# Tax Policy and Investment in a Global Economy*

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**Abstract**

This paper combines administrative tax data and a model of global investment behavior to evaluate the investment and firm valuation effects of the Tax Cuts and Jobs Act (TCJA) of 2017, the largest corporate tax reduction in the history of the United States. We extend the canonical model of Hall and Jorgenson (1967) to a multinational setting in which a firm produces in domestic and international locations. We use the model to characterize and measure four determinants of domestic investment: domestic and foreign marginal tax rates and cost-of-capital subsidies. We estimate elasticities of domestic investment with respect to each and use them to identify the structural parameters of our model, to quantify which parts of the reform mattered most to investment, and to conduct policy counterfactuals. We have five main findings. First, the TCJA caused domestic investment of firms with the mean tax change to increase by roughly 20% relative to firms experiencing no tax change. Second, the TCJA created large incentives for some U.S. multinationals to increase foreign capital, which rose substantially following the law change. Third, domestic investment also increases in response to foreign incentives, indicating complementarity between domestic and foreign capital in production. Fourth, the general equilibrium long-run effects of the TCJA on the domestic and total capital of U.S. firms are around 6% and 9%, respectively. Finally, in our model, the dynamic labor and corporate tax revenue feedback in the first 10 years is less than 2% of baseline corporate revenue, as investment growth causes both higher labor tax revenues from wage growth and offsetting corporate revenue declines from more depreciation deductions. Consequently, the fall in total corporate tax revenue from the tax cut is close to the static effect.

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# 1 Introduction

The Tax Cuts and Jobs Act (TCJA) of 2017 was the largest corporate tax reduction in the history of the United States.[1] It lowered statutory corporate tax rates from 35% to 21%, changed a host of investment incentives, and fundamentally altered the treatment of international income. Collectively, these corporate tax changes were scored to reduce corporate tax revenue by $100 to $150 billion dollars per year (JCT, 2017; CBO, 2018). Yet, both at the time of passage and in its aftermath, economists have not reached consensus on even ballpark estimates of its effects on investment (Barro and Furman, 2018; Auerbach, 2018; Council of Economic Advisers, 2019; Gale and Haldeman, 2021) or whether it would pay for itself (Goodspeed and Hassett, 2022).

This paper uses confidential, firm-level tax returns together with a model of global investment behavior to evaluate the effects of the TCJA corporate tax provisions on domestic and foreign investment, capital, and tax receipts. We have five main findings. First, the main domestic provisions—the reduction in the corporate rate and full expensing of investment—stimulated investment in tangible capital within the range of earlier estimates but at the lower end. The TCJA caused domestic investment of firms with the mean tax change to increase by roughly 20% relative to firms experiencing no tax change. Second, novel international tax provisions, which were designed to on-shore reporting of income from intangible capital, also created an incentive for some U.S. multinationals to increase their foreign tangible capital. Third, we estimate within-firm complementarity between foreign and domestic capital, as the international tax provisions also stimulated *domestic* investment. Fourth, using our general equilibrium model, the long-run effects of the TCJA on the domestic and total capital of U.S. corporations are around 6% and 9%, respectively. Finally, the total effect on corporate tax revenue is close to the mechanical effect, because higher depreciation deductions offset additional labor and corporate tax revenue from capital accumulation.

We begin by developing a model of firm investment behavior to structure the empirical analysis. Each firm operates domestic and possibly foreign production lines using domestic and foreign capital, which may be either complements or substitutes in production, along with labor and materials. Firms make standard investment decisions, taking account of the tax code. Specifically, a firm pays a rate $\tau$ on domestic source income and $\bar{\tau}$ on foreign source income and receives an investment subsidy $\Gamma$ on domestic investment and $\bar{\Gamma}$ on foreign investment. The domestic terms $\tau$ and $\Gamma$ incorporate TCJA changes to the corporate tax rate and expensing of

[1] The official name of the act is given in 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." It was originally called the "Tax Cuts and Jobs Act," but this title was changed for procedural reasons.

investment and collapse to the workhorse Hall and Jorgenson (1967) framework for domestic-only firms. The foreign tax terms allow the model to also accommodate the novel, more opaque changes to the international tax regime. We linearize the model across steady-states to derive an estimating equation that characterizes the investment elasticity to the TCJA changes to $\tau, \Gamma, \bar{\tau}$, and $\bar{\Gamma}$ as a function of the ratio of pre-TCJA foreign-to-domestic capital and four key structural parameters $\alpha, \sigma, a$, and $\bar{a}$ that together govern the returns-to-scale in capital, the elasticity of substitution between domestic and foreign capital, and the relative importance of each source of capital in local profits.

Our data set consists of a representative panel of C-corporation tax returns from the U.S. Treasury. We measure firm-level empirical counterparts to each of $\tau, \Gamma, \bar{\tau}, \bar{\Gamma}$. The domestic rate $\tau$ falls mainly because of the reduction in the statutory corporate rate from 35% to 21%. However, this change has heterogeneous impact across firms depending on their likelihood of having positive taxable income and their use of deductions and credits. Building on Auerbach (1983), Shevlin (1990), and Graham (1996), we use pre-TCJA firm-specific income dynamics to simulate taxable income trajectories for each firm. We extend this work by incorporating firm-specific use of deductions, credits, and the cap on total General Business Credits (GBCs). We construct new firm-level marginal effective tax rates (METRs) with and without TCJA as the additional present value of taxes paid when taxable income in a year rises by a marginal amount, taking account of the change in the statutory rate, new rules on loss carrybacks and carryforwards, and the repeal of the Domestic Production Activities Deduction (DPAD) and Alternative Minimum Tax (AMT).

The domestic investment subsidy $\Gamma$ increases mainly because of the change to full expensing of equipment. The impact of this change also varies across firms, depending on the normal tax depreciation schedule of its investment mix as well as on whether the firm's pre-TCJA investment fell below the Section 179 limit. In addition to modeling these provisions, we also incorporate the TCJA's Foreign Deemed Intangible Income (FDII) deduction, which reduces a firm's domestic tax on the export share of income exceeding 10% of its domestic tangible assets. We show that FDII effectively reduces $\tau$ and $\Gamma$ for firms subject to it.

We incorporate two main foreign provisions in TCJA. First, TCJA moved the U.S. from a global system in which a U.S. corporation would eventually have to pay taxes on all foreign source income to a territorial system that applies the U.S. corporate rate only to domestic source income. Second, in an effort to discourage location of intangible capital abroad, the TCJA introduced a domestic tax on deemed Global Intangible Low-Taxed Income (GILTI), which requires firms to pay U.S. taxes on foreign income exceeding 10% of foreign tangible capital when such income would otherwise be taxed at a low enough rate. We show that GILTI effectively increases $\bar{\tau}$ and $\bar{\Gamma}$ for firms subject to it.

We estimate the tax elasticities using the model structure and our measurement of tax shocks in the cross-section of firms. We regress the log change in firm-level domestic investment on the four tax policy changes $\tau, \Gamma, \bar{\tau}$, and $\bar{\Gamma}$. Among firms that operate only domestically, we find elasticities to the domestic tax terms in line with earlier literature (see Zwick and Mahon (2017) for a list of estimates). Firms with international operations likewise respond to the domestic tax terms. In addition, their domestic investment responds positively to the effective foreign subsidy $\bar{\Gamma}$. Our theory interprets this response as evidence of complementarity between domestic and foreign capital; the GILTI tax incentivizes firms to increase foreign capital, which in turn causes domestic capital to increase when domestic and foreign capital are complements in production. We report several robustness exercises that address particular concerns with the specification, such as testing for pretrends; including detailed industry fixed effects; or controls for the "trade war," firm size bins, or lagged investment.

