and Redlick [2011, Table 1]), the largest cuts in labor-income-weighted average marginal tax rates (including federal and state income taxes and social-security taxes) are -4.5 percentage points for 1947-48 and 1986-88, -3.6 percentage points for 1963-65, -2.5 percentage points for 1953-54 and 1982-84, and -2.1 percentage points for 2002-03. The largest increases are 15.4 percentage points for 1939-42, 12.9 percentage points for 1972-81, 4.7 percentage points for 1915-18, and 4.2 percentage points for 1967-69. (The Clinton tax increase for 1992-94 was 1.6 percentage points.) The large increases are associated particularly with wars and also pick up the increase in Social Security and Medicare payroll taxes. The sharp cut in the average marginal tax rate for 1948 is hard to evaluate because this change featured the national introduction of joint filing. Although the income-weighted average marginal tax rate fell sharply, the rate would have risen for many lower-earning spouses, who likely have high labor-supply elasticities. For this reason, Barro and Redlick (2011, Table 1) focused on results that that excluded the year 1949.

smaller than that in the Reagan 1986 reform (4.5 points from 1986 to 1988) and the Kennedy-Johnson 1964 tax cut (3.6 points from 1963 to 1965), and about the same as the G.W. Bush 2003 tax cut (2.1 points from 2003 to 2004).[35]

We can estimate the impact of the changes in individual marginal income-tax rates using existing reduced-form analyses of U.S. macroeconomic data. This method has the advantage of being grounded in empirical data but the disadvantage of not reflecting much of the specifics of the tax changes or potential differences in the context today versus the past.

A number of papers have used regression-based methods to assess the impact of tax cuts, including Romer and Romer (2010), Barro and Redlick (2011), Mertens and Ravn (2013), Mertens and Montiel-Olea (2017), and Zidar (2017). We emphasize Barro and Redlick, henceforth BR, and Mertens and Montiel-Olea, henceforth MM, because they focused on marginal tax rates, rather than average tax rates. We do not consider the issues about the impact of distributional changes in the tax cuts raised by MM and Zidar (2017).

In BR, the counter-part of τ is the labor-income weighted average marginal income-tax rate, factoring in federal income taxes, social-security taxes, and State income taxes. BR found empirically that a cut in τ by 1 percentage point raises the level of per capita GDP by 0.5 percent over the next two years (Table 2, Columns 1 and 4). Therefore, with τ down by 2.3 percentage points in 2018, per capita GDP should rise by 1.15 percent by 2019, implying a boost to the average growth rate by 0.6 percentage point per year for 2018-19. This estimated effect on the growth rate is temporary, lasting for only two years.

MM used a structural vector auto-regression (SVAR) framework that includes instrument variables. The instruments were constructed from a narrative approach, following Romer and

[35] These numbers come from Barro and Redlick (2011, Table 1).

Romer (2010), which isolated changes in marginal income-tax rates that were arguably exogenous with respect to changes in the macro economy or in government spending. Their analysis (Table 3) treats eight federal individual tax reforms as featuring exogenous tax-rate changes: 1948, 1964, 1978, 1981, 1986, 1990, 1993, and 2003. In their analysis, only the changes in marginal tax rates through the following year were considered (for example, the 1986 reform entered only for its effects through 1987). Their concept of τ is the labor-income weighted average marginal income-tax rate, including federal income taxes and social-security taxes but not State income taxes.

The MM estimated model (Figure 5) implies that a cut in τ by 1 percentage point (corresponding to a rise in $1-\tau$ by about 1.5 percent) leads to an expansion of the level of real GDP by around 1 percent in 1-2 years. This estimated effect is about twice that found by BR. A likely reason for the difference is that MM more convincingly isolated exogenous tax-rate changes, whereas BR picks up some changes that tend to be counter-cyclical; that is, tax-rate cuts tending to happen when the economy is weak.

The MM results imply that a cut in τ by 2.3 percentage points in 2018 would raise the level of real GDP by 2.3 percent by 2019.[36] Hence, the effect on the average GDP growth rate for 2018-19 is about 1.2 percentage points per year, also about twice that predicted by BR.

