Investment Expensing Without Tax Credits or Interest Deductibility: A Macroeconomic Evaluation

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Abstract

The marginal effective tax rate (METR), a measure of how taxation affects investment returns, varies significantly across asset types (e.g., structures versus equipment) and financing methods (debt versus equity). This variation distorts capital allocation. A tax reform that allows immediate expensing of investment while eliminating interest deductibility and investment tax credits would equalize METRs across investments, promoting a more efficient allocation of capital. This paper evaluates the macroeconomic effects of such a reform using a dynamic general equilibrium model that incorporates heterogeneous capital types, debt and equity financing, interest deductibility, and accelerated depreciation. The results show that the reform boosts investment and output. It leads to short-term fiscal deficits and an initial increase in government debt, followed by long-run surpluses and debt reduction. R&D investment declines persistently due to the removal of the investment tax credit.

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1 Introduction

The marginal effective tax rate (METR), a measure of how taxation affects the return on investment, varies significantly across types of capital (e.g., structures, equipment, software, and R&D) and sources of financing (debt versus equity).[1] Although the 2017 tax reform narrowed the gap between the METRs for equity- and debt-financed investment and reduced the overall METR for typically-financed investment, substantial variation in METRs persists.[2] This heterogeneity distorts capital allocation by favoring certain types of investment and financing over others.

One way to equalize the METR across different types of investments is to allow businesses to immediately expense all investment costs, rather than depreciate them over time, while eliminating investment tax credits and the deductibility of interest expenses. Immediate expensing would make the METR uniform across assets with different economic and tax depreciation schedules. Removing investment tax credits would eliminate disparities due to different tax credits. Eliminating interest

[1] The METR is the percentage of the pre-tax rate of return on an investment that is paid in taxes, taking into account all tax provisions, including statutory tax rates, capital depreciation allowances, investment tax credits, and deductions for investment and interest expenses (see Fullerton 1999).

[2] Before the 2017 tax reform, the METR on typically-financed corporate investment ranged from 12 percent to 42 percent depending on the asset type (CBO 2014, Figure 1). The range was higher for equity-financed (from 21 to 47 percent) than for debt-financed investment (from −42 to 22 percent). The METR ranges were similarly large for pass-through businesses. The 2017 tax reform included a permanent cut in the corporate income tax rate, a temporary increase in bonus depreciation for equipment and software, and a cap on interest deductibility (30 percent of EBIT, or EBITDA before 2022). As a result, the METR on equity-financed corporate investment fell from 35 to 22 percent, while the METR on debt-financed investment rose from −9 to 7 percent (DeBacker and Kasher 2018, Table 2). The overall METR on typically-financed corporate investment declined from 28 to 19 percent. See also Gravelle and Marples (2021, Tables 1-5).

deductibility would remove the tax advantage of debt, aligning the METR for equity- and debt-financed investment.

This paper examines the macroeconomic effects of such a tax reform using a dynamic general equilibrium model that incorporates heterogeneous capital types, debt and equity financing, interest deductibility, and accelerated capital depreciation. The reform consists of allowing full and immediate expensing of all investments, while eliminating investment tax credits and removing interest deductibility for *newly issued* business debt.

According to the model, the reform stimulates both investment and output. Aggregate investment rises by 8 percent in the first year and 2 percent after ten years. Business output increases by 0.5 percent initially and 0.3 percent after a decade. By making the METR uniform across investments, the reform promotes a more efficient allocation of capital.

The main drawback of the reform is that it generates sizeable fiscal deficits in the early years. This occurs because businesses can immediately deduct all new investment expenses, while still claiming depreciation on pre-reform capital and interest deductions on pre-reform debt. Over time, however, initial deficits turn into fiscal surpluses, as these deductions phase out: depreciation declines as old capital depreciates, and interest deductions fall as existing debt is repaid. Consequently, government debt rises in the short term, peaking at 10 percent above its steady-state level after 15 years, but gradually declines thereafter, eventually falling below the steady state in the long run.

Another drawback of the reform is that eliminating the R&D tax credit discourages R&D investment, leading to a 6 percent decline in the long-run R&D capital stock. Given the critical role of R&D in innovation, technological progress, and growth, policymakers may consider maintaining the tax credit. A modified version of the reform that retains the R&D tax credit would instead result in a 2 percent increase in the long-run R&D stock, while producing similar effects on other macroeconomic variables. This alternative reform would stimulate investment and output slightly more than the baseline but would also lead to a 2 percentage point higher increase in government debt after 15 years.

Related literature

This paper belongs to the extensive literature assessing the macroeconomic effects of tax policy using dynamic general equilibrium models. These models differ in structure and focus across studies. For example, Domeij and Heathcote (2004) model heterogeneous households and incomplete markets; Forni, Monteforte, and Sessa (2009) include price stickiness and rule-of-thumb consumers; Fernández-Villaverde (2010) emphasizes financial frictions; Altig et al. (2001) model life-cycle and intragenerational heterogeneity; and Zeida (2022) incorporates heterogeneous households, life-cycle behavior, occupational choice, and entrepreneurial human capital. House and Shapiro (2006) demonstrate that immediate tax cuts stimulate investment and output, whereas delayed tax cuts have contractionary effects. Zubairy (2014) estimates that the effects of tax cuts build gradually, since they are primarily driven by the response of investment. Sims and Wolff (2018) show that tax cuts are more stimulative during economic expansions. Castelletti Font, Clerc, and Lemoine (2018) find that capital income tax cuts are more expansionary than labor income tax cuts. Slavík and Yazici (2019) emphasize the benefits of eliminating the capital tax differential between equipment and structures. Furno (2022) argues that the stimulative effects of corporate tax cuts were smaller in 2017 than in the 1960s because tax depreciation was faster and the corporate share of economic activity smaller. Bhattarai, Lee, Park, and Yang (2022) show that permanent capital tax cuts are more expansionary when financed by lump-sum transfer reductions rather than increases in distortionary taxes. Relative to this literature, my paper contributes by modeling heterogeneous capital types, debt and equity financing, interest deductibility, and accelerated depreciation to study reforms that alter investment expensing, interest expense deductions, and tax credits.

This paper also contributes to the partial-equilibrium literature that examines the tax implications for the user cost of capital, the METR, and tax neutrality. Hall and Jorgenson (1967) and Auerbach (1983a) describe how immediate investment expensing reduces tax distortions in investment decisions, thereby promoting a more efficient allocation of capital. Auerbach (1983b) further shows that interest deductibility distorts the cost of capital by making investment decisions sensitive to the financing choice, thereby undermining tax neutrality. Boadway and Bruce (1984) propose a pure-profits tax that combines immediate investment expensing with the elimination of interest deductibility to promote tax neutrality across investment types and financing methods.

Finally, this paper relates to the empirical literature documenting how tax credits, accelerated depreciation, and debt financing influence investment behavior. Hines (1993) provides evidence that R&D tax credits stimulate investment, estimating the price sensitivity of R&D spending to be between -1.2 and -1.6. Several empirical studies show that faster depreciation stimulates investment.[3] Additional studies provide indirect evidence that debt financing influences investment by demonstrating that the weighted average cost of capital, which is affected by the mix of debt and equity financing, plays a significant role in firms' investment decisions.[4]

[3]These studies identify the effect of faster depreciation by leveraging the fact that only shorter-duration assets qualified for the increases in bonus depreciation enacted in 2001-2004 and 2008-2010. Using quarterly data on 36 types of capital, House and Shapiro (2008) find that eligible investment rose sharply in response to the increase in bonus depreciation in 2001-2004, estimating an investment elasticity to the bonus depreciation rate between 6 and 14. Using firm-level data, Zwick and Mahon (2017) also report a strong response, estimating that the increases in bonus depreciation raised investment in eligible capital relative to ineligible capital by 10.4 percent in 2001-2004 and 16.9 percent in 2008-1010. See also Ohrn (2018, 2019) and Curtis et al. (2022).

[4]Bierman (1993) summarizes the evidence from a survey of capital budgeting among Fortune 100 industrial firms (with responses from 74 firms) and reports that 93 percent of respondents used the weighted average cost of capital to evaluate the discounted value of new investments. Using firm-level data, Frank and Shen (2016) estimate a significant effect of the weighted average cost of capital on corporate investment, although the sign of the effect depends on how the cost of equity is measured. In their analysis, the average cost of debt is approximately half the cost of equity, and debt provides a tax benefit, so debt financing lowers the weighted average cost of capital.

2 Model

The model builds on Occhino (2023a). The main differences are that, in this paper, I let inside equity be endogenous, I improve the financial distress cost function and its parametrization, and I incorporate some modeling features from Occhino (2023b) that are relevant for analyzing the tax reform: the production function includes three types of capital (equipment and software, structures, and R&D); firms are allowed to deduct only a fraction $\zeta_t \in [0, 1]$ of their interest expenses; and there is a constant inflation rate, $\pi > 0$.

The model features a continuum of representative households and firms, each of measure one, as well as a government sector. Firms are owned by agents separate from households. Households supply both labor and financial capital to firms. Firms invest, produce output, and pay taxes on their income, net of tax depreciation and interest deductions. The government balances its intertemporal budget constraint through lump-sum transfers to households.

2.1 Firms

2.1.1 Capital, investment, depreciation, and production

There are three types of economic capital in the model: equipment and software (E), structures (S), and R&D (R). The category E includes not only equipment but also intellectual property products other than R&D, such as software and artistic originals.

The firm begins period t with three types of capital, k_t^i, for $i = E, S, R$. Let $k_t \equiv \sum_{i=E,S,R} k_t^i$ be aggregate economic capital. Production is a function of the three types of capital and labor, l_t:

$$y_t = Af\left(k_t^E, k_t^S, k_t^R, l_t\right), \tag{1}$$

where $A > 0$, $f\left(k^E, k^S, k^R, l\right) \equiv (k^E)^{\alpha^E}(k^S)^{\alpha^S}(k^R)^{\alpha^R} l^{1-\alpha}$, $\alpha^E > 0$, $\alpha^S > 0$, $\alpha^R > 0$, and $\alpha \equiv \sum_{i=E,S,R} \alpha^i < 1$. Revenue in period t equals output, y_t, while the wage bill equals the product of the wage rate, w_t, and labor demand, l_t.

The firm invests x_t^i in type-i capital, so the capital stock evolves according to the law of motion:

$$k_{t+1}^i = (1 - \delta^i) k_t^i + x_t^i \qquad \text{for } i = E, S, R, \tag{2}$$

where $\delta^i \in (0, 1)$ is the economic depreciation rate of type-i capital. Let aggregate investment be defined as $x_t \equiv \sum_{i=E,S,R} x_t^i$.

2.1.2 Tax capital and tax depreciation

Tax depreciation may differ from economic depreciation, reflecting features such as accelerated depreciation methods. Type-i capital depreciates for tax purposes at the tax depreciation rate $\tilde{\delta}^i \in (0, 1)$.