The estimated elasticities provide moments to identify the structural parameters of our model. For the domestic-only firms, the theory dictates that the coefficients on $\tau$ and $\Gamma$ have opposite signs of equal magnitude, each of which equals the inverse of $1-\alpha$. We therefore obtain the scale parameter for these firms using the coefficient from this restricted regression. For multinational firms, the target moments include the regression coefficients as well as the pre-TCJA ratios of foreign-to-domestic capital and profits. We provide analytic expressions showing that these moments (together with an adjustment cost term that we calibrate externally) jointly identify the structural parameters. The estimated parameters have reasonable values: $\alpha$ ranges from 0.54 to 0.73, indicating substantial concavity in the production function, $\sigma$ falls slightly below 1 to ensure sufficient complementarity between local and foreign capital, and $a$ implies that domestic earnings depend overwhelmingly on domestic rather than foreign capital. As validation, we show that in both the data and the estimated model that U.S. multinational firms subject to GILTI increase their foreign capital in the first two years following the law change by an additional 10-14%.

We use the estimated model to quantify the response of corporate capital in general equilibrium when aggregate labor remains fixed and wages rise, to disentangle which parts of the reform mattered most to investment, and to assess the revenue consequences. As a starting point, we first provide a "model-free" quantification of the effect on corporate capital in partial equilibrium. To do so, we form several "portfolios" of firms based on their domestic/multinational status and pre and post-TCJA tax rates. We then use the regression coefficients and initial capital levels directly to compute fitted values of the change in capital in each portfolio due to TCJA. This exercise suggests a long-run increase in domestic corporate capital of 15%. However, it is partial equilibrium in the sense that the fitted values omit the regression constant term and hence omit any effects of other changes such as in wages that affect all firms. We perform the same partial equilibrium exercise in the model and obtain a partial equilibrium increase in capital of 12%.

The first main quantitative result from the model is a general equilibrium long-run increase in domestic corporate capital of 7.4%. To compute the general equilibrium increase, we solve jointly for the change in capital in each portfolio of firms and a representative non-C-corporate sector holding aggregate labor fixed, which results in a rise in the wage of roughly 0.9% as the capital stock increases. The 95% confidence interval taking account of the estimation uncertainty around the parameters excludes an increase in capital of less than 2.6% or greater than 12.2%. Total capital owned by domestic firms rises by proportionately more than domestic capital, primarily due to the strong incentive in the GILTI rule for firms to accumulate foreign capital.

Our second quantitative result evaluates the impact of several major provisions in isolation. The changes to the METR by themselves deliver an increase in capital of about 3.5% after 15 years. Of course, these changes also cost the most in terms of revenue. The expensing provisions and GILTI on their own increase capital by about 2% and 1.5%, respectively. We also show that phase-out of expensing has relatively small short-run effects on capital accumulation but substantially lowers the long-run level.

The third main quantiative model result is to estimate the tax revenue consequences of the dynamic changes in capital induced by the reform.[2] Corporate tax revenues fall initially due to increased adjustment costs and larger depreciation deductions. Over time, higher profits from capital accumulation offset these forces. However, because the negative revenue impact of higher depreciation deductions persists, total dynamic corporate revenue effects are substantially negative over the first 10 years and never exceed 5% of pre-TCJA revenue. We provide an envelope argument intuition for why even the long-run dynamic revenue effects remain small. Labor tax revenues also increase since the wage bill depends on the capital stock and generate additional revenue of nearly 15% of pre-TCJA corporate tax revenue by year 10. Taken together, the dynamic labor and corporate tax revenue feedback in the first 10 years is less than 2% of baseline corporate revenue. Thus, in the medium term, the fall in total corporate tax revenue from the tax cut is close to the static effect.

[2]This exercise is not intended to serve as a formal dynamic score of the reform because we leave unmodeled several response margins and components of the reform (e.g., the individual tax provisions).

Finally, we provide auxiliary validation of these results. Since our primary empirical approach compares highly-exposed to less-exposed firms within the United States, we also validate our investment findings using an alternative approach with a non-US-based comparison group. We synthetically match publicly-traded U.S. firms to similar foreign firms using Compustat data and compare the evolution of investment before and after the TCJA. For each U.S. firm in Compustat, we obtain a firm-specific synthetic counterfactual as a weighted average of foreign firms and then aggregate across all firms and by industry. Investment at publicly-traded U.S. firms increased by around 15% relative to the control group in the first two years after the reform. This magnitude is smaller than but inside the confidence interval of the change in global investment by U.S. corporations in our estimated model and could reflect differences in measurement of M&A activity in Compustat. We corroborate the synthetic control results in several ways: backdating, using Canadian firms and the same method in a placebo analysis, leaving out groups of foreign countries from the set of comparison countries, and controlling directly for contemporaneous tariff shocks in the manufacturing sector.

**Related literature.** We provide new estimates of the effects of the largest corporate tax cut in U.S. history. Due to its size and prominence, an early literature reported expected effects using calibrated models (Barro and Furman, 2018; Slemrod, 2018; Gale, Gelfond, Krupkin, Mazur and Toder, 2019; Clausing, 2020). Garcia-Bernardo, Janský and Zucman (2022) use aggregate data and public filings to study the effect on profit shifting.[3] Our measurement of the TCJA firm-level shocks using Treasury tax returns, including specific forms that identify which firms deduct FDII or pay GILTI, allows us to link these provisions to firm real outcomes. Earlier analysis of investment outcomes comes from Kennedy, Dobridge, Landefeld and Mortenson (2022), who exploit the variation in the domestic corporate rate cut across C-corporations and S-corporations of similar size. We estimate investment effects that are quite close to theirs, despite using a different sample of firms and different tax rate variation.[4]

Our paper broadens this literature in three ways. First, we focus our analysis on a sample of large firms, including the multinational corporations exposed to the novel tax policy provisions

[3] Our paper is not centrally concerned with profit shifting or the impact of the reform on this behavior. Nevertheless, we use theoretical extensions to clarify when profit shifting motives might interact with the firm's real investment decisions. We also confirm our main results are not driven by the small number of firms who are likely active profit shifters. Our findings complement recent work more focused on the real implications of profit shifting, e.g., JC's new paper.

[4] Though they focus on wage outcomes along the income distribution, in a regression of investment relative to lagged capital on the log of the net-of-tax rate, they find a coefficient of 0.52. Our closest specification is in table 6, which shows a coefficient for domestic firms of 0.49 and a coefficient of 0.50 on the analogous tax term for multinational firms.

targeting foreign and intangible income. Second, we meticulously measure for each firm the impact of the key provisions of the TCJA on foreign and domestic tax rates and the cost of capital. We also integrate these different policy instruments into our structural model. Third, we deploy a structural model to analyze long-run responses to the reform, aggregate effects in general equilibrium, and policy counterfactuals.

We contribute to the theoretical and empirical literature on tax policy and investment behavior.[5] We develop a structural model with multinational production and estimate the model's parameters. The overall profits elasticity of capital appears in the canonical Hall and Jorgenson (1967) framework and links our results to evaluations of past corporate tax policy changes. Our estimates fall within the range of past work but at the lower end.[6] The parameters governing the relationship between domestic and foreign capital within a firm have less antecedent, although this parameter matters centrally to international tax policy (Costinot and Werning, 2019). Desai, Foley and Hines Jr (2009) and Becker and Riedel (2012) are important exceptions and like us find evidence of complementarity.