A strength and weakness of the SVAR methodology employed by MM is that in includes the tax-rate variable as part of the system. Therefore, the estimation delivers forecasts of the degree of permanence of tax-rate changes based on what has been true historically, given the

[36] Mertens (2018, Table II, Panel C) carries out a similar exercise and predicts a rise in real GDP by 2.3 percent by 2019. His analysis assumes that the 2017 law lowers the average marginal income-tax rate by 2.75 percentage points, larger than the 2.3 points that we assumed. Mertens (Table II, Panel A) also summarizes results based on changes in average tax rates. This analysis applies the estimated changes in federal tax revenue from the 2017 law to the models estimated by Romer and Romer (2010) and others. The average predicted rise in real GDP by 2019 is then 1.6 percent.

information contained in the variables included in the dynamic system. The MM study finds that, empirically, the changes in average marginal income-tax rates from the individual income tax tend themselves to be temporary. That is, this tax rate tends to revert over time back to its initial level.[37] The estimated effects of tax-rate changes on real GDP—in MM and also in BR—can then be viewed as applying to durations of tax-rate changes that applied typically in the past. That is, the estimated effects represent responses to tax-rate changes that would be rationally viewed as partly temporary.

A reasonable way to assess the effects from the changes in individual taxation in the 2017 law is to average the predictions from the BR and MM studies. That method would predict increases in GDP growth rates for 2018-19 by 0.9 percentage point per year. The predicted growth effects beyond 2019 are close to zero.

The predicted short-run growth effect from the individual tax change dwarfs the estimated effects from the business tax changes shown in Table 12. Those results imply an increase in GDP growth rates in the range of 0.04 to 0.13 percentage point per year over a 10-year horizon, depending especially on whether one uses the law-as-written or provisions-permanent approach. Thus, the overall predicted effect on the GDP growth rate for 2018-2019 based on the regression methodology is in the range of 0.9 to 1.1 percentage points per year.

There are important issues in interpreting and applying these short-run results to these particular tax cuts in this particular economic circumstances. Both BR and MM are attempting to pick up supply-side effects through regressions on marginal tax rates. Nevertheless, it is possible

[37] As an example, the Reagan 1986 tax-rate cuts were partially reversed by future tax-law changes and bracket creep. This political behavior means that the effects of tax-rate changes on the level of per capita GDP would also be temporary. However, empirically, MM found that the average marginal income-tax rate tends to revert back more quickly than real GDP to its initial level (their Figure 5).

that at least some of this effect could be a standard demand-side Keynesian effect, something one author thinks is possible and the other author has done substantial research showing it is not the case. Such rapid changes in output, also, raise the possibility that the Federal Reserve would seek to offset some of the increment to growth—either because it was causing inflation or because they did not fully appreciate the supply shift—in which case the numbers would be lower. Moreover the current context with a low unemployment rate may also be relevant in understanding the macroeconomic impact of the tax cuts.

The business tax changes are the main source of higher predicted economic growth in the long run. Beyond 2019, the predicted growth effect from the individual tax changes is close to zero, whereas that from the business tax changes is 0 to 0.1 percentage point per year for 2020-2027. Thus, the overall predicted impact on the GDP growth rate for 2020-2027 is also 0 to 0.1 percentage point per year.

VI. Comparison to Other Estimates

Our results for the law as written case are similar to several other macroeconomic analyses of the 2017 tax law that are summarized in Table 15. Few analyses have been published of the permanent provisions case we also examined so we cannot compare those results.

The JCT (2017b) estimated that the law would add an average of 0.7 percent to GDP over the ten-year budget window, with about 0.8 percent in additional output upfront but output 0.1 to 0.2 percent higher at the end of the budget window and an even smaller change or negative after thirty years. This estimate reflects a weighted average of three models: the "Macroeconomic Equilibrium Growth" (MEG) model, an Overlapping Generations (OLG) model, and a Dynamic Stochastic General Equilibrium (DSGE) model. The Tax Policy Center also estimated an initial

0.8 percent boost to output and a 0.0 percent change in output in 2027 and 2037 (Page et al. 2017). The Penn-Wharton Budget Model (2017) used an OLG model to estimate a 0.6 percent to 1.1 percent increase in output at the end of the first decade and a 0.7 percent to 1.6 percent increase in output by 2040. Finally, the Tax Foundation (2017) used a comparative statics steady-state model to estimate that output would increase by 0.4 percent in 2018 and 1.7 percent in the long run. These estimates are all shown in Table 15. In addition to these estimates a number of authors have published estimates of elements of the law, like cutting the corporate rate without offsets.