In addition, a fraction $\kappa_t^i \in [0, 1]$ of type-i investment expenses can be immediately deducted (i.e., *expensed*) from taxable income in the period in which the expenses are incurred. This investment expensing fraction captures two provisions: bonus depreciation, which allows partial expensing of investment in equipment and software; and immediate expensing for R&D, a provision that expired in 2022.

Because tax and economic depreciation differ, it is necessary to track tax capital (the capital stock as measured by the tax system) separately from economic capital. Let $\tilde{k}_t^i$ denote the real stock of type-i tax capital at the beginning of period t, and let aggregate tax capital be $\tilde{k}_t \equiv \sum_{i=E,S,R} \tilde{k}_t^i$. Then, tax depreciation is

$$D_t^i = \tilde{\delta}^i \tilde{k}_t^i + \kappa_t^i x_t^i \qquad \text{for } i = E, S, R, \tag{3}$$

and tax capital evolves according to the law of motion:

$$P_{t+1} \tilde{k}_{t+1}^i = P_t \tilde{k}_t^i + P_t x_t^i - P_t D_t^i \qquad \text{for } i = E, S, R, \tag{4}$$

$$(1 + \pi) \tilde{k}_{t+1}^i = (1 - \tilde{\delta}^i) \tilde{k}_t^i + (1 - \kappa_t^i) x_t^i \qquad \text{for } i = E, S, R, \tag{5}$$

where P_t is the aggregate price level in period t, and $\pi_t \equiv P_{t+1}/P_t - 1$ is the inflation rate. The inflation rate is assumed to be positive and constant over time. Although constant, inflation affects the income tax deductions for capital depreciation and interest expenses and the level of taxes paid by firms and households.

2.1.3 Debt and equity financing

The firm finances its investment through a combination of debt, b_t, and outside equity, e_t, both measured in real terms. Let

$$a_t \equiv b_t + e_t \tag{6}$$

be the firm's financial capital, the sum of debt and outside equity, and let

$$\theta_t \equiv \frac{b_t}{a_t} \tag{7}$$

be the debt share of financial capital, so

$$b_t \equiv \theta_t a_t, \tag{8}$$

$$e_t \equiv (1 - \theta_t) a_t. \tag{9}$$

Outside equity includes all financial instruments whose returns are not deductible from taxable income, such as preferred equity. Let r_t and r_t^e denote the real interest rate on debt and the real return on equity, respectively. Each period, the firm repays $(1 + r_t)b_t + (1 + r_t^e)e_t$ and issues new debt, b_{t+1}, and outside equity, e_{t+1}.

While business owners issue outside equity, they retain control of the firm through their holdings of inside equity and remain the residual claimants. Myers (2000) is the seminal article modeling the decision to issue outside equity by insiders, such as managers and entrepreneurs. Let s_t be the value of inside equity, and let

$$E_t \equiv s_t + e_t \tag{10}$$

be total equity, the sum of inside and outside equity. The sum of debt and total equity equals the firm's value,

$$V_t = b_t + E_t. \tag{11}$$

The firm's financing choice follows the trade-off theory of capital structure. On one hand, debt provides a tax advantage, as the firm can deduct interest expenses incurred on its debt, but not the return on equity. On the other hand, debt imposes financial distress costs, i.e., agency and transaction costs associated with the risk of financial distress and default. This trade-off determines the firm's optimal mix of debt and equity financing. According to Myers (1984): "Costs of financial distress include the legal and administrative costs of bankruptcy, as well as the subtler agency, moral hazard, monitoring and contracting costs which can erode firm value even if formal default is avoided." Barro and Furman (2018) introduce similar "costs implied by the positive effect of leverage on a corporation's probability of default and bankruptcy".

I model the financial distress costs as an increasing and convex function of the debt share of financial capital. The financial distress costs are

$$w(\theta_t)a_t, \tag{12}$$

where $w(\theta) \equiv \Psi\theta^{1+1/\psi}$, $\Psi > 0$, and $\psi > 0$. A higher debt share of financial capital, θ_t, increases both the tax benefits of debt and the financial distress costs. The firm chooses its optimal mix of debt and equity by trading off the benefits and costs of debt financing.

2.1.4 Taxable income and tax liability

Let

$$R_t \equiv r_t + \pi \tag{13}$$

be the nominal interest rate, and let $\zeta_t \in [0, 1]$ denote the fraction of interest expenses that can be deducted for tax purposes. Taxable income, H_t, is obtained by subtracting labor costs, tax depreciation, and interest expenses from revenue:

$$H_t = y_t - w_t l_t - \sum_{i=E,S,R} D_t^i - \zeta_t R_t b_t. \tag{14}$$

The last two terms are the tax shields provided by capital depreciation and interest deductibility, respectively.

The firm pays income taxes at the tax rate $\tau_t \in [0, 1)$, but receives an investment tax credit equal to a fraction $\chi_t^i \in [0, 1)$ of its type-i investment expenses, so the tax liability is

$$X_t = \tau_t H_t - \sum_{i=E,S,R} \chi_t^i x_t^i. \tag{15}$$

2.1.5 Optimization problem

The dividend distributed by the firm is obtained by summing revenue and cash flow from financing and subtracting the labor costs, investment expenses, tax liability, and financial distress costs:

$$d_t = y_t - w_t l_t - \sum_{i=E,S,R} x_t^i - X_t + [b_{t+1} + e_{t+1} - (1+r_t)b_t - (1+r_t^e)e_t] - w(\theta_t)a_t. \tag{16}$$

Substituting the expressions for D_t^i, H_t, and X_t from (3), (14), and (15) into (16), we obtain

$$\begin{aligned} d_t &= y_t - w_t l_t - \sum_{i=E,S,R} x_t^i - \tau_t \left(y_t - w_t l_t - \sum_{i=E,S,R} \tilde{\delta}^i \tilde{k}_t^i - \sum_{i=E,S,R} \kappa_t^i x_t^i - \zeta_t R_t b_t \right) + \\ &\quad \sum_{i=E,S,R} \chi_t^i x_t^i + b_{t+1} + e_{t+1} - (1+r_t)b_t - (1+r_t^e)e_t - w(\theta_t)a_t \\ d_t &= (1-\tau_t)(y_t - w_t l_t) - \sum_{i=E,S,R} (1 - \tau_t \kappa_t^i - \chi_t^i) x_t^i + \sum_{i=E,S,R} \tau_t \tilde{\delta}^i \tilde{k}_t^i + b_{t+1} + \\ &\quad e_{t+1} - (1 + r_t - \tau_t \zeta_t R_t) b_t - (1+r_t^e)e_t - w(\theta_t)a_t. \end{aligned}$$

Then, substituting the expressions for y_t, b_t, and e_t from (1), (8), and (9), we obtain

$$\begin{aligned} d_t &= (1-\tau_t)\left[Af\left(k_t^S, k_t^E, k_t^R, l_t\right) - w_t l_t\right] - \sum_{i=E,S,R} (1 - \tau_t \kappa_t^i - \chi_t^i) x_t^i + \sum_{i=E,S,R} \tau_t \tilde{\delta}^i \tilde{k}_t^i + \\ &\quad \theta_{t+1} a_{t+1} + (1-\theta_{t+1}) a_{t+1} - (1 + r_t - \tau_t \zeta_t R_t) \theta_t a_t - (1+r_t^e)(1-\theta_t) a_t - w(\theta_t) a_t \\ d_t &= (1-\tau_t)\left[Af\left(k_t^S, k_t^E, k_t^R, l_t\right) - w_t l_t\right] - \sum_{i=E,S,R} (1 - \tau_t \kappa_t^i - \chi_t^i) x_t^i + \sum_{i=E,S,R} \tau_t \tilde{\delta}^i \tilde{k}_t^i + \\ &\quad a_{t+1} - [1 + \theta_t (r_t - \tau_t \zeta_t R_t) + (1-\theta_t) r_t^e + w(\theta_t)] a_t. \end{aligned} \tag{17}$$

Business owners receive dividends d_t, pay dividend taxes at the rate τ^d, consume c_t, and pay consumption taxes at the rate τ^c:

$$(1+\tau^c)c_t = (1-\tau^d)d_t. \tag{18}$$

Using (17) and (18),

$$\frac{1+\tau^c}{1-\tau^d}c_t = (1-\tau_t)\left[Af\left(k_t^S, k_t^E, k_t^R, l_t\right) - w_t l_t\right] - \sum_{i=E,S,R}(1-\tau_t\kappa_t^i - \chi_t^i)x_t^i + \sum_{i=E,S,R}\tau_t\tilde{\delta}^i\tilde{k}_t^i + a_{t+1} - [1+\theta_t(r_t - \tau_t\zeta_t R_t) + (1-\theta_t)r_t^e + w(\theta_t)]a_t. \tag{19}$$

The intertemporal optimization problem solved by the business owners is

$$\max_{\left\{c_t, l_t, a_{t+1}, \theta_{t+1}, \{x_t^i, k_{t+1}^i, \tilde{k}_{t+1}^i\}_{i=E,S,R}\right\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty}\beta^t u\left(c_t\right) \tag{20}$$

subject to (2), (5), and (19),

given initial values for the state variables $a_0, \theta_0, \{k_0^i, \tilde{k}_0^i\}_{i=E,S,R}$. The utility function $u(c)$ is such that $u'(c) \equiv c^{-\gamma}$, $\gamma > 0$ is the relative risk aversion, $\beta \in (0,1)$ is the discount factor, and E_0 is the expectation operator.

2.1.6 First-order conditions

Let μ_t^i, ν_t^i, and λ_t be the Lagrange multipliers associated with the constraints (2), (5), and (19), respectively. The first-order conditions with respect to c_t, l_t, x_t^i, k_{t+1}^i, $\tilde{k}_{t+1}^i$, a_{t+1}, and θ_{t+1} are, respectively,

$$\beta^t u'\left(c_t\right) = \lambda_t\frac{1+\tau^c}{1-\tau^d} \tag{21}$$

$$A\frac{\partial f(k_t^S, k_t^E, k_t^R, l_t)}{\partial l_t} = w_t \tag{22}$$

$$\lambda_t(1-\tau_t\kappa_t^i - \chi_t^i) = \mu_t^i + \nu_t^i(1-\kappa_t^i) \tag{23}$$

$$\mu_t^i = E_t\left\{\lambda_{t+1}(1-\tau_{t+1})A\frac{\partial f\left(k_{t+1}^S, k_{t+1}^E, k_{t+1}^R, l_{t+1}\right)}{\partial k_{t+1}^i} + \mu_{t+1}^i(1-\delta^i)\right\} \tag{24}$$

$$(1+\pi)\nu_t^i = E_t\left\{\lambda_{t+1}\tau_{t+1}\tilde{\delta}^i + \nu_{t+1}^i(1-\tilde{\delta}^i)\right\} \tag{25}$$

$$\lambda_t = E_t \left\{ \lambda_{t+1} \left[1 + \theta_{t+1}(r_{t+1} - \tau_{t+1}\zeta_{t+1}R_{t+1}) + (1-\theta_{t+1})r^e_{t+1} + w(\theta_{t+1}) \right] \right\} \tag{26}$$

$$0 = E_t \left\{ \lambda_{t+1} \left[r_{t+1} - \tau_{t+1}\zeta_{t+1}R_{t+1} - r^e_{t+1} + w'(\theta_{t+1}) \right] \right\}. \tag{27}$$

The final two conditions capture the trade-offs between the benefits and costs of financing. Condition (26) states that the marginal benefit of raising financial capital equals its marginal cost. On one hand, acquiring one additional unit of financial capital, a_{t+1}, relaxes the current-period budget constraint by one unit. On the other hand, it tightens the next-period budget constraint by $1 + \theta_{t+1}r_{t+1}(1-\tau_{t+1}) + (1 - \theta_{t+1})r^e_{t+1} + w(\theta_{t+1})$ units by raising the after-tax return on financial capital (reduced by the tax shield on debt) and the financial distress costs.