Our quantitative model enables an analysis of policy counterfactuals. Indeed, many of the provisions of TCJA remain contested in the political arena. We decompose the effect of the reform into its constituent parts, such as expensing, lower rates, and international provisions. Future research can use our estimates to consider alternative policy proposals.

# 2 Policy Background

## 2.1 Motivation for the TCJA

The primary goal of the TCJA's corporate provisions was to increase U.S. competitiveness and investment by bringing rates more in line with international levels. Specifically, policymakers argued that the U.S. corporate tax system was not internationally competitive in terms of statutory tax rates and its worldwide rather than territorial structure (Council of Economic Advisers,

[5] This literature includes Hall and Jorgenson (1967); Summers (1981); Feldstein (1982); Poterba and Summers (1983); Auerbach and Hassett (1992); Cummins, Hassett and Hubbard (1994, 1996); Hines (1996); Chirinko, Fazzari and Meyer (1999); Devereux and Griffith (2003); Desai and Goolsbee (2004); House and Shapiro (2008); Edgerton (2010); Dharmapala, Foley and Forbes (2011); Yagan (2015); Zwick and Mahon (2017); Ohrn (2018); Giroud and Rauh (2019); Suárez Serrato (2018); Bilicka (2019); Curtis, Garrett, Ohrn, Roberts and Suárez Serrato (2021); Akcigit, Grigsby, Nicholas and Stantcheva (2021); Moon (2022).

[6] Hassett and Hubbard (2002) propose a consensus range of 0.5 to 1 for regressions of investment relative to capital on the tax term. In analogous specifications, we estimate coefficients of 0.42 (s.e.=0.08) and 0.61 (s.e.=0.15) for domestic and multinational firms, respectively. In Appendix A.9, we show how this specification relates to our model parameters.

2018). These concerns came against the backdrop of sluggish domestic investment (Gutiérrez and Philippon, 2017; Alexander and Eberly, 2018) and deepening cross-border investment.

Figure 1 uses aggregates from our tax return data (described in detail in section 4) and Compustat to contextualize the reform. The figure shows consistent series of domestic and global capital accumulation, investment, revenue, and cash holdings by U.S. publicly-traded firms from 1967-2019. Until the early 1990s, U.S. firms had very little foreign investment or capital. Since that time, most of the growth in global capital by U.S. public firms has occurred abroad. This pattern along with high foreign profits and cash holdings also led to concerns about profit-shifting. The international focus of TCJA differs from earlier corporate tax changes in the U.S. that occurred before the period of deep globalization and that have shaped much of our understanding of the investment effects of tax policy.

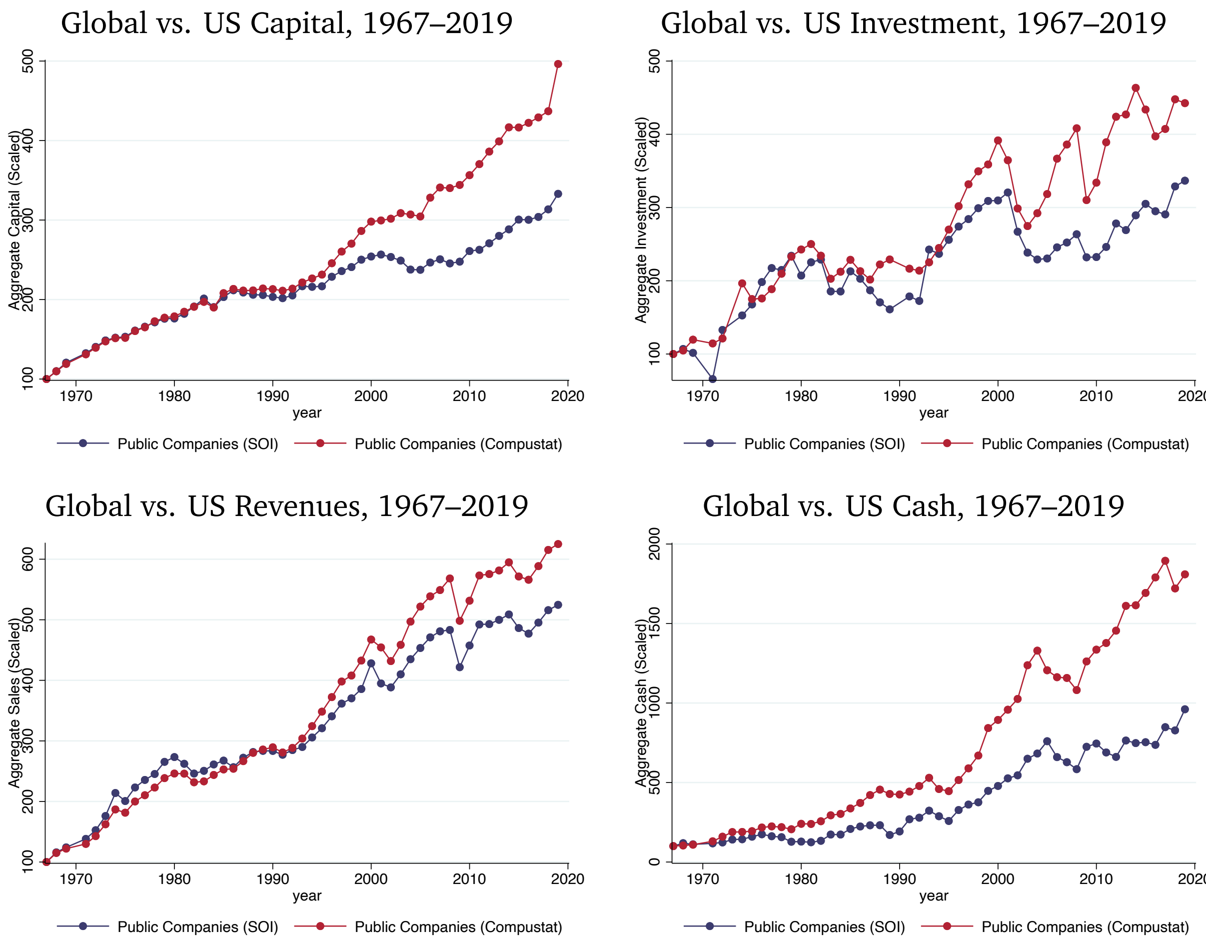
## 2.2 Main Corporate Provisions of the TCJA

In our model, tax policy affects firm investment through changing the marginal effective tax rate (METR) on corporate profits and the tax term in the cost of capital. Table 1 lists the major provisions affecting these components for either domestic or foreign activity. The last column shows the estimated 10-year tax revenue estimate from the Joint Committee on Taxation (JCT, 2017). These "static" estimates include some behavioral responses, such as income shifting between tax bases or changes in tax credit takeup, but they assume no effect of the TCJA on the aggregate capital stock. In section 7 we assess the effect of the dynamic changes in capital on revenue.

The most important provision for the domestic METR was the reduction in the statutory top corporate tax rate for C-corporations from 35% to 21%. Of course, for many firms the METR differs from the statutory rate because of credits or deductions that make taxable income negative or otherwise modify the effective rate. The TCJA also changed some of these provisions, including removing the ability of firms to carry back net operating losses (NOLs) to offset previous years' taxes, limiting the deduction from carrying forward previous years' NOLs to 80% of taxable income, repealing the Domestic Production Activity Deduction (DPAD), which had reduced METRs for qualifying firms, especially in the manufacturing sector, and repealing the corporate Alternative Minimum Tax (AMT). Furthermore, the relevance of the statutory rate reduction for the METR depends on pre-TCJA behavior, because firms without taxable income (perhaps due to high use of deductions and credits) or those facing binding limits on credit usage do not face the statutory rate and hence do not experience the full rate reduction.[7] Our

[7]A firm without taxable income can still have a positive METR if the firm expects to pay taxes in the future,

Figure 1: Increasingly Global Investment




*Notes:* These figures use merged Compustat–SOI datasets to plot aggregates for domestic variables versus global variables for firms we are able to merge each year. We use the following Compustat variables for global measures: PPENT for capital, CAPX for investment, SALE for revenues, and CHE+IVAO for cash. Pre-1993 SOI investment only includes ITC-eligible basis, understating the divergence in the figure. The last year of Compustat PPENT includes capitalized operating leases per a change in accounting rules, which explains the jump in that series.

measurement of METRs in section 4 accounts for all of these features.