Table 15
Summary of Macroeconomic Analyses of the 2017 Tax Law

	Percent Increase in Output			**Growth Rate (p.p.)**
	2018	2027	Long-run	2017-2027
Joint Committee on Taxation (2017b)	0.8%*	0.1 to 0.2%	~0.0%	0.01 to 0.02
Tax Policy Center (2017)	0.8%	0.0%	0.0%	0.00
Penn Wharton Budget Model (2017)	N/A	0.6 to 1.1%	0.7 to 1.6%	0.06 to 0.12
Tax Foundation (2017)	0.4%	2.8%	1.7%	0.29

* JCT does not provide a 2018 but says that the tax cut will be 0.8% to 0.9% for most of the window.

Note: Tax Policy Center analysis published by Page et al. 2017. Based on sources listed and authors' calculations.

VII. Conclusion

Future tax changes are inevitable given all of the expirations in the law today and the likelihood that the gap between projected revenue and projected spending will be closed, at least in part, with additional revenue. Both authors think that macroeconomic modelling can make a useful contribution to understanding future revenue changes. Such modelling is one ingredient of a broader welfare analysis and is also essential for understanding the fiscal impact of legislation.

Both authors also believe the modelling contains some important lessons—for example, expensing investment while eliminating the deductibility of interest would reduce the effective corporate marginal tax rate on investment to zero, thereby boosting capital accumulation and growth.

Both authors also agree with Milton Friedman that the only way to cut taxes is to cut spending. The authors disagree on the proper level of spending. But to the degree the political system has set such a level, tax cuts today simply shift taxes to the future without actually reducing them in a present-value sense. Moreover, tax cuts that represent deviations from tax smoothing are more distortionary than smooth taxes (Barro 1979).

The authors also differ in a number of respects, both in terms of their interpretation of the results, their preferred models and their ultimate evaluations of the wisdom of the 2017 tax law and the best next steps for tax reform. This paper is not the place to fully discuss all of these issues, but the following gives each author's perspective on the aspects of these issues that are most directly related to the modelling in this paper—highlighting the divergences that remain after the attempts at convergence we have made in this paper.

Jason Furman's View

I wanted to provide my personal perspective on the results in this paper and its implications for evaluating the 2017 tax law and the process for tax reform going forward.

First, the bulk of this paper focuses on one model, a Ramsey model. This model has real strengths: it is transparent, internally consistent and maps into some of the most important questions in tax reforms. Within the context of this model, I believe the estimates in this paper are reasonable. If I had written it by myself using the same model I would have chosen some other parameters for the central case like a lower capital share to reflect that part of the increase in the capital share may reflect an increase in pure profits, higher present values of depreciation allowances to reflect the fact that depreciation allowances have many safe bond-like characteristics, and a more standard cost of capital formula that places more weight on debt financed investment.[38] Moreover, I personally prefer the estimates that incorporate crowd out in Section IV, which I believe better captures the consequences of the tax law. But even with those different parameters the overall takeaways would be largely the same.

Second, the Ramsey model has important limitations so that I believe that for public policy purposes its results are useful and informative but that it should only be one among many models (like overlapping generations and dynamic stochastic general equilibrium) and its results should be interpreted with care. Some of the limitations we already discussed in Section V, including issues about not fully capturing the composition of capital, the international effects, and other more granular features of the tax code. Incorporating these could result in results that were larger or smaller than what we present, with the largest uncertainty around the international provisions which are more likely to result in additional growth relative to our estimates than the opposite.

The bigger issues with applying the Ramsey framework to tax changes, especially those that have no explicit financing, do not fully record where all of the capital comes from. Some likely comes from abroad—and would need to be repaid—something that could be captured in national income results but not in GDP results. To the degree that the supply of capital is not infinitely elastic, then some of the capital will come from other sectors in the economy—like residential real estate. Finally, and important from the perspective of welfare, some of it will

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[38] For example, using our economic and tax policy parameters in the cost-of-capital formula developed by Deveraux and Griffith (1998) formula as implemented using the Mathur-Kallen model (available at https://www.aei.org/wp-content/uploads/2017/12/taxes_investment_growth.xlsx), the reduction in the average user cost of capital for the corporate sector would be 1 percent in the actual law case and 6 percent in the provisions permanent case, as compared to the 4 percent and 8 percent respectively that we find in our results.

come from reduced consumption upfront to finance greater consumption later. The Ramsey model misses some of these issues and focusing on comparative long-run steady states looks more at the end result that happens in the further future than the costs and benefits along the way.