Condition (27) states that the marginal benefit of substituting debt for equity equals the marginal cost. Increasing debt by one unit while simultaneously reducing outside equity by one unit has three effects: It raises the tax shield from interest deductibility by $r_{t+1}\tau_{t+1}$; It raises financial distress costs by $w'(\theta_{t+1})$; And it alters the return paid on financial capital by the spread $r_{t+1} - r^e_{t+1}$.

Note that, in a partial-equilibrium, deterministic version of the model, where r_{t+1} and r^e_{t+1} are held constant, (27) implies that the debt share of financial capital, θ_{t+1}, increases with the tax rate, τ_{t+1}. Intuitively, a higher tax rate raises the value of the interest deductibility tax shield and the tax advantage of debt relative to equity, thereby encouraging firms to substitute debt for equity financing.

2.2 Households

Households consume $\tilde{c}_t$ and pay consumption taxes at the rate τ^c. They receive a constant endowment of goods, y^H, and supply labor, n_t, earning labor income $w_t n_t$ and paying labor income taxes at the rate $\tilde{\tau}$. They lend to the government by purchasing government debt, B_{t+1}, and supply financial capital to firms in the form of debt, b_{t+1}, and equity, e_{t+1}. They receive gross returns on these financial assets from firms and the government. They also receive lump-sum transfers, Z_t, from the government. They pay taxes on interest income at the ordinary income tax rate, $\tilde{\tau}_t$, and on equity returns at the capital income tax rate, τ^e. Their budget constraint is

$$(1+\tau^c)\tilde{c}_t + b_{t+1} + e_{t+1} + B_{t+1} = (1-\tilde{\tau}_t)(y^H + w_t n_t) + [1 + r_t - \tilde{\tau}_t(r_t + \pi)]b_t + \\ [1 + r_t^e - \tau^e(r_t^e + \pi)]e_t + [1 + r_t^B - \tilde{\tau}_t(r_t^B + \pi)]B_t + Z_t. \tag{28}$$

The households' optimization problem is

$$\max_{\{\tilde{c}_t, n_t, e_{t+1}, b_{t+1}, B_{t+1}\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \tilde{\beta}^t [u(\tilde{c}_t) - v(n_t)] \tag{29}$$

subject to (28),

where the utility function $u(\tilde{c})$ is the same as the one for firm owners, $v(n) \equiv \Phi n^{1+1/\varphi}$, $\Phi > 0$, $\varphi > 0$, and $\tilde{\beta} > 0$.

The first-order conditions are

$$\frac{v'(n_t)}{u'(\tilde{c}_t)} = \frac{1-\tilde{\tau}_t}{1+\tau^c} w_t \tag{30}$$

$$1 = E_t \left\{ \frac{\tilde{\beta} u'(\tilde{c}_{t+1})}{u'(\tilde{c}_t)} [1 + r_{t+1} - \tilde{\tau}_{t+1}(r_{t+1} + \pi)] \right\} \tag{31}$$

$$1 = E_t \left\{ \frac{\tilde{\beta} u'(\tilde{c}_{t+1})}{u'(\tilde{c}_t)} \left[1 + r_{t+1}^e - \tau^e(r_{t+1}^e + \pi)\right] \right\} \tag{32}$$

$$1 = E_t \left\{ \frac{\tilde{\beta} u'(\tilde{c}_{t+1})}{u'(\tilde{c}_t)} \left[1 + r_{t+1}^B - \tilde{\tau}_{t+1}(r_{t+1}^B + \pi)\right] \right\}. \tag{33}$$

2.3 Government

The government receives a constant endowment of goods, y^G, issues debt, B_{t+1}, and collects tax revenue, T_t, from households and firms:

$$T_t \equiv X_t + \tilde{\tau}_t(y^H + w_t n_t + r_t b_t + r_t^B B_t) + \tau^e r_t^e e_t + \tau^d d_t + \tau^c(c_t + \tilde{c}_t). \tag{34}$$

It uses the proceeds to finance government spending, G, distribute lump-sum transfers to households, Z_t, and repay the gross-of-interest debt held by households:

$$G + Z_t + (1 + r_t^B)B_t = y^G + T_t + B_{t+1}. \tag{35}$$

I assume that the lump-sum transfers, Z_t, adjust over time to ensure that government debt is stationary and an equilibrium exists:

$$Z_t = Z - \lambda(B_t - B) \tag{36}$$

where $\lambda > 0$. Not only is this assumption necessary for the existence of equilibrium, but it also serves to capture potential cuts to mandatory spending programs, such as Social Security, Medicare, and Medicaid, that may be implemented in response to rising government debt. As long as an equilibrium exists, the timing of the adjustment in Z_t affects only the path of government debt and, indirectly, tax revenue since tax revenue depends on the tax on government debt interest payments. The timing does not affect the dynamics of other variables, as households hold all government debt and Ricardian equivalence holds.

2.4 Equilibrium conditions

Let

$$C_t \equiv c_t + \tilde{c}_t \tag{37}$$

be aggregate private consumption, the sum of consumption of business owners and households, and let

$$Y_t \equiv y_t + y^H + y^G \tag{38}$$

be GDP, the sum of the output of businesses, households, and the government.

The equilibrium condition in the goods market equates the sum of private and public consumption, investment, and financial distress costs to GDP, while the equilibrium condition in the labor market equates labor demand with labor supply:

$$C_t + G + x_t + w(\theta_t)a_t = Y_t \tag{39}$$

$$l_t = n_t. \tag{40}$$

2.5 Parameters and steady-state values

The model's parameters and steady-state values are reported in Table 1. The calibration procedure follows, in part, Occhino (2023a, 2023b), with updates to target the year 2023 instead of 2017. In particular, the policy parameters differ to reflect changes introduced by the 2017 tax reform, which reduced the income tax rates for households and businesses beginning in 2018, required the amortization of R&D expenses over five years starting in 2022, and limited the deductibility of interest expenses to 30% of earnings before interest and taxes (EBIT), also starting in 2022.

A few standard parameters are set in line with the literature. The model period is one year. The steady-state real interest rate and inflation rate are $r = 0.04$ and $\pi = 0.02$. Given r, π, and the tax rates, the preferences discount factors of households and business owners, $\tilde{\beta}$ and β, are set to satisfy the steady-state first-order conditions. The relative risk aversion is $\gamma = 2$. The Frisch elasticity of labor supply is $\varphi = 0.5$, and the utility-function parameter Φ is calibrated so that $l = 1/3$ in the steady state.

The steady-state level of GDP is normalized to $Y = 1$. The parameter A is calibrated so that $y = 0.77$, and the remaining production parameters are set to $y^H = 0.125$ and $y^G = 0.105$, to match the gross value added shares of the business (77 percent), private-nonbusiness (12.5 percent), and government (10.5 percent) sectors (BEA, National Income and Product Accounts, Table 1.3.5).

The economic depreciation rates are set to $\delta^E = 0.14$, $\delta^S = 0.035$, and $\delta^R = 0.22$, consistent with the 2023 BEA estimates of the average age of private capital (7.1 years for equipment, 28.8 years for structures, and 4.5 years for R&D; BEA, Fixed Assets Accounts, Table 2.9).

To calibrate the α^i parameters of the production function, I use the firms' first-order conditions (21) and (23)-(26) together with the tax policy parameters, to derive the steady-state marginal product of type-i capital, $MPK^i \equiv A\partial f\left(k^E, k^S, k^R, l\right)/\partial k^i$, for $i = E, S, R$. Also,

$$MPK^i \equiv A\frac{\partial f\left(k^E, k^S, k^R, l\right)}{\partial k^i} = \alpha^i \frac{y}{k^i} = \alpha^i \frac{y\delta^i}{x^i} \qquad \text{for } i = E, S, R,$$

where the last step uses the steady-state relationship $x^i = \delta^i k^i$. It follows that

$$\alpha^i = \frac{MPK^i}{\delta^i}\frac{x^i}{y} \qquad\qquad \text{for } i = E, S, R.$$

I set the investment-output ratios to $x^E/y = 0.084$ for equipment and software, $x^S/y = 0.074$ for structures, and $x^R/y = 0.029$ for R&D, matching the 2023 ratios of private fixed investment to private (business and nonbusiness) output, (BEA, Fixed Assets Accounts, Table 2.7, and National Income and Product Accounts, Table 1.3.5). These ratios and the previously determined values for MPK^i and δ^i yield $\alpha^E = 0.103$, $\alpha^S = 0.154$, and $\alpha^R = 0.032$.

The business income tax rate is set to match the statutory corporate tax rate, $\tau = 0.21$. The ordinary income tax rate is $\tilde{\tau} = 0.28$, consistent with the effective marginal federal tax rate on labor income estimated by CBO (2018, Table B-1). The capital income tax rate is $\tau^e = 0.15$, matching the long-term capital gains tax rate for the median taxpayer. The dividend tax rate is $\tau^d = 0.15$, matching the rate on qualified dividends for the median taxpayer. The consumption tax rate is $\tau^c = 0.06$, consistent with the median state sales tax rate.

The expensing fractions for structures and R&D are set to zero, $\kappa^S = 0$ and $\kappa^R = 0$. The expensing fraction for equipment and software has varied substantially over time. Before the 2017 tax reform, 50 percent of investment expenses in equipment and software could be immediately deducted under bonus depreciation. The bonus depreciation was raised to 100 percent in 2018, but has been reduced by 20 percentage points per year since 2023. Congress recently raised it to 100 percent permanently. I set $\kappa^E = 0.75$ to target the average bonus depreciation over 2013-2022.