The TCJA made two changes that implicate the domestic effective cost of capital. The first directly targets the cost of capital by allowing firms to immediately expense equipment investment. The second occurs through a new deduction for Foreign Derived Intangible Income (FDII). This provision allows firms to deduct from domestic income 37.5% of the component deemed due to domestic intangible capital and sold abroad. The deduction is implemented

because of loss carryforwards. The leading example of binding credit usage concerns General Business Credits (GBCs), which are limited to 75% of taxable income. A firm for which this limit always binds has an effective marginal tax rate equal to 25% of the statutory marginal rate.

Table 1: Main Provisions of the TCJA Affecting Investment

| Provision | Pre-TCJA | Post-TCJA | Cost |
|---|---|---|---|
| **Domestic Provisions** | | | |
| 1. Top corporate rate | 35% | 21% | −1.35T |
| 2. Accelerated depreciation | 50% bonus | Full expensing for 5 years, then phase-out | −86B |
| 3. Domestic Production Activities Deduction (DPAD) | 9% of qualified production activity income | None | +98B |
| 4. Alternative Minimum Tax | Applicable if mean revenues >\$7.5M | None | −40B |
| 5. Foreign-Derived Intangible Income (FDII) | None | 37.5% deduction on export share of deemed intangible income | −64B |
| 6. Net operating losses | 2 year carryback + carryforward | No carryback and limited to 80% of income | +201B |
| **Foreign Provisions** | | | |
| 1. Foreign subsidiary income | Taxable when repatriated | Not taxed | −224B |
| 2. Global Intangible Low Tax Income (GILTI) | None | Minimum tax of 10.5% on foreign deemed intangible income | +112B |
| Total | | | −1.35T |

*Notes:* The table describes the main provisions of the TCJA affecting corporate investment. The last column shows the estimated revenue impact over 2018-2027 from JCT (2017).

as the export share of domestic income in excess of 10% of domestic tangible capital. While intended to encourage firms to report profits in the U.S., we show in appendix A.6 that the FDII deduction has the same effect on investment incentives as a reduction in the domestic METR and an increase in the cost of capital for tangible assets. The latter effect owes to the exclusion of income up to 10% of domestic tangible capital; thus, a marginal increase in domestic tangible capital mechanically reduces the FDII deduction and increases taxes owed.

The reform also changed international corporate tax.[8] Prior to the TCJA, U.S. firms paid domestic taxes on any foreign profits repatriated as dividends to the U.S. parent. The new system replaces this worldwide approach with a territorial tax. Firms deduct the full amount of repatriated dividends from their domestic income, which exempts foreign profits from domestic income tax. The TCJA supplements this territorial system with a minimum tax on some foreign

[8] See Gale, Gelfond, Krupkin, Mazur and Toder (2019) for additional detail on these provisions.

income, implemented via a foreign provision analogous to the FDII deduction, known as the Global Intangible Low-Taxed Income (GILTI) tax. The TCJA defines GILTI as foreign income in excess of 10% of foreign tangible capital. A corporation can deduct 50% of this income and further claim credits for 80% of foreign taxes paid. The GILTI provision often is described as a minimum tax, because a corporation with foreign income and no foreign taxes paid will pay 10.5% (= $0.5 \times 21$) on foreign income in excess of 10% of foreign tangible capital. We show in appendix A.6 that GILTI has the same effect on investment incentives as an increase in the foreign METR and a decrease in the foreign cost of capital for tangible assets. The latter effect owes to the exclusion of income up to 10% of foreign tangible capital; thus, a marginal increase in the foreign tangible capital stock mechanically reduces GILTI tax.

The TCJA made several other changes that affect businesses but that we do not include in our baseline analysis. Most important, the provisions for bonus depreciation are scheduled to phase out over time and the rates in FDII and GILTI change as well.[9] We assume that firms in 2018 and 2019 expected these provisions to be permanent, following Desai and Goolsbee (2004) and consistent with limited evidence of intertemporal substitution in House and Shapiro (2008) and Zwick and Mahon (2017), and explore sensitivity to this assumption through our quantitative model.[10] Other domestic provisions do not directly change the marginal incentives for C-corporation investment in tangible capital, including those reducing the limit for interest deductions from 50% to 30% of income and the generosity of the Research and Experimentation tax credit. We consider theoretical extensions that show how our user cost equations change when incorporating these factors.

On the foreign side, the TCJA mandated a transition tax for firms with outstanding stocks of unrepatriated foreign earnings of 15.5% for cash and 8% for illiquid assets and gave firms eight years to pay this tax. The TCJA also implemented a base erosion and anti-abuse tax (BEAT), which imposed a tax on payments from U.S. firms to foreign affiliates in excess of 3% of total deductions. While important for tax revenues and profit shifting by multinationals, these provisions are less relevant for the investment behavior of these firms.

The TCJA also reduced top individual income tax rates and created a deduction for qualify-

[9] The TCJA allowed full expensing of equipment investment through 2022, after which the bonus amount declines by 20p.p. per year until it reaches zero in 2027. The FDII deduction falls from 37.5% to 21.875% and the GILTI deduction from 50% to 37.5% beginning in 2026.

[10] To preview, if firms expected the expensing provisions to expire, our estimated investment elasticities likely overstate the investment response to a permanent change to full expensing. The short-run overreaction occurs because standard values for discount and depreciation rates imply that the intertemporal substitution toward investment in periods with higher expensing outweighs the lower steady-state capital value. In this sense, the paper's conclusions about the overall investment effects of the TCJA's corporate provisions provide an upper bound if firms expected the expensing provisions to expire.

ing business income under Section 199A, which reduced the effective tax rates for pass-through businesses and changed labor supply incentives. Estimating the impact of these provisions on aggregate investment is beyond the scope of our study.

# 3 Model

In this section we extend the canonical Hall and Jorgenson (1967) tax-adjusted user cost framework to a multinational setting. The model relates the response of investment to four tax terms: the METRs $\tau$ on domestic source income and $\bar{\tau}$ on foreign source income and the cost-of-capital subsidies $\Gamma$ on domestic investment and $\bar{\Gamma}$ on foreign investment. This result guides our measurement and reduced form cross-sectional empirical specification. Furthermore, the investment elasticities depend on a small set of parameters governing the scale of production, the elasticity of substitution between domestic and foreign capital, the relative importance of foreign capital in the domestic earnings function and vice versa, and the relative size of the foreign operation. Using regression coefficients from section 5 and other moments, we estimate these parameters in section 6 and then use them in quantitative exercises in section 7.

## 3.1 Setup

Time is continuous and runs forever. Atomistic firms operate up to two locations, one domestic and the other international. Each location produces output using local and foreign capital and local labor and materials. We denote by $X$ and $\bar{X}$ the domestic and international values of a variable $X$ and describe the optimization problem of the domestic operation, with the international operation mirror-symmetric. We describe the decision problem of a single firm and omit firm-specific subscripts except when we discuss general equilibrium.