Moreover, having lump sum financing operating in the background to make sure the government's transversality condition is satisfied and focusing on GDP rather than welfare sweeps some important issues under the rug. The model we are using has the feature that the lower the tax rates are the higher the growth rate will be. In fact, negative tax rates produce even higher GDP than zero tax rates. In one sense, it is certainly true that replacing distortionary taxation with lump sum taxation likely would lead to efficiency improvements. In another sense, this is both politically unrealistic and does not recognize the point of the tax system. As such, this model may be better suited to comparing reforms with similar revenue paths—ideally revenue neutral reforms—than comparing reforms with very different revenue levels.

Third, I believe the results of this model generally support my skepticism about the desirability of the 2017 tax law (beyond the critical issues of distribution, effects on the health system, and other issues that are important to me but beyond the scope of this paper). I believe it is most relevant to analyze the law that Congress actually passed because it reflects their priorities and tradeoffs. Moreover, most of the claims advocating for the law were based on the law that was actually passed and I would note that the Administration's FY 2019 Budget does not propose to extend expensing. While it is possible that expensing is made permanent or the amortization of R&D is cancelled, those are separate policy questions that should and will be addressed going forward.

The law that Congress actually passed would, according to our analysis, raise the level of GDP by 0.4 percent in 2027 while cutting the R&D component of investment. If Congress had just made 50 percent bonus depreciation for equipment permanent that would have raised the level of GDP by 0.3 percent in 2027. Moreover, making bonus depreciation permanent would have had cost one-sixth as much so if you look at the estimates reflecting crowd out then bonus depreciation would have been even better at 0.3 percent of GDP as compared to 0.2 percent of GDP for the law that Congress passed.[39]

Moreover, any evaluation should not be based on GDP but based on welfare. In particular, the ideal procedure would be to do a dynamic distributional analysis (see Elmendorf et al. 2008 and Furman 2016). Such an analysis would incorporate the direct impacts of the tax changes on households, the cost of lump sum financing, the welfare effects of reduced consumption and increased leisure (if relevant), and also the growth effects described in this paper. I have not done this full analysis but I suspect it would find that the 2017 law as written was not welfare improving for the median household and was dominated by just making the bonus depreciation that had been in the law from 2008 through 2017 permanent.

In addition—and an issue Robert and I would disagree on—I find the assumption of lump sum financing, or equivalent spending reductions, assumed in the modelling either unrealistic or undesirable and think there is a substantial chance that higher deficits would lead to damaging spending cuts, non-smooth tax changes, or other costs.

Finally, the most important question is what to do going forward. The Ramsey model finds that making all of the provisions in effect in 2019 would add modestly to growth, raising the annual growth rate by 0.1 percentage point over the next decade, at an additional lump sum

[39] Under the Administration's version of the tax law being made permanent, which assumes the individual and estate provisions are made permanent but expensing is phased out, the change in GDP under the law is the same as what would have happened if bonus depreciation had been made permanent in the case of crowd out and slightly higher absent crowd out.

cost of $450 per year per household. For the reasons discussed above, I think this is unlikely to be substantially welfare improving for the median household. More importantly, this paper contains an important finding that it is possible to substantially improve on growth while raising revenue through a tax reform that improves the tax base and raises taxes rates. In particular, a combination of expensing all capital investment, disallowing all interest deductions, and raising the tax rate would add 0.2 percentage point to the growth rate over the next decade while increasing revenue. Such a reform would also have to work out other issues that are not addressed in his model, for example further international tax reforms like some form of border adjustment or toughening the parameters of the new minimum tax system to ensure that higher statutory tax rates in the United States did not lead to shifting overseas.

Ultimately, however, for me the most important priority is that we need more revenue, and as I learned in graduate school when I read Barro (1979), the sooner we do that the better—so we can avoid larger abrupt increases in taxes in the future. And both Robert and I agree that perhaps this could ultimately include spending reforms and maybe even a value-added tax.