The tax depreciation rates for equipment and structures are set to twice their respective economic depreciation rates, $\tilde{\delta}^E = 2\delta^E$ and $\tilde{\delta}^S = 2\delta^S$, to reflect the fact that most businesses use accelerated depreciation (double-declining balance method, switching to straight-line method when depreciation deductions are maximized). R&D expenses must be amortized over five years, implying a half-life of 2.5 years. Accordingly, the tax depreciation rate for R&D is set to $\tilde{\delta}^R = 1/2.5 = 0.4$.

The investment tax credit fraction for R&D, $\chi^R = 0.06$, captures the Research and Experimentation Tax Credit, which is approximately 6 percent of R&D investment expenses (Office of Tax Analysis 2016 and Barro and Furman 2018). The other investment tax credit fractions are set to zero, $\chi^E = 0$ and $\chi^S = 0$.

Regarding the interest deductibility fraction, ζ, Barro and Furman (2018, pp. 275-276) assume that the limit on interest deductibility introduced by the 2017 tax reform has constrained investment for 15 percent of firms since 2022. Motivated by their assumption, I approximate this limit by setting $\zeta = 1 - 0.15 = 0.85$.

The parameters set so far determine the present discounted value of the firm, V, which equals the sum of debt and total equity: $b + E = V$. To set the individual values of b and E, note that corporate debt was 23 percent of corporate equity in 2023 (Debt as a Percentage of the Market Value of Corporate Equities, Nonfinancial Corporate Business, Federal Reserve via FRED). Accordingly, I set $b/E = 0.23$. From the last two relationships,

$$E = \frac{1}{1 + 0.23}V$$
$$b = \frac{0.23}{1 + 0.23}V.$$

I set the share of outside equity equal to 50 percent of total equity:

$$\omega \equiv e/E = 0.5.$$

This parameter choice affects the distribution of aggregate consumption between households and business owners: The household consumption share, $\tilde{c}/C$, increases as ω rises. However, as shown in Section 3.7, this parameter has only a very small effect on the model's results. Given b and e, I compute financial capital as $a \equiv b + e$, and the debt share of financial capital as $\theta \equiv b/a$.

Regarding the financial distress cost exponent, ψ, de Mooij (2011) estimates that a one percentage point increase in the corporate tax rate raises the debt-asset ratio by between 0.17 and 0.28 percentage points. These estimates imply a value of ψ between 0.073 and 0.121, as I show in Appendix A, so I use the midpoint, $\psi = 0.097$. I will also examine the case where the debt share is constant and does not respond to tax rate changes ($\psi \to 0$) and the case of unit elasticity ($\psi = 1$). The financial distress cost scale parameter, Ψ, is set to satisfy the firm's first-order condition (27). With this setting, steady-state financial distress costs equal $w(\theta)a = 0.00004$.

Government spending, $G = 0.17$, equals 17 percent of GDP (BEA, National Income and Product Accounts, Table 1.1.5). Government lump-sum transfers, Z, are calibrated so that government debt, $B = 0.93$, equals 93 percent of GDP, matching federal debt held by the public as a percentage of GDP (U.S. Office of Management and Budget via FRED). The responsiveness of lump-sum transfers to government debt is set equal to the interest rate on government debt, $\lambda = r^B$.

As a result of the calibration, aggregate consumption, investment, and capital are 68.6 percent, 14.4 percent, and 219.2 percent of GDP, respectively. The steady-state consumption levels of households and business owners are $\tilde{c} = 0.662$ and $c = 0.024$, respectively.

3 Results

The tax reform consists of increases in investment expensing fractions, a reduction in the R&D tax credit, and the elimination of interest deductibility for newly issued debt. In this section, we first examine the macroeconomic effects of these policy changes individually. We then assess the combined impact of the tax reform, followed by an analysis of a modified reform that retains the R&D tax credit. Finally, we consider the effects of increases in business and labor taxes and conduct sensitivity analysis.[5]

[5]The model is solved using Dynare, employing a first-order linear approximation and Klein's QZ decomposition method).

3.1 Effects of expensing fractions

The solid line in Figure 1 displays the effects of a permanent 100-percentage point increase in the expensing fraction for investment in E$S ($\kappa_t^E$). In all figures, the responses of x_t^i, x_t, k_t^i, k_t, w_t, C_t, l_t, y_t, a_t, $\tilde{k}_t$, and B_t are expressed as ratios to their respective steady-state values, so that they can be interpreted as percentage responses to a one-percentage point tax cut. The responses of all other variables are reported in levels.

An increase in the expensing fraction reduces the METR and stimulates investment in equipment and software (E&S). Investment in E&S rises by 28 percent in the first year and by 4.5 percent afterwards. The stock of E&S remains 4 percent above steady state persistently. Investment in structures decreases in the first year, as firms substitute E&S for structures, but recovers after the first year. All types of capital rise in the long run.

Aggregate investment is 2.8 percent higher after ten years, and the capital stock remains above its steady-state level in the long run. The larger capital stock raises the marginal product of labor, which boosts labor demand and the wage rate.

The increase in investment demand pushes up the intertemporal price of goods and the interest rate, discouraging consumption and encouraging labor supply. With higher capital and labor, business output expands to meet the greater investment demand. Business output rises by 0.5 percent after ten years.

Increased expensing generates large decreases in the business tax liability in the initial years. The effect diminishes over time, as tax capital falls and lowers tax depreciation. The decline in the tax liability reduces the business demand for financial capital.

Government tax revenue falls by less than the decline in business tax liability because the revenue from other taxes rises as the economy expands. Nonetheless, the fall in tax revenue causes government debt to increase by 5 percent after ten years, requiring a reduction in transfers to households equivalent to 0.2 percent of GDP.

The dashed and dotted lines in Figure 1 show the effects of 100-percentage-point increases in the expensing fractions for investment in structures (κ_t^S) and in R&D (κ_t^R), respectively.

Intuitively, increasing the expensing fraction for structures (/R&D) stimulates investment in that specific type of capital, but discourages investment in the other two types in the first year. The effects on the other macroeconomic variables are qualitatively similar to those observed when the expensing fraction for E&S is increased. The magnitude of the effects differs because each type of capital contributes differently to production. In the case of structures, financial capital rises following the increase in the expensing fraction because the additional funding needs created by higher investment demand are only partially met by the reduction in the business tax liability.

3.2 Effects of tax credits

The solid line in Figure 2 displays the effects of a permanent 100-percentage-point increase in the tax credit for investment in E&S (χ_t^E). When interpreting the size of the effects, it should be noted that the increase is unrealistically large, as tax credits typically change by only a few percentage points.

The effects and intuition are qualitatively similar to those of an increase in the expensing fraction. One difference is that tax capital tends to rise as investment increases in response to higher tax credit, whereas it declines when the investment expensing fraction is increased.

The effects of a tax credit increase are greater than those of an expensing fraction increase, as the tax credit reduces the METR to a greater extent. After ten years, business output and investment rise by 17 percent and 87 percent, respectively, while they rise by 0.5 percent and 2.8 percent, respectively, in the case of an expensing fraction increase.

The dashed and dotted lines in Figure 2 show the effects of 100-percentage-point increases in the tax credits for investment in structures (χ_t^S) and R&D (χ_t^R), respectively. The effects and intuition are qualitatively similar to those of increases in the expensing fractions, but they are much larger quantitatively. Specifically, the tax credit effects on business output and investment are an order of magnitude greater than the expensing fraction effects.

3.3 Effects of interest deductibility

The solid line in Figure 3 displays the effects of eliminating interest deductibility for *newly issued* debt.

Since interest payments remain deductible for previously issued debt, the fraction of total interest payments that can be deducted, ζ_t, declines gradually over time as older debt matures:

$$\zeta_t = \zeta(1-\rho)^{t-1} \qquad\qquad \text{for } t \geq 1,$$

where ζ is the steady-state value, $\rho \in (0,1)$ is the decay rate, and $t = 1$ indicates the first year of the tax reform. To calibrate the decay rate, note that in 2022 loans and bonds accounted for 62 and 38 percent of outstanding corporate liabilities, respectively, with average maturities of 4.16 and 8.38 years (Boyarchenko and Elias 2024). These figures imply an average maturity of business debt of $0.62 \times 4.16 + 0.38 \times 8.38 = 5.76$ years, which corresponds to a decay rate of $\rho = 1/5.76 = 0.174$.

The decline in the interest deductibility fraction increases the METR and lowers investment in all types of capital. Aggregate investment is 6 percent lower after ten years, and capital remains persistently below its steady-state level. The decrease in investment demand reduces the intertemporal price of goods and the interest rate, thereby encouraging household consumption and discouraging labor supply. With lower capital and labor, output falls. Output is 0.9 percent lower after ten years.

The decline in investment demand reduces firms' demand for financial capital. As interest expenses become less deductible over time, the tax advantage of debt decreases, leading businesses to substitute equity for debt and lower the debt share of financial capital.

The business tax liability rises over time because interest expenses on newly issued debt are no longer deductible, and newly issued debt gradually accounts for a larger share of total debt. Government tax revenue rises by less then the business tax liability because the revenue from other taxes declines as the economy contracts. Because of the increased government tax revenue, government debt falls by 1.9 percent after ten years, permitting an increase in transfers to households.

An alternative option would be to eliminate interest deductibility not only for newly issued debt but also for previously issued debt. The dashed line in Figure 3 shows the effects of eliminating interest deductibility for all debt ($\zeta_t = 0$, for all $t \geq 1$.) The effects are similar to those of eliminating deductibility only for newly issued debt, but they are generally larger and more front-loaded. The main drawback of this option is its potential difficulty of implementation, as it requires retroactively changing the deductibility rules for previously issued debt.

3.4 Effects of the tax reform

The tax reform consists of four policy changes. First, it raises the expensing fraction for investment in E&S by 25 percentage points, from 75 percent to full expensing. Second, it increases the expensing fraction for investment in structures and R&D by 100 percentage points, from zero to full expensing. Third, it decreases the tax credit for investment in R&D by 6 percentage points, from 6 percent to zero. Finally, it removes the deductibility of interest on *newly issued* business debt.

Because of linearity, the total effect of the tax reform equals the weighted sum of the effects of its components: 25 percent of the solid line in Figure 1 (E&S expensing increase); 100 percent of the dashed and dotted lines in Figure 1 (structures and R&D expensing increases); −6 percent of the dotted line in Figure 2 (R&D tax credit elimination); 100 percent of the solid line in Figure 3 (interest deductibility elimination for new debt). The resulting total effect is shown by the solid line in Figure 4.

The tax reform benefits structures the most and R&D the least. The expensing fraction rises by 25 pp for E&S and by 100 pp for structures and R&D, but the R&D tax credit is eliminated. As a result, investment in structures surges 48 percent in the first year, while investments in E&S and R&D fall by 13 percent and 32 percent, respectively, as businesses substitute structures for other types of capital. After ten years, investment in structures remains 8 percent above steady state, whereas investment in R&D stays 6 percent below. In the long run, the stocks of E&S and structures increase, but R&D declines. Overall, aggregate investment rises 8 percent in the first year and 2 percent after ten years.