The domestic operation produces output $Q_t$ by combining local and foreign capital $K_t$ and $\bar{K}_t$ with local labor $L_t$ and materials $M_t$:

$$Q_t = \left(A_t \mathscr{K}_t^{\alpha_{\mathscr{K}}} L_t^{\alpha_L} M_t^{\alpha_M}\right)^{\mathscr{M}}, \tag{1}$$

$$\text{where: } \mathscr{K} = \left(a K^{\frac{\sigma-1}{\sigma}} + (1-a)\bar{K}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}. \tag{2}$$

Here $A_t$ denotes (scaled) total factor productivity, $\mathscr{K}$ is a composite of domestic and international capital with elasticity of substitution $\sigma > 0$, $a$ governs the relative importance of foreign capital in determining domestic revenue, $\mathscr{M} \geq 1$ is the firm's equilibrium markup and arises from the demand constraint $Q_t \propto P_t^{-\frac{\mathscr{M}}{\mathscr{M}-1}}$, and $\mathscr{M}\left(\alpha_{\mathscr{K}} + \alpha_L + \alpha_M\right) \leq 1$. At each date $t$, the firm takes the capital stocks as pre-determined and factor prices $P_t^L$ and $P_t^M$ as exogenous and chooses $L$ and $M$ to maximize operating earnings $P_t Q_t - P_t^L L_t - P_t^M M_t$.

Appendix A.1 shows that this optimization problem results in an earnings function that depends only on capital:

$$F\left(K_t, \bar{K}_t; Z_t\right) \equiv P_t Q_t - P_t^L L_t - P_t^M M_t = Z_t \mathscr{K}_t^{\alpha} = Z_t \left(a K_t^{\frac{\sigma-1}{\sigma}} + (1-a)\bar{K}_t^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\alpha}{\sigma-1}}, \tag{3}$$

where $\alpha \equiv \frac{\alpha_{\mathscr{K}}}{1-(\alpha_L+\alpha_M)} \subseteq [0,1]$ and $Z_t \propto A_t^{\alpha/\alpha_{\mathscr{K}}}$. In particular, $Z$ is lower if TFP $A$ is lower or the factor cost of labor or materials is higher. Curvature in the profit function arises whenever the revenue function features diminishing returns to scale, $\alpha_{\mathscr{K}} + \alpha_L + \alpha_M < 1$, whether the diminishing returns result from market power ($\mathscr{M} > 1$) or diminishing returns to scale in the production of physical output. The earnings function in the international location takes a similar form:

$$\bar{F}\left(\bar{K}_t, K_t; \bar{Z}_t\right) = \bar{Z}_t \left(\bar{a}\bar{K}_t^{\frac{\sigma-1}{\sigma}} + (1-\bar{a}) K_t^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\alpha}{\sigma-1}}. \tag{4}$$

The scale parameter $\alpha$, elasticity of substitution $\sigma$, $a$ and $\bar{a}$ which determine the importance of non-local capital in generating earnings, and the relative productivity $\bar{Z}/Z$ collectively characterize a firm. Immediately, a domestic-only firm has $a = 1$ and $\bar{Z} = 0$.[11]

The functions $F$ and $\bar{F}$ embody all complementarities or substitution in production across locations, with the elasticity of substitution $\sigma$ and the curvature $\alpha$ determining these forces: $\text{sign}(F_{K\bar{K}}) = \text{sign}(\alpha + 1/\sigma - 1)$. The literature on multinational firms and their location choice has articulated reasons for either complementarity or substitution to dominate. In Helpman (1984), more foreign tangible capital increases the productivity of domestic capital, because larger foreign scale increases brand recognition and hence demand for domestic output, and because it requires more managerial capacity that also benefits domestic production. Appendix A.3 incorporates such forces as part of a general accumulation of intangible capital that is non-rival within the firm and shows that they give rise to complementarity in the same sense as $F_{K\bar{K}} > 0$. Vertical integration of production, or "global value chains", within the firm also generates complementarity between $K$ and $\bar{K}$, because more foreign capital increases the upstream supply of imported inputs or downstream demand for domestic output, both of which raise the marginal product of domestic capital (Antrás and Chor, 2022). Alternatively, substitution may arise if local and foreign plants of the same firm compete to serve the same

[11] A slight generalization would require a firm to pay a fixed cost to operate foreign capital, in which case the parameters for a domestic-only firm would not necessarily lie in the corner. This model has the same implications as our baseline environment except that we do not allow domestic-only firms to become multinationals in response to the TCJA.

destinations, as greater foreign scale then crowds out domestic production. Brainard (1993) provides a model of this proximity-concentration trade-off. The functional form in equation (2) allows for all of these possibilities as well as the case of independence while remaining tractable enough to guide empirical work. Estimating the degree of complementarity or substitution will be a key outcome of the analysis.[12]

Domestic capital evolves dynamically as $\dot{K}_t = I_t - \delta K_t$, where $I_t$ is gross investment and $\delta$ is the rate of depreciation. The cost of a unit of domestic investment is $(1-\Gamma_t)\, P_t^K$, where $\Gamma_t$ contains the present value of depreciation allowances as well as any other tax provisions such as the FDII deduction that link taxes paid to tangible capital.[13] In addition, changing the capital stock incurs an adjustment cost $\Phi(I_t, K_t) = (\phi/(1+\gamma))(I_t/K_t - \delta)^{1+\gamma} K_t$ paid in tax-deductible units (e.g. labor). Total domestic taxable profits consist of operating earnings net of these adjustment costs, $F\left(K_t, \bar{K}_t; Z_t\right) - \Phi(I_t, K_t)$, and are taxed at rate $\tau_t$. An analogous set of equations hold for international capital and profits.

The cash flow returned to equity or debt holders each period is:

$$
\begin{aligned}
D_t = {} & (1-\tau_t)\left(F\left(K_t, \bar{K}_t; Z_t\right) - \Phi(I_t, K_t)\right) + (1-\bar{\tau}_t)\left(\bar{F}\left(\bar{K}_t, K_t, \bar{Z}_t\right) - \bar{\Phi}\left(\bar{I}_t, \bar{K}_t\right)\right) \\
& - (1-\Gamma_t)\, P_t^K I_t - \left(1-\bar{\Gamma}_t\right) P_t^{\bar{K}} \bar{I}_t.
\end{aligned} \tag{5}
$$

The firm maximizes the present value of cash flows with a discount rate $\rho$, subject to initial conditions $K_0$ and $\bar{K}_0$ and the dynamic evolution equations.

We make three remarks on this setup. First, for now we do not need to keep track of which government collects the tax revenue generated by $\tau$ or $\bar{\tau}$ or the details of the subsidies $\Gamma$ and $\bar{\Gamma}$; for the firm's choice of capital, all that matters is the marginal incentives it faces. We revisit this issue in section 7.3 when assessing the revenue effects of TCJA. Second, we do not directly model the full system of tax credits and loss provisions, but will take account of these in the measurement of the marginal incentives $\tau, \Gamma, \bar{\tau}, \bar{\Gamma}$. Third, equation (5) makes clear that the functions $F(K, \bar{K}; Z)$ and $\bar{F}(\bar{K}, K, \bar{Z})$ provide mappings between local and foreign tangible capital and local and foreign taxable earnings. In the presence of profit-shifting, these mappings may differ from the physical production functions relating local and foreign capital

[12] While engineered for flexibility to allow for complementarity or substitution between domestic and foreign capital, equations (1) and (2) also implicate substitution between other factors. For example, a decline in the foreign wage can cause domestic $\mathscr{K}$ and hence wages to increase or decrease, depending on parameters, but within limits imposed by the model's structure. Since we do not directly estimate substitution between other factors, we avoid counterfactual exercises that involve a change in foreign factor prices.