Robert Barro's View

The 2017 tax reform is an important step in improving the efficiency of the U.S. tax system. On the corporate side, the main changes are the full expensing of equipment and the cut in the corporate-profits tax rate. These changes imply that user costs on corporate capital fall on average by 8 percent and that capital-labor ratios rise in the long run on average by 12 percent. The expansion in equipment by 14 percent reflects mainly the full expensing, and the rise in structures by 16 percent reflects mostly the cut in the tax rate. Overall, the predicted rise in long-run output per worker in the corporate sector is by 5 percent, and the rise in corporate wages should also be 5 percent. Over a 10-year interval, the added GDP growth rate should be 0.1 to 0.2 percentage point per year.

The cut in the average marginal income-tax rate on individuals by 2.3 percentage points should be expansionary in the short run, leading to extra GDP growth by 0.9 percentage points per year through 2019. Hence, the cuts on the individual side dominate the predicted addition to economic growth in the short run. However, in the longer term, the key element for growth comes from the corporate changes.

Naturally, the 2017 tax legislation is not perfect. A better plan would have introduced full expensing for all forms of capital spending on a permanent basis. In this scenario, the cut in the corporate-profits tax rate would have been a minor issue. Moreover, tax reform is best viewed as part of a broad reform package—reminiscent perhaps of the Bowles-Simpson Commission. Such a package would particularly feature entitlement reforms and maybe even a value-added tax.

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APPENDIX: JCT-BASED REVENUE ESTIMATES

Appendix Table 1 summarizes the cost of the provisions of the 2017 tax law according to the JCT's conventional score, which assumes no macroeconomic feedback from the law but does reflect an extensive set of microeconomic behavioral changes like shifting of home loans or charitable giving. The table also shows the authors' estimates of the cost of an alternative, discussed below, that would make all of the 2019 provisions permanent—including extending expiring provisions and cancelling delayed offsets. The numbers are shown both for the traditional ten-year budget window and also for 2027. Given the substantial timing shifts, especially on the corporate side, the 2027 numbers are a better guide to the steady state under the new law.

Conventional Revenue Score of the 2017 Tax Law

	2027 Law		2019 Law Permanent	
	2027	2018-2027	2027	2018-2027
Individual and Estate (excluding passthrough)				
Gross Cuts				
Statutory Rates	$0	-$1,214	-$186	-$1,525
Standard Deduction	$0	-$720	-$106	-$899
Child Credit	$1	-$544	-$76	-$694
Alternative Minimum Tax	$0	-$637	-$108	-$777
Estate Tax	-$3	-$83	-$13	-$94
Subtotal, Gross Individual Cuts	*-$3*	*-$3,198*	*-$488*	*-$3,989*
Gross Increases				
Personal Exemption	$0	$1,212	$182	$1,517
Itemized Deductions	$0	$676	$112	$835
Shared Responsibility Payment	$53	$314	$53	$314
Chained CPI	$32	$134	$32	$134
Other	$2	$2	$2	$2
Subtotal, Gross Individual Increases	*$86*	*$2,337*	*$380*	*$2,801*
Subtotal, Individual	***$84***	***-$862***	***-$108***	***-$1,188***
Passthrough	***-$1***	***-$265***	***-$42***	***-$344***
Corporate				
Gross Cuts				
Rate	-$156	-$1,349	-$156	-$1,349
Expensing	$14	-$86	-$5	-$150
Territorial system	-$26	-$224	-$26	-$224
Other	-$3	-$127	-$9	-$161
Subtotal, Gross Corporate Cuts	*-$172*	*-$1,785*	*-$196*	*-$1,883*
Gross Increases				
Manufacturing Deduction	$12	$98	$12	$98
Interest Limitation	$37	$253	$21	$179
Net Operating Losses Limitation	$11	$201	$11	$201
Amortization of R&D Expenditures	$6	$120	$0	$0
Global Intangibles	$5	$49	-$22	$9
Inbound Investments	$27	$150	$17	$134
Other	$23	$585	$23	$585
Subtotal, Gross Corporate Increases	*$121*	*$1,456*	*$62*	*$1,206*
Subtotal, Corporate	***-$50***	***-$330***	***-$134***	***-$677***
Total	**$33**	**-$1,456**	**-$284**	**-$2,209**

Note: May not sum due to rounding.
Source: Joint Committee on Taxation (2017a); authors' calculations.