The increased investment demand pushes up the intertemporal price of goods and the interest rate, dampening consumption but stimulating households' labor supply. With greater capital and labor inputs, business output rises by 0.5 percent in the first year and 0.3 percent after ten years.

The debt share falls by 17 percentage points after ten years because of the removal of interest deductibility. This debt reduction may lower firms' riskiness and help mitigate the financial distortions associated with debt financing. For example, Karpavičius and Yu (2016) find that eliminating interest deductibility leads to less-levered, less-risky firms in a calibrated dynamic stochastic partial-equilibrium model.

The higher investment expensing fractions lower both the business tax liability and government tax revenue in the early years. Over time, however, these effects reverse as the stock of tax capital and associated tax depreciation deductions decrease, and a smaller share of total interest expenses remains deductible.

Government debt peaks at 10 percent above its steady-state level after 15 years before beginning to decline. Such an increase in government debt could create financial stress in the initial years, particularly in periods of already elevated debt-to-GDP ratios. Over the long run, however, tax revenue remains above its steady-state level, driving government debt below steady state after 50 years (not shown).

The tax reform's benefit for economic efficiency can be assessed using the steady-state METRs at the business and total levels. The *business METR* accounts only for tax provisions that apply at the business level, while the *total METR* also incorporates taxes paid by financial investors (households in this model). Investor-level taxes vary widely depending on whether the investor is domestic or foreign, and whether the asset is held short-term, long-term, or until the investor's death. See CBO (2014, Appendix A, page 29) for a discussion of the difference between business and total METRs.

The steady-state business METR for each type of investment $i = E, S, R$ is defined as

$$\text{Business METR}^i \equiv \frac{r^{i,BT} - r^{AT}}{r^{i,BT}},$$
$$\text{where } r^{i,BT} \equiv MPK^i - \delta^i,$$
$$r^{AT} \equiv \frac{1}{\beta} - 1.$$

Here, $r^{i,BT}$ and r^{AT} are the before-tax and after-tax rates of return on type-i investment, respectively, and MPK^i is the marginal product of type-i capital.

Before the tax reform, the business METRs for investment in E&S, structures, and R&D are 0.054, 0.194, and -0.608 (a 60.8 percent subsidy), respectively. The METR for E&S is lower than for structures because its higher expensing fraction reduces the tax burden. The METR for R&D is negative because of the benefit provided by the tax credit.

After the tax reform, the steady-state business METRs are zero for all investment types. In other words, when investment expensing fractions are set to 100 percent, investment tax credits are eliminated, and interest expenses are non-deductible, the business tax becomes neutral. With the METR equalized across all types of investment, capital is allocated efficiently.

The steady-state total METR is defined like the business METR, except the after-tax rate of return on type-i investment incorporates households' taxes on interest and equity returns:

$$\text{Total METR}^i \equiv \frac{r^{i,BT} - \tilde{r}^{AT}}{r^{i,BT}},$$
$$\text{where } r^{i,BT} \equiv MPK^i - \delta^i$$
$$\tilde{r}^{AT} \equiv \theta[(1-\tilde{\tau})r - \tilde{\tau}\pi] + (1-\theta)[(1-\tau^e)r^e - \tau^e\pi] = 1/\tilde{\beta} - 1.$$

Because the investor-level taxes reduce the after-tax return, the total METR is higher than the business METR.

Before the tax reform, the total METRs for investment in E&S, structures, and R&D are 0.278, 0.385, and −0.228, respectively. After the tax reform, the steady-state total METRs converge to 0.307 for all investment types, ensuring efficient capital allocation. However, because these total METRs remain positive, the consumption-investment margin is still distorted. The total METRs would fall to zero and the distortion would be eliminated if households' taxes on interest and equity returns, $\tilde{\tau}$ and τ^e, were also set to zero.

Overall, the tax reform delivers broad benefits to the economy. It boosts investment and output in the short run, and raises capital stock and the wage rate in the long run. By equalizing METRs across investment types, it promotes an efficient allocation of capital. While it increases government debt over the first decades, it ultimately reduces debt below its steady-state level in the long run.

3.5 Effects of the modified tax reform

One effect of the baseline tax reform that could be more detrimental than the model suggests is the elimination of the R&D tax credit. Without this credit, R&D investment falls, reducing the long-run stock of R&D. Given the central role of R&D in fostering innovation, technological progress, and economic growth, policymakers might prefer to retain the credit. The dashed line in Figure 4 illustrates the effects of a modified tax reform that is identical to the baseline except that it preserves the R&D tax credit.

Since the modified tax reform both increases the expensing fraction and preserves the tax credit, R&D investment rises immediately and remains above its steady-state level, leading to a higher long-run R&D capital stock. The modified reform stimulates aggregate investment and output more than the baseline. However, by maintaining the tax credit, it further reduces the business tax liability and government tax revenue, resulting in a greater increase in government debt. The other macroeconomic effects remain similar to those of the baseline.

After the modified tax reform, the steady-state business METRs for investment in E&S and structures fall to zero, as in the baseline case, while the METR for R&D drops to -1.355, reflecting the combined effect of full expensing and the preserved tax credit. The steady-state total METRs for E&S, structures, and R&D are 0.307, 0.307, and -0.633, respectively. Thus, the modified reform maintains neutrality between E&S and structures while providing a substantial subsidy to R&D investment.

3.6 Effects of business and labor taxes

Since the tax reform raises government debt, policymakers may want to accompany it with an increase in other taxes. The solid line in Figure 5 shows the effects of a unit (100 percentage points) increase in the business tax rate, τ_t. The aid interpretation, I describe the results in terms of a 1 percentage point increase.

The tax increase lowers investment in structures but raises investment in E&S and R&D in the first period. As shown in Occhino (2023a), a higher business income tax rate discourages investment when the expensing fraction is low (as for structures). However, it stimulates investment when the expensing fraction is high, because the higher tax rate significantly increases the value of the tax deduction (as for E&S). Similarly, a business tax increase discourages investment when the tax credit is low, but stimulates it when the tax credit is high (as for R&D).

Aggregate investment falls by 0.5 percent in the initial year and remains persistently below its steady-state level. The weaker investment demand lowers the intertemporal price of goods and the real interest rate, which in turn discourages labor supply. Business output is 0.1 percent lower after ten years.

The decline in investment demand reduces the business demand for financial capital. Also, the tax hike increases the tax advantage of debt, prompting firms to substitute debt for equity and raising the debt share. The business tax liability and government tax revenue increase, causing government debt to fall by 0.6 percent after ten years. This implies that a very large increase in the business tax rate would be required to offset the short-term fiscal cost of the tax reform. For example, a 15-percentage-point increase in the business tax rate would be needed to offset the government debt increased generated by the tax reform after ten years.

The dashed line in Figure 5 displays the effects of a unit (100 percentage point) increase in the labor tax rate $\tilde{\tau}_t$.

A 1 percentage point increase in the labor tax rate reduces investment, labor, and output more than an equivalent increase in the business tax rate. Output falls by 0.3 percent in the first year and 0.4 percent after ten years. The rise in tax revenue is larger, leading to a greater reduction in government debt. In fact, an increase of just 3 percentage points in the labor tax rate would fully offset the rise in government debt generated by the tax reform.

3.7 Sensitivity

Figure 6 summarizes the model's sensitivity to the non-standard parameters and to the assumption regarding the financing of the tax reform.

The model's results are sensitive to the debt share of financial capital, θ (first row of Figure 6). When the debt share is high, eliminating interest deductibility substantially increases the METR and business tax liability, producing a large contractionary effect on investment and output. Consequently, a higher θ, implies a greater business tax liability, a lower path for government debt, and smaller expansionary effects on investment and output. When $\theta = 0.4$, business output shows little response to the tax reform beyond the initial period.

The results are not highly sensitive to the share of outside equity, ω (second row of Figure 6). This parameter has a limited role because it affects only the budget constraints of households and firms, without altering the first-order or equilibrium conditions. When ω increases from 10 to 90 percent, the output effect decreases by only 0.3 percentage points after ten years.

The financial distress cost exponent, ψ, governs the extent to which businesses substitute debt for equity financing as the tax advantage of debt increases. To see it, substitute $w'(\theta_{t+1}) = \Psi(1+1/\psi)\theta_{t+1}^{1/\psi}$ in the first-order condition (27) to obtain

$$0 = E_t \left\{ \lambda_{t+1} \left[r_{t+1} - \tau_{t+1}\zeta_{t+1}R_{t+1} - r^e_{t+1} + \Psi(1+1/\psi)\theta_{t+1}^{1/\psi} \right] \right\}.$$

Under simplifying partial-equilibrium assumptions, businesses increase the debt share of financial capital, θ_{t+1}, in response to a rise in $\tau_{t+1}\zeta_{t+1}R_{t+1}$. The larger the financial distress cost exponent, ψ, the greater the increase in θ_{t+1}. When the tax reform eliminates interest deductibility, the interest deductibility fraction, ζ_{t+1}, and the tax advantage of debt decline, prompting firms to substitute equity for debt and reduce θ. When ψ is higher, businesses substitute more equity for debt, resulting in larger increases in business tax liability and government tax revenue, a lower path for government debt, and smaller expansionary effects of the tax reform (third row of Figure 6).

The model's results are highly sensitive to the interest deductibility fraction, ζ (fourth row of Figure 6). Eliminating interest deductibility has contractionary effects. The larger the interest deductibility fraction, ζ, the stronger the contractionary effects of this provision and the smaller the overall expansionary effects of the tax reform. An increase of 15 percentage points in ζ reduces the output effect by 0.2 percentage points after ten years. At the same time, a higher ζ means that eliminating interest deductibility generates more government revenue, shifting the government debt path downward.

The effects of eliminating interest deductibility depend to some extent on the interest deductibility decay rate, ρ (fifth row of Figure 6). A higher ρ implies a faster phase-out of interest deductibility and, consequently, a more contractionary impact of the provision. When $\rho = 1$, so deductibility is eliminated immediately, the output effect is 0.2 percentage points smaller after ten years. At the same time, a higher decay rate accelerates the elimination of interest deductibility, increases government tax revenue, and shifts the government debt path downward.

The timing of lump-sum government transfers to households affects only government debt because of Ricardian equivalence. Consequently, the transfer response rate to government debt, λ, affects only the path of government debt, and does not affect other model results. A higher λ leads to larger transfer cuts and a lower path for government debt (sixth row of Figure 6).

The sensitivity of the model's results to other, more standard parameters is in line with other calibrated dynamic general equilibrium models. For example, the results depend intuitively on the Frisch elasticity of labor supply, φ. A higher Frisch elasticity increases the responsiveness of labor supply to the tax reform, leading to larger increases in output and investment (seventh row of Figure 6).