[13] For example, if a firm faces a constant tax rate $\tau_t$ and can immediately deduct depreciation of $\theta_t$ ("bonus" depreciation) for an investment made at date $t$ and subsequently deduct $(1-\theta_t)d_{h|t}$ at horizon $h$ (not to be confused with economic depreciation of $\delta$), then $\Gamma_t = \theta_t \tau_t + (1-\theta_t)\tau_t \zeta_t$ where $\zeta_t = \int_0^\infty e^{-rh} d_{h|t}\, dh$.

to true local and foreign earnings. Nonetheless, because the firm maximizes after-tax profits, the functions $F(K,\bar{K};Z)$ and $\bar{F}(\bar{K},K,\bar{Z})$ determine the choice of capital. Section 3.3 discusses an extension that explicitly incorporates profit-shifting motives.

## 3.2 Dynamic System and Linearization Across Steady States

Denoting by $\lambda_t$ and $\bar{\lambda}_t$ the costate variables associated with domestic and international capital accumulation, the necessary conditions for domestic investment and capital can be written (see appendix A.2):

$$\text{FOC } (I_t): \qquad \dot{K}_t/K_t = \left[\frac{1}{\phi}\left(\frac{\lambda_t - P_t^K(1-\Gamma_t)}{(1-\tau_t)}\right)\right]^{\frac{1}{\gamma}}, \tag{6}$$

$$\text{FOC}(K_t): \qquad \dot{\lambda}_t = (\rho+\delta)\lambda_t - (1-\tau_t)(F_1-\Phi_2) - (1-\bar{\tau}_t)\bar{F}_2, \tag{7}$$

where $F_n$ denotes the derivative of $F\left(K,\bar{K};Z\right)$ and $\Phi_n$ denotes the derivative of $\Phi(I_t,K_t)$ with respect to argument $n$. In addition, the transversality condition requires $\lim_{T\to\infty} e^{\rho T}\lambda_T K_T = \lim_{T\to\infty} e^{\rho T}\bar{\lambda}_T\bar{K}_T = 0$. The analogous equations hold for foreign capital. The terminal values of $\lambda$ and $\bar{\lambda}$ complete the system and are given by their values in steady state:

$$\lambda^* = (1-\Gamma^*)P^K,\ \bar{\lambda}^* = \left(1-\bar{\Gamma}^*\right)P^{\bar{K}}. \tag{8}$$

A key feature of this framework is that it admits a tractable and intuitive expression for the change in capital across the pre and post-reform steady states. Let $R^* = (\rho+\delta)(1-\Gamma^*)P^K$ denote the steady state user cost of capital.[14] Rearranging equation (7) and its foreign counterpart in the steady state with $\dot{\lambda}_t = \dot{\bar{\lambda}}_t = 0$ and substituting using equation (8) gives the steady state system:

$$(1-\tau^*)F_1^* + (1-\bar{\tau}^*)\bar{F}_2^* = R^*, \tag{9}$$

$$(1-\bar{\tau}^*)\bar{F}_1^* + (1-\tau^*)F_2^* = \bar{R}^*. \tag{10}$$

Recognizing that $F_1^* = F_1\left(K^*,\bar{K}^*;Z^*\right), F_2^* = F_2\left(K^*,\bar{K}^*;Z^*\right), \bar{F}_1^* = \bar{F}_1\left(\bar{K}^*,K^*;Z^*\right), \bar{F}_2^* = \bar{F}_2\left(\bar{K}^*,K^*;Z^*\right)$, equations (9) and (10) give a system of two non-linear equations in two unknowns $K^*$ and $\bar{K}^*$. We next totally differentiate this system to obtain an estimating equation relating capital to tax

[14]Dating back to Hall and Jorgenson (1967), most studies define the user cost as the implicit rental rate of capital after applying all taxes, that is, dividing the expression defining $R^*$ by $(1-\tau)$. Equations (9) and (10) show that this convention does not easily extend to the multinational setting where a firm faces potentially many corporate tax rates.

changes.

As a preliminary step, let $\chi_K \equiv \bar{K}^*/K^*$ denote the steady state ratio of international to domestic capital, $\chi_R = \bar{R}^*/R^*$ the ratio of international to domestic steady state user cost, and:

$$s_1 \equiv \frac{a\left(K^*\right)^{\frac{\sigma-1}{\sigma}}}{a\left(K^*\right)^{\frac{\sigma-1}{\sigma}}+(1-a)\left(\bar{K}^*\right)^{\frac{\sigma-1}{\sigma}}} = \frac{a}{a+(1-a)\,\chi_K^{\frac{\sigma-1}{\sigma}}} \subseteq [0,1], \tag{11}$$

$$\bar{s}_1 \equiv \frac{\bar{a}\left(\bar{K}^*\right)^{\frac{\sigma-1}{\sigma}}}{\bar{a}\left(\bar{K}^*\right)^{\frac{\sigma-1}{\sigma}}+(1-\bar{a})\left(K^*\right)^{\frac{\sigma-1}{\sigma}}} = \frac{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}}}{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}}+(1-\bar{a})} \subseteq [0,1], \tag{12}$$

$$s_{F_1} \equiv \frac{(1-\tau^*)\,F_1^*}{R^*} = \frac{a\left((1-\bar{a})\,\chi_R-\bar{a}\chi_K^{-\frac{1}{\sigma}}\right)}{(1-\bar{a}-a)\,\chi_K^{-\frac{1}{\sigma}}}, \subseteq [0,1], \tag{13}$$

$$s_{\bar{F}_1} \equiv \frac{(1-\bar{\tau}^*)\,\bar{F}_1^*}{\bar{R}^*} = 1-\frac{(1-a)\left((1-\bar{a})\,\chi_R-\bar{a}\chi_K^{-\frac{1}{\sigma}}\right)}{(1-\bar{a}-a)\,\chi_R} \subseteq [0,1] \tag{14}$$

denote shares of the capital inputs and marginal product terms, respectively. The second equalities show that these share terms depend on $\sigma, a, \bar{a}$ and the observable ratios $\chi_K$ and $\chi_R$.[15] Let $\tilde{\alpha} = \sigma\,(\alpha+1/\sigma-1) \subseteq (-\infty, 1]$.

The four tax terms central to our analysis are $\hat{\Gamma} = d\Gamma/(1-\Gamma)$, $\hat{\bar{\Gamma}} = d\bar{\Gamma}/\left(1-\bar{\Gamma}\right)$, $\hat{\tau} = d\tau/(1-\tau)$, $\hat{\bar{\tau}} = d\bar{\tau}/(1-\bar{\tau})$. Letting lower case $k, \bar{k}, i, \bar{i}, p^K, p^{\bar{K}}, r, \bar{r}, z, \bar{z}$ denote log deviations of their uppercase variables, appendix A.2 gives the main result of this section:

$$k = \frac{\omega_{k,r}\hat{\Gamma}+\left(1-\omega_{k,r}\right)\hat{\bar{\Gamma}}-\omega_{k,\tau}\hat{\tau}-\left(1-\omega_{k,\tau}\right)\hat{\bar{\tau}}+\epsilon}{1-\alpha}, \tag{15}$$

$$\text{where: } \omega_{k,r} \equiv \frac{1-\left((1-s_1)-s_{\bar{F}_1}\,(1-s_1-\bar{s}_1)\right)\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\,\tilde{\alpha}}, \tag{16}$$

$$\omega_{k,\tau} \equiv \frac{s_{F_1}+\left(1-s_{F_1}-s_{\bar{F}_1}\right)\bar{s}_1\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\,\tilde{\alpha}}, \tag{17}$$

$$\epsilon \equiv \omega_{k,\tau}z+\left(1-\omega_{k,\tau}\right)\bar{z}-\omega_{k,r}\left(\frac{d\rho+d\delta}{\rho+\delta}+p^K\right)-\left(1-\omega_{k,r}\right)\left(\frac{d\bar{\rho}+d\bar{\delta}}{\bar{\rho}+\bar{\delta}}+p^{\bar{K}}\right). \tag{18}$$