The model's results are largely insensitive to the assumption regarding the financing of the tax reform (last row of Figure 6). In the baseline case, $\mathcal{I} = 0$, the government stabilizes debt by reducing lump-sum transfers to households, implying that the tax reform is implicitly financed by households. In the alternative case, $\mathcal{I} = 1$, the reform is financed through lump-sum taxes on businesses: the reduction in business tax liability generated by the reform is rebated to the government in a lump sum manner each period. Relative to $\mathcal{I} = 0$, the $\mathcal{I} = 1$ scenario redistributes wealth from businesses to households. This wealth effect increases household consumption and leisure, reduces labor supply, and leads to a small decline in output. However, the difference in output responses between the two cases is minimal—only 0.1 percentage point after ten years.

4 Conclusion

This paper has analyzed the macroeconomic effects of a tax reform that allows immediate expensing of investment while eliminating investment tax credits and interest deductibility. The reform offers several economic benefits. It equalizes the METR across all types of investment, thereby promoting a more efficient allocation of capital. It also has stimulative effects on investment and output: aggregate investment and business output rise by 8 percent and 0.5 percent, respectively, in the first year, and by 2 percent and 0.4 percent after ten years.

The main drawback of the reform is that it generates fiscal deficits in the early years, leading to a 10 percent increase in government debt after 15 years. Modestly increasing the business income tax rate would be insufficient to offset the rise in debt. In contrast, raising the labor income tax rate by three percentage points would be enough to prevent the government debt from increasing. Importantly, however, the reform produces fiscal surpluses in the long run, so that government debt eventually falls below its initial steady-state level.

Another drawback of the reform is that eliminating the investment tax credit discourages R&D investment, leading to a 6 percent reduction in the long-run stock of R&D. A modified version of the reform that retains the R&D tax credit would result in a higher government debt path, but would increase the long-run stock of R&D by 2 percent.

A Calibration of ψ

The steady-state firm's first-order condition (27) is

$$\begin{aligned}
w'(\theta) &= \tau\zeta R + r^e - r \\
\Psi(1+1/\psi)\theta^{1/\psi} &= \tau\zeta R + r^e - r \\
\log\left(\Psi(1+1/\psi)\theta^{1/\psi}\right) &= \log\left(\tau\zeta R + r^e - r\right) \\
\log\left(\Psi(1+1/\psi)\right) + (1/\psi)\log(\theta) &= \log\left(\tau\zeta R + r^e - r\right) \\
\psi\log\left(\Psi(1+1/\psi)\right) + \log(\theta) &= \psi\log\left(\tau\zeta R + r^e - r\right).
\end{aligned}$$

Holding R, r^e, and r constant,

$$\Delta \log(\theta) = \psi \Delta \log\left(\tau\zeta R + r^e - r\right)$$

$$\Delta \log(\theta) \approx \psi \frac{\zeta R}{\tau\zeta R + r^e - r} \Delta\tau \tag{41}$$

for $\Delta\tau$ small.

Also,

$$\log(\theta) \equiv \log\left(\frac{b}{b+e}\right) = \log\left(\frac{b}{b+\omega E}\right) = -\log\left(\frac{b+\omega E}{b}\right) = -\log\left(1+\frac{\omega E}{b}\right)$$
$$\approx -\omega\frac{E}{b} = -\omega\frac{E+b-b}{b} = -\omega\left(\frac{E+b}{b}-1\right) = -\omega\left(\frac{V}{b}-1\right).$$

Then,

$$\Delta \log(\theta) \approx -\omega\Delta\left(V/b\right)$$

$$\Delta \log(\theta) \approx \omega\frac{\Delta\left(b/V\right)}{\left(b/V\right)^2} \tag{42}$$

where the last step uses the first-order approximation $\Delta(1/x) \approx -\Delta x/x^2$, for $x = b/V$.

Using (41) and (42),

$$\psi\frac{\zeta R}{\tau\zeta R + r^e - r}\Delta\tau \approx \omega\frac{\Delta\left(b/V\right)}{\left(b/V\right)^2}$$

$$\psi \approx \omega\,\frac{\tau\zeta R + r^e - r}{\zeta R\left(b/V\right)^2}\,\frac{\Delta\left(b/V\right)}{\Delta\tau}$$

$$\psi \approx 0.43\frac{\Delta\left(b/V\right)}{\Delta\tau} \tag{43}$$

where the last step evaluates the expression using the parameter and steady-state values: $\omega = 0.5$, $\tau = 0.21$, $\zeta = 0.85$, $R = 0.06$, $r^e = 0.031$, $r = 0.04$, and $b/V = 0.187$.

de Mooij (2011) estimates that a one-percentage-point increase in the corporate tax rate raises the debt-asset ratio by between 0.17 and 0.28 percentage points, i.e., $\Delta(b/V)/\Delta\tau \in [0.17, 0.28]$. Substituting these estimates into (43) gives

$$\psi \in [0.43 \times 0.17, 0.43 \times 0.28] = [0.073, 0.121], \tag{44}$$

with a midpoint value of $\psi = 0.097$.

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	Description	Value	Targeted moments and notes
r	real interest rate	0.04	
π	inflation rate	0.02	
β	bus. owner pref. discount factor	0.971	implied by r, π, and tax rates
$\tilde{\beta}$	household pref. discount factor	0.977	implied by r, π, and tax rates
γ	relative risk aversion	2	
φ	Frisch elasticity of labor supply	0.5	
Φ	labor disutility parameter	22.96	$l = n = 1/3$
w	real wage rate	1.644	
r^e	real equity return rate	0.031	implied by r, π, and tax rates
α^E	production function exponent of E&S	0.103	E&S investment-output ratio, x^E/y
α^S	production function exponent of Struct	0.154	Struct investment-output ratio, x^S/y
α^R	production function exponent of R&D	0.032	R&D investment-output ratio, x^R/y
δ^E	economic depreciation rate of E&S	0.14	E&S average age
δ^S	economic depreciation rate of Struct	0.035	Struct average age
δ^R	economic depreciation rate of R&D	0.22	R&D average age
Y	GDP	1	
A	production function scale	1.342	GDP share of bus. output, $y/Y = 0.77$
y^H	household endowment	0.125	GDP share of private non-bus. output
y^G	govt. endowment	0.105	GDP share of govt. output
τ	bus. income tax rate	0.21	corporate tax rate
$\tilde{\tau}$	ordinary income tax rate	0.28	effective marginal labor tax rate
τ^e	capital income tax rate	0.15	capital gain tax rate
τ^d	dividend tax rate	0.15	dividend tax rate
τ^c	consumption tax rate	0.06	sales tax rate
κ^E	investment expensing fraction for E&S	0.75	average 2013-2022 bonus depreciation
κ^S	investment expensing fraction for Struct	0	
κ^R	investment expensing fraction for R&D	0	
$\tilde{\delta}^E$	tax depreciation rate for E&S	0.28	accelerated depreciation, $\tilde{\delta}^E = 2\delta^E$
$\tilde{\delta}^S$	tax depreciation rate for Struct	0.07	accelerated depreciation, $\tilde{\delta}^S = 2\delta^S$
$\tilde{\delta}^R$	tax depreciation rate for R&D	0.4	5-year amortization of R&D expenses
χ^E	investment tax credit fraction for E&S	0	
χ^S	investment tax credit fraction for Struct	0	
χ^R	investment tax credit fraction for R&D	0.06	R&D tax credit
ζ	interest deductibility fraction	0.85	deduction limited to 30% of EBIT
ρ	interest deductibility decay rate	0.174	corporate debt average maturity
H	bus. taxable income	0.077	
X	bus. tax liability	0.015	
T	govt. tax revenue	0.266	
V	firm value	1.635	
θ	debt share of financial capital	0.315	
ω	ratio of outside equity to total equity	0.5	
b	debt	0.306	corporate debt-equity ratio
e	outside equity	0.665	
a	financial capital	0.971	
E	total equity	1.33	
ψ	financial distress cost exponent	0.097	response of debt-asset ratio to τ
Ψ	financial distress cost scale	20.11	
G	govt. spending	0.17	GDP share of govt. spending
Z	govt. lump-sum transfers	0.164	govt. debt-to-GDP ratio, $B/Y = 0.93$
λ	lump-sum transfers response	0.04	$\lambda = r$
C	aggregate consumption	0.686	
x	investment	0.144	
k	economic capital	2.192	
$\tilde{k}$	tax capital	0.74	

Table 1: Parameters and steady-state values. *Note: The length of a period is 1 year.*

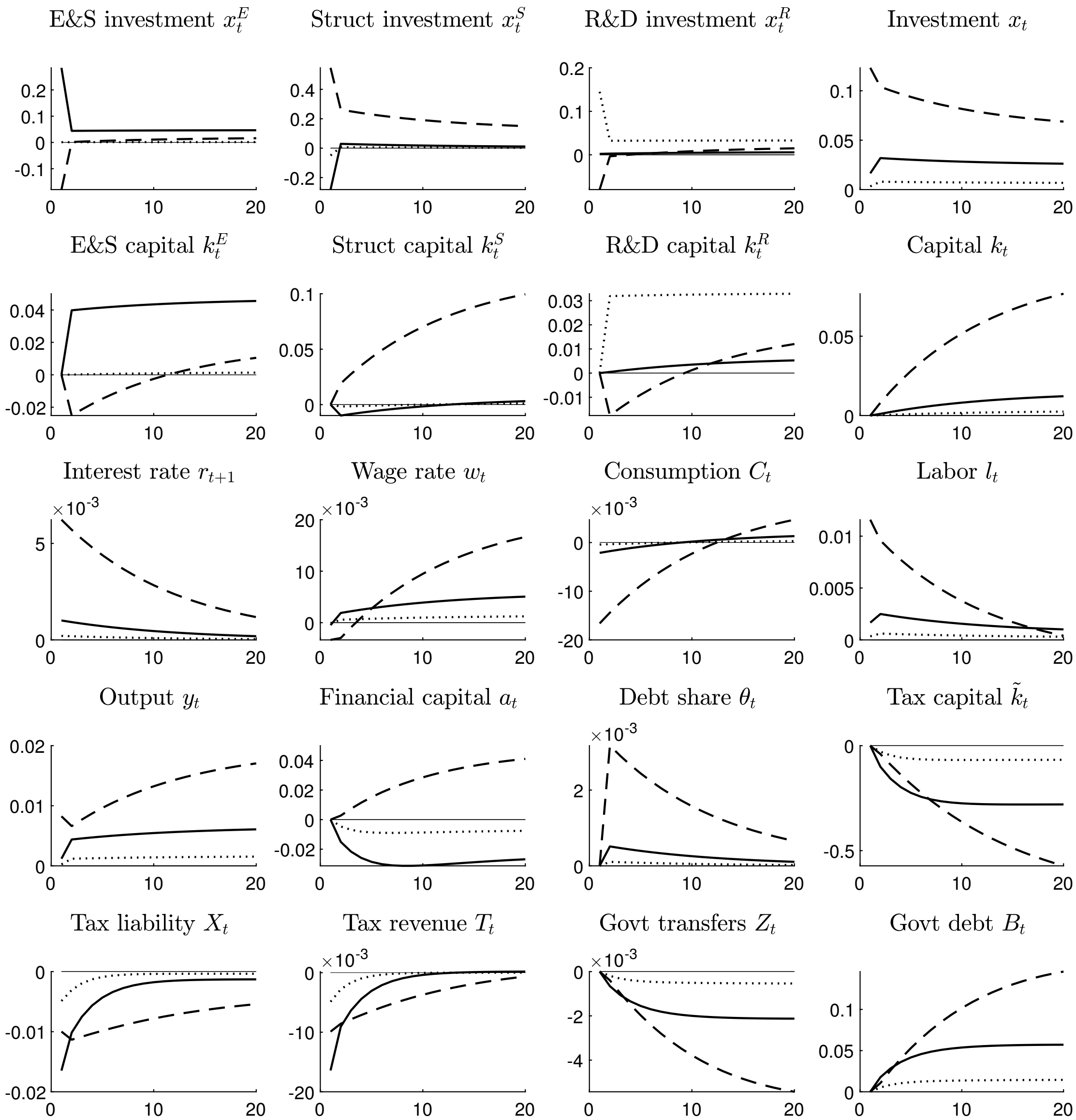

Figure 1: Effect of investment expensing fractions, κ_t^i. The solid, dashed, and dotted lines show the effect of a 100 percentage point increase in the expensing fraction for investment in equipment and software (E&S), structures, and R&D, respectively.