[15] While the second equalities in equations (11) and (12) follow immediately by dividing the numerator and denominator by $(K^*)^{\frac{\sigma-1}{\sigma}}$, proving the second equalities in equations (13) and (14) requires using equations (9) and (10) and a substantial amount of algebra, which we detail in Appendix A.2.3. The ratio $\chi_R$ is directly a function of parameters; the ratio $\chi_K$ is an equilibrium object that depends on $\alpha, \sigma, a, \bar{a}$ and the ratios of $\bar{Z}^*/Z^*$ and $(1-\bar{\tau}^*)/(1-\tau^*)$. The advantage of writing the shares in terms of $\chi_R$ and $\chi_K$ is that the unobserved firm-specific ratio of productivities $\bar{Z}^*/Z^*$ is replaced by observable factor quantities and prices.

Thus, long-run capital responds according to the elasticity $1/(1-\alpha)$ to a weighted average of the deviations of domestic and foreign tax rates and costs of capital. The appearance of the returns to scale $1-\alpha$ in the denominator of the long-run elasticity is standard; in the case of a domestic-only firm, $\omega_{k,r} = \omega_{k,\tau} = 1$ and the long-run elasticity collapses to $k = (\hat{\Gamma} - \hat{\tau})/(1-\alpha)$. Our contribution is to show that it carries over into the multinational setting with appropriately-defined weights $\omega_{k,r}$ and $\omega_{k,\tau}$ multiplying the domestic and foreign tax changes. These weights are functions of the parameters $\alpha, \sigma, a, \bar{a}$ and the steady-state ratios of foreign-to-domestic capital and user cost.[16]

Importantly, while the weights on domestic and international taxes sum to one, negative weights and hence elasticities on the foreign terms are possible. In the case of $\Gamma$ and $\bar{\Gamma}$, the domestic weight exceeds one if and only if $F_{K\bar{K}} < 0$, i.e. if $\alpha + 1/\sigma < 1$.[17] Intuitively, cheaper foreign capital ($\bar{\Gamma} \uparrow$) results in higher $\bar{K}$; whether this increase crowds out or in $K$ depends on whether $F_{K\bar{K}}$ is positive or negative. The sign of the coefficient multiplying $\bar{\Gamma}$ therefore reveals whether domestic and foreign capital are complements or substitutes. In the special case where $F_{K\bar{K}} = 0$, the domestic capital decision does not depend on foreign capital and $\omega_{k,r}$ equals one just as in the domestic-only case. The determination of whether $\omega_{k,\tau}$ exceeds one is more complicated because foreign taxes directly affect both $K$ and $\bar{K}$; in the special case of $F_{K\bar{K}} = 0$ and *ex ante* symmetry ($\tau^* = \bar{\tau}^*, R^* = \bar{R}^*, Z^* = \bar{Z}^* \Rightarrow K^* = \bar{K}^*$), the term $\omega_{k,\tau}$ simply equals the domestic capital share in the production function $a$.

We also can characterize the responses of foreign capital $\bar{k}$ and total capital $k^T = d\ln\left(K + \bar{K}\right)$:

$$\bar{k} = \frac{\omega_{\bar{k},\bar{r}} \hat{\bar{\Gamma}} + \left(1 - \omega_{\bar{k},\bar{r}}\right) \hat{\Gamma} - \omega_{\bar{k},\bar{\tau}} \hat{\bar{\tau}} - \left(1 - \omega_{\bar{k},\bar{\tau}}\right) \hat{\tau} + \bar{\epsilon}}{1-\alpha}, \tag{19}$$

$$k^T = \frac{\omega^T_{k,r} \hat{\Gamma} + \left(1 - \omega^T_{k,r}\right) \hat{\bar{\Gamma}} - \omega^T_{k,\tau} \hat{\tau} - \left(1 - \omega^T_{k,\tau}\right) \hat{\bar{\tau}} + \epsilon^T}{1-\alpha}, \tag{20}$$

where the expressions for $\omega_{\bar{k},\bar{r}}$, $\omega_{\bar{k},\bar{\tau}}$, $\omega^T_{k,r}$ and $\omega^T_{k,\tau}$ are given in appendix A.2. The terms $\epsilon, \bar{\epsilon}$, and $\epsilon^T$ capture determinants of capital other than tax policy, including the foreign and domestic profit shifters $z$ and $\bar{z}$, discount rates $\rho$ and $\bar{\rho}$, depreciation rates $\delta$ and $\bar{\delta}$, and market prices

[16] Equation (15) nests several special cases: (i) the standard closed economy one factor model when $a = 1$, in which case domestic profits depend only on domestic capital, $\omega_{k,r} = \omega_{k,\tau} = 1$, and capital responds to the domestic "tax term" $(1-\Gamma)/(1-\tau)$ with elasticity $1/(1-\alpha)$; (ii) the closed economy two factor model when $\bar{Z}^* = s_{\bar{F}_1} = 0$ and $s_{F_1} = 1$, in which case $\omega_{k,\tau} = 1$ and $\omega_{k,r} = 1 - (1-s_1)\tilde{\alpha}$; and (iii) *ex ante* symmetry with $\tau^* = \bar{\tau}^*, R^* = \bar{R}^*$, and $Z^* = \bar{Z}^*$, in which case $K^* = \bar{K}^*$ and hence $s_1 = \bar{s}_1 = s_{F_1} = s_{\bar{F}_1} = a$.

[17] Proof: It is immediate from equation (16) that $\omega_{k,r} = 1$ if $\tilde{\alpha} = \sigma(\alpha + 1/\sigma - 1) = 0$. Furthermore, $\partial \omega_{k,r}/\partial \tilde{\alpha} \propto -\left(\left(1 - s_{F_1}\right)\bar{s}_1 + s_{F_1}(1-s_1)\right)$. Since $s_{F_1}, s_1, \bar{s}_1 \subseteq [0,1]$ the term in the parentheses is also between zero and one and the derivative is negative.

of capital $p^K$ and $p^{\bar{K}}$.

Equations (15) to (20) frame our empirical exercise. We use corporate tax returns to measure $k$ and $\bar{k}$ and the policy shocks $\hat{\Gamma}, \hat{\tau}, \hat{\bar{\Gamma}}$, and $\hat{\bar{\tau}}$. The possibility that the firm-specific drivers of investment contained in the residuals $\epsilon, \bar{\epsilon}$, and $\epsilon^T$ may be correlated with changes in taxes motivates the measurement of ex ante tax shocks and robustness analysis.

### 3.3 Extensions

Appendix A.2 extends the baseline model to allow for separate investment in equipment and structures, each with its own depreciation rate and cost-of-capital. Assuming a constant elasticity of substitution in the production function across different types of capital, equation (15) continues to hold for total capital, with the user cost terms replaced by appropriately-weighted changes in the user costs of each type. We use this result in the measurement of changes to $\Gamma$.