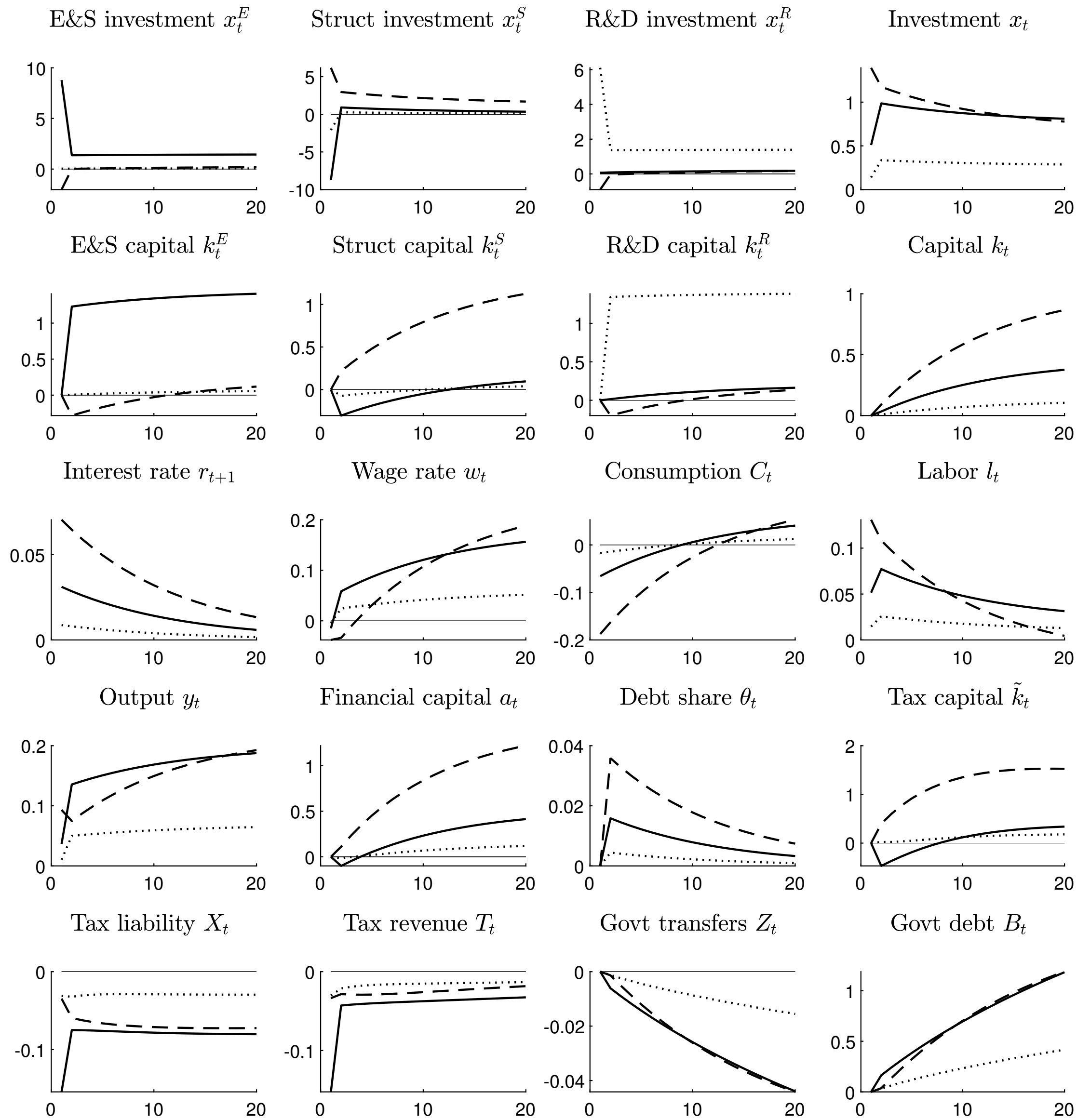

Figure 2: Effect of investment tax credits, χ_t^i. The solid, dashed, and dotted lines show the effect of a 100 percentage point increase in the tax credit for investment in equipment and software (E&S), structures, and R&D, respectively.

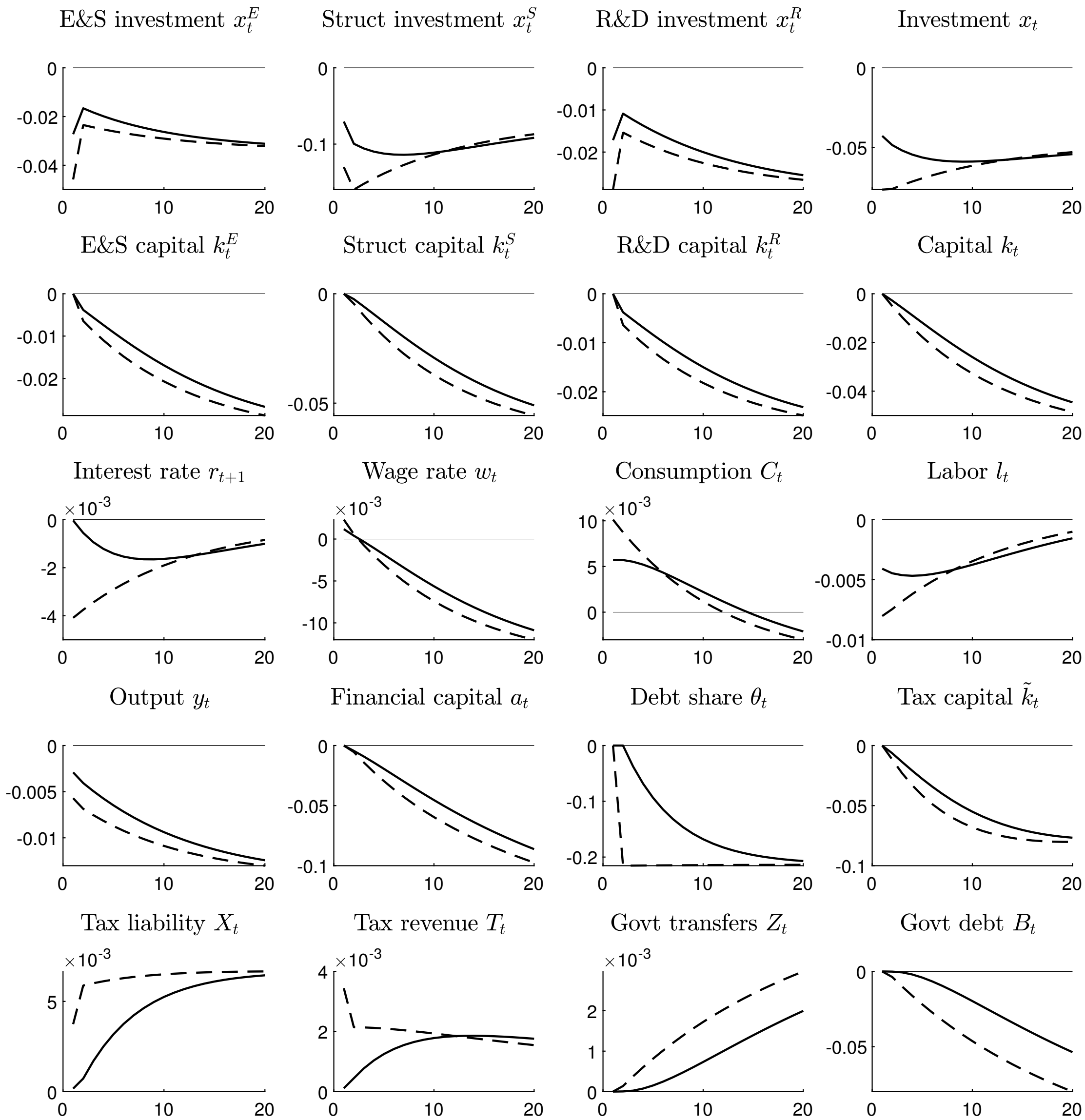

Figure 3: Effect of eliminating interest deductibility, ζ_t. The solid and dashed lines show the effect of eliminating interest deductibility for newly issued debt and for all debt, respectively.

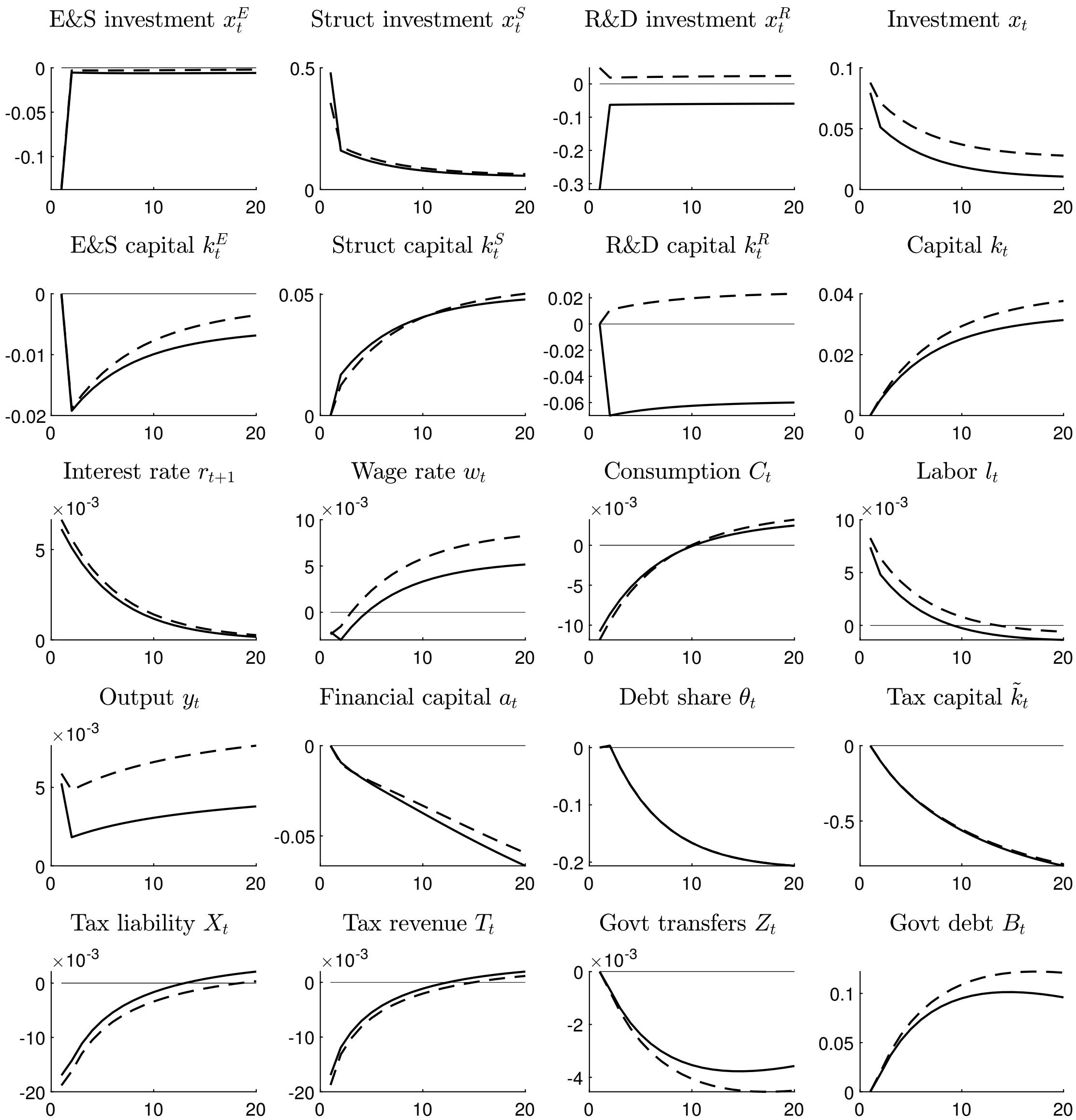

Figure 4: Effect of the tax reform. The solid line shows the effect of a tax reform that allows immediate investment expensing while eliminating tax credits and interest deductibility for newly issued debt. The dashed line shows the effect of a modified tax reform that maintains the R&D tax credit.

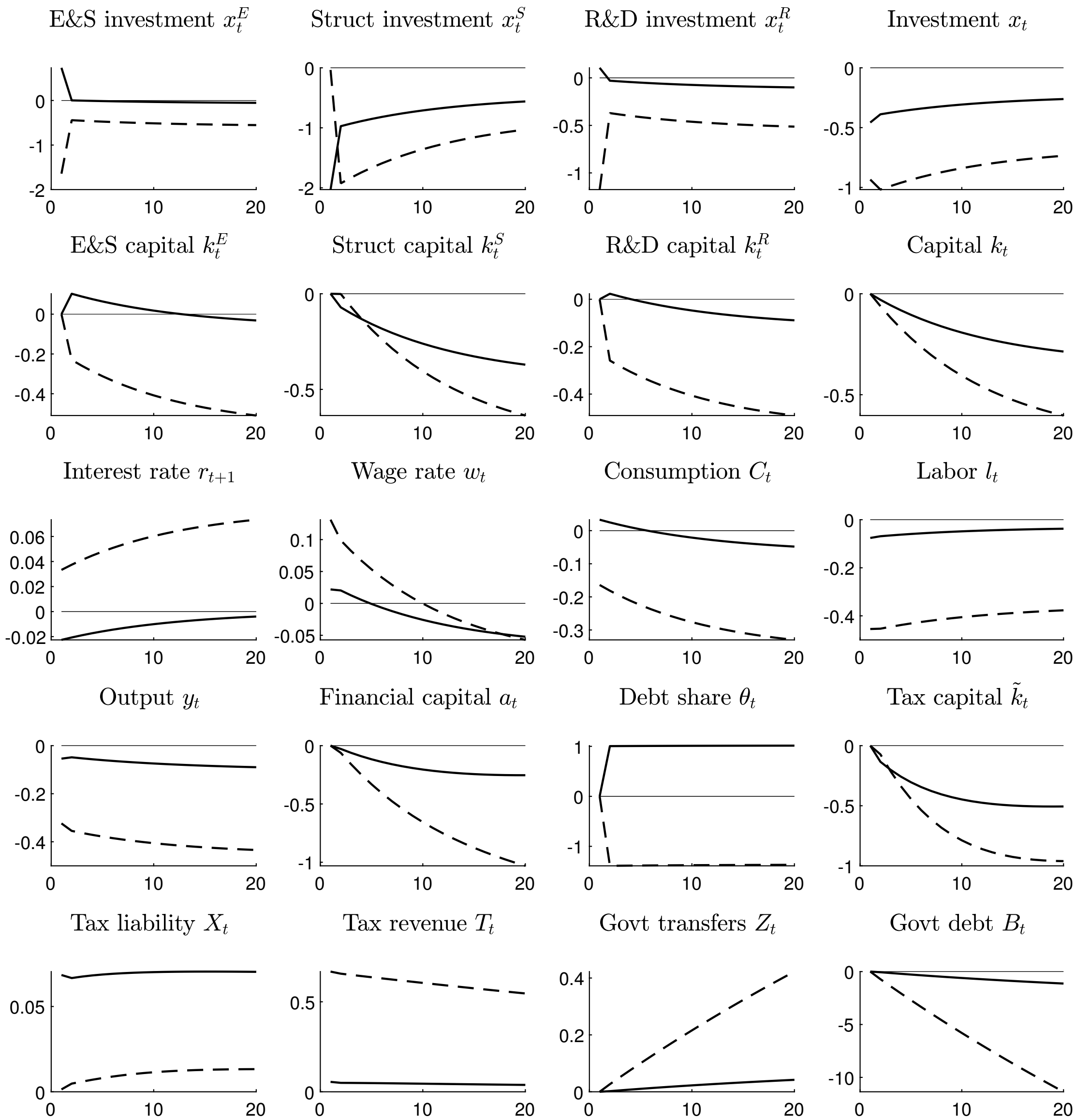

Figure 5: Effect of business and labor income taxes, τ_t and $\tilde{\tau}_t$. The solid and dashed lines show the effect of a 100 percentage point increase in the tax rate on business and labor income, respectively.

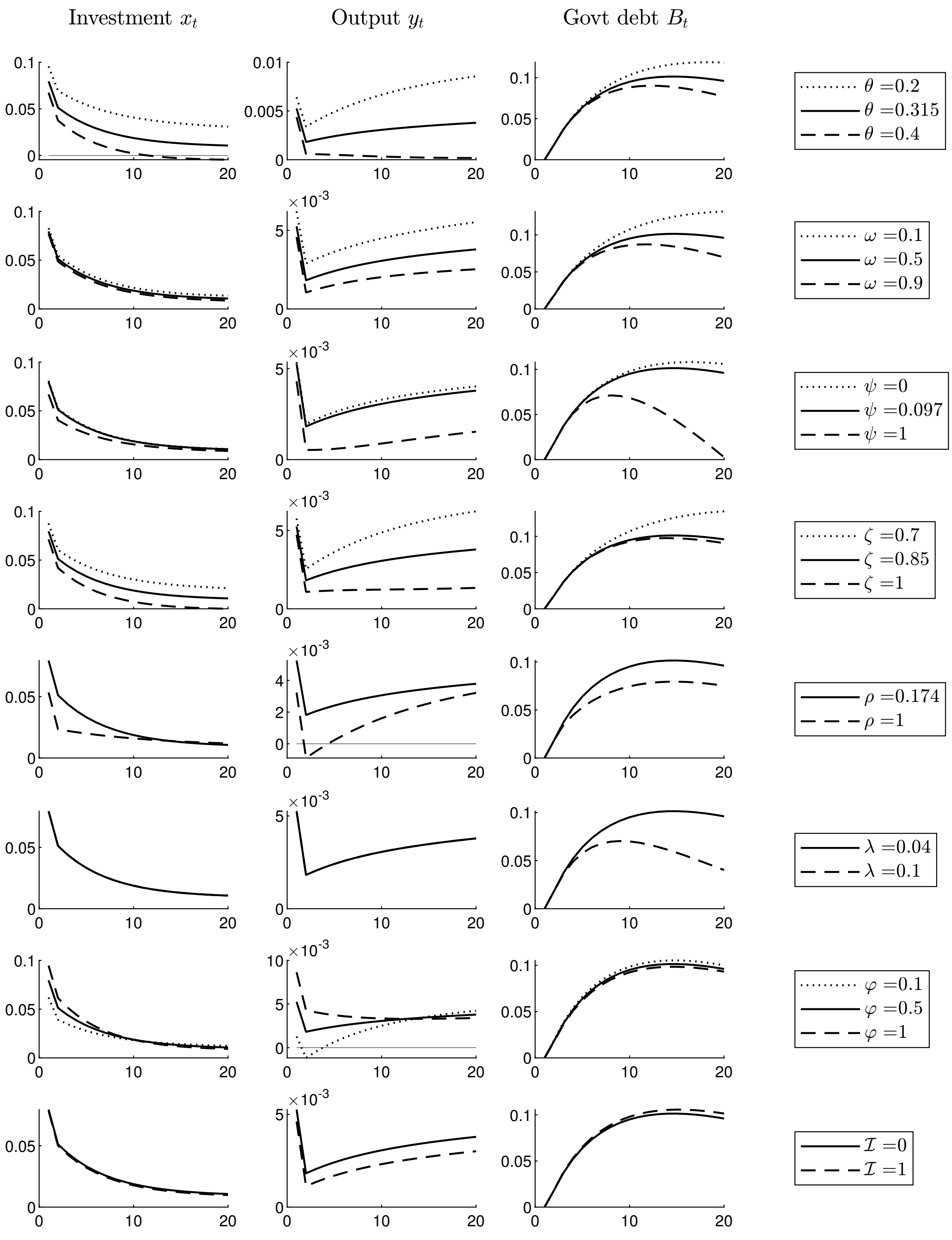

Figure 6: Parameter sensitivity. Parameters are set at their benchmark values, except where otherwise indicated in the legend.