Appendices A.3 to A.5 introduce three new considerations into the baseline environment. The first explicitly models the dynamic accumulation of intangible capital. Intangible capital is fully non-rival within the firm; it increases the productivity of both the domestic and foreign operation. As in Helpman (1984), it therefore induces complementarity between domestic and foreign tangible capital, since cheaper foreign tangible capital results in more intangible capital accumulation which in turn makes domestic tangible capital more profitable. Equation (15) has two changes as a result: $\omega_{k,r}$ now reflects the complementarity arising from intangible capital as well as from $\sigma$ and $a$, and a new term arises if the user cost of intangible capital changes.

The second change explicitly incorporates the location choice of intangible capital, as key provisions of TCJA such as FDII and GILTI targeted this margin. Unlike equipment and structures, by definition intangible capital does not have a physical location nor does its movement across borders leave a verifiable record in shipping or customs data, making the location of intangible capital and the associated profits in low-tax jurisdictions an attractive tax strategy. In our framework, if firms allocate intangible capital across jurisdictions to minimize taxes without any regard to the location of physical capital, then nothing changes in the firm's physical investment decision and equations (15), (19), and (20) remain unaltered. In the case where the relative location of physical capital constrains the firm's location decision of intangible capital, two changes arise. First, in the realistic case of $\tau > \bar{\tau}$, the pre-TCJA domestic user cost rises and the foreign user cost falls, as the accumulation of domestic capital reduces the firm's ability to shift profits abroad using intangibles. Second, the reduction in the difference $\tau - \bar{\tau}$ under TCJA has the additional effect of reducing the wedge between the user costs.

The third new consideration involves the tax deduction of interest payments. Once again, if firms make their financial capital structure decision independently of their choice of physical capital, then nothing changes in the firm's physical investment decision and equations (15), (19) and (20) remain unaltered. In the case where these decisions interact, perhaps because of a leverage constraint tying the optimal amount of debt to the quantity of physical capital, again two changes arise. First, the pre-TCJA domestic user cost falls, as the accumulation of domestic capital increases the firms' ability to issue tax-shielded debt. Second, the reduction in $\tau$ has a smaller effect on investment because it simultaneously reduces the value of the tax shield.

### 3.4 General Equilibrium

While equation (15) holds firm-by-firm, the residual $\epsilon$ contains changes to factor prices common to all firms. In the cross-section regressions in section 5, these common changes appear in the constant term and do not impact the identification of the parameters governing the tax elasticities. For general equilibrium questions such as the effect of TCJA on aggregate investment or revenue, however, higher factor demand will cause factor prices to increase if supply curves slope up. To model this feedback, we subscript individual firms with $i$ and let $X_t^D = \sum_i X_{i,t}$ denote aggregate demand for factor $X \in \{K, L, M\}$. Factor supply obeys $X_t^S / X_t^* = \left(P_t^X / \left(P_t^X\right)^*\right)^{\nu_X}$ and in equilibrium $X_t^D = X_t^S = X_t$. To preview, we impose an extreme but realistic calibration of the supply curves: we set $\nu_M = \nu_K = \infty$ since raw materials tend to trade on international markets and recent literature does not find an effect of investment demand on the price of capital goods (House, Mocanu and Shapiro, 2022), and $\nu_L = 0$ in accordance with balanced growth path preferences.[18]

## 4 Data and Measurement of Tax Rates and Investment

This section describes the measurement of the key shock and outcome variables.

[18] House, Mocanu and Shapiro (2022) show that the early and influential evidence of capital prices responding to investment incentives in Goolsbee (1998) disappears when using more recent vintages of data on the Goolsbee sample or extending the sample period. The factor supply function for labor can be microfounded from workers with utility $C^{1-\gamma}/(1-\gamma) - \nu L^{1+\chi}/(1+\chi)$ and no saving technology, $C = wL$. Setting the wage proportional to the marginal rate of substitution and solving gives $L_t \propto \left(P_t^L\right)^{\nu_L}$, with $\nu_L \equiv \frac{1-\gamma}{\chi+\gamma}$. Keeping $L$ constant on a balanced growth path requires $\gamma = 1$ and hence $\nu_L = 0$; intuitively, with balanced growth preferences the equilibrium quantity of labor does not respond to shifts in the labor demand curve.

## 4.1 U.S. Corporate Tax Files

We measure firm-level tax rates and investment for a representative sample of C-corporations using information reported on corporate tax returns. Our data set starts from the size-stratified samples of roughly 100,000 C-corporation and S-corporation returns per year that are produced and cleaned by the IRS Statistics of Income (SOI) division. Firms selected into the SOI sample remain in the sample unless they change tax identifier or fall into a size stratum with a lower sampling probability, giving us a panel (see Zwick and Mahon (2017) for details). We drop S corporations (∼50% of the sample), financial firms (NAICS 52), firms with less than \$1 million in domestic tangible assets (∼25%), and firms with insufficient history to permit measurement of each policy shock variable. These refinements leave a sample of approximately 12,000 firms. We augment the SOI Corporate Sample with variables and tax years drawn from the population of corporate returns. Our main analysis uses tax returns from 2011 through 2019, although we use data going back to 1993 when measuring some of the policy shock variables.[19]

For each firm-year, we combine data from Forms 1120, 4562, 5471, and 1118. Form 1120 is the corporate income tax return required of all domestic corporations and contains income statement and balance sheet items, taxes, deductions, and credits, as well as basic firm characteristics such as industry. Form 4562 is required for a firm to claim depreciation and amortization and contains investment expenditure by tax duration bin. Form 5471 is required of corporations with ownership stakes in foreign corporations and includes the foreign subsidiary income statement and balance sheet items as well as foreign taxes paid (see Dowd, Landefeld and Moore (2017) for details). We define multinational firms as having positive 5471 tangible capital.[20] Form 1118 covers foreign tax credits and in particular contains information related to GILTI obligations. Using information on these forms, we develop measures of the impact of the reform on the tax terms $(\Gamma, \tau, \bar{\Gamma}, \bar{\tau})$ and firm-level outcomes.

**Domestic Cost of Capital ($\Gamma$).** The effective discount to the cost of capital for firm $i$, $\Gamma_{i,t}$, starts with the time-varying present value of depreciation allowances in each of $j \in J$ asset types. Denoting the no-bonus present value of depreciation allowances as $\zeta_{j,0} = \int_0^\infty e^{-rh} d_{j,h|t} dh$, the level of bonus depreciation as $\theta_t$, and bonus eligibility as $\mathbb{I}\{\text{eligible}\}$, the total present value

[19] The analysis sample is approximately 10% the size of the sample in Zwick and Mahon (2017), which included more small firms, S-corporations, and a longer panel.

[20] A handful (roughly 100) of firms in our sample have positive but *de minimus* foreign presence, which we define as having 5471 capital and earnings both less than 1% of their domestic counterpart. We put these firms in the domestic group as well.

of allowances of asset type $j$ is $\zeta_t^j = \mathbb{I}\{\text{eligible}\}\left(\theta_t + (1-\theta_t)\zeta_{j,0}\right) + (1-\mathbb{I}\{\text{eligible}\})\zeta_{j,0}$. We calculate this present value for each depreciable life category on Form 4562 under both pre-TCJA bonus depreciation of $\theta = 0.5$ and post-TCJA bonus depreciation of $\theta = 1$.

We aggregate the asset-level depreciation allowances $\zeta_t^j$ to the firm level using firm-specific investment shares, defined following Zwick and Mahon (2017) as the firm's pre-2011 average share of depreciable investment in each Form 4562 depreciable life category.[21] This treatment is consistent with the model extension to multiple types of investment in appendix A.2. Denoting by $\zeta_{i,t}$ the firm-level weighted-average present value of allowances, the present value of tax savings is $\tau_{i,t}\zeta_{i,t}$, where $\tau_{i,t}$ is the firm's marginal tax rate defined below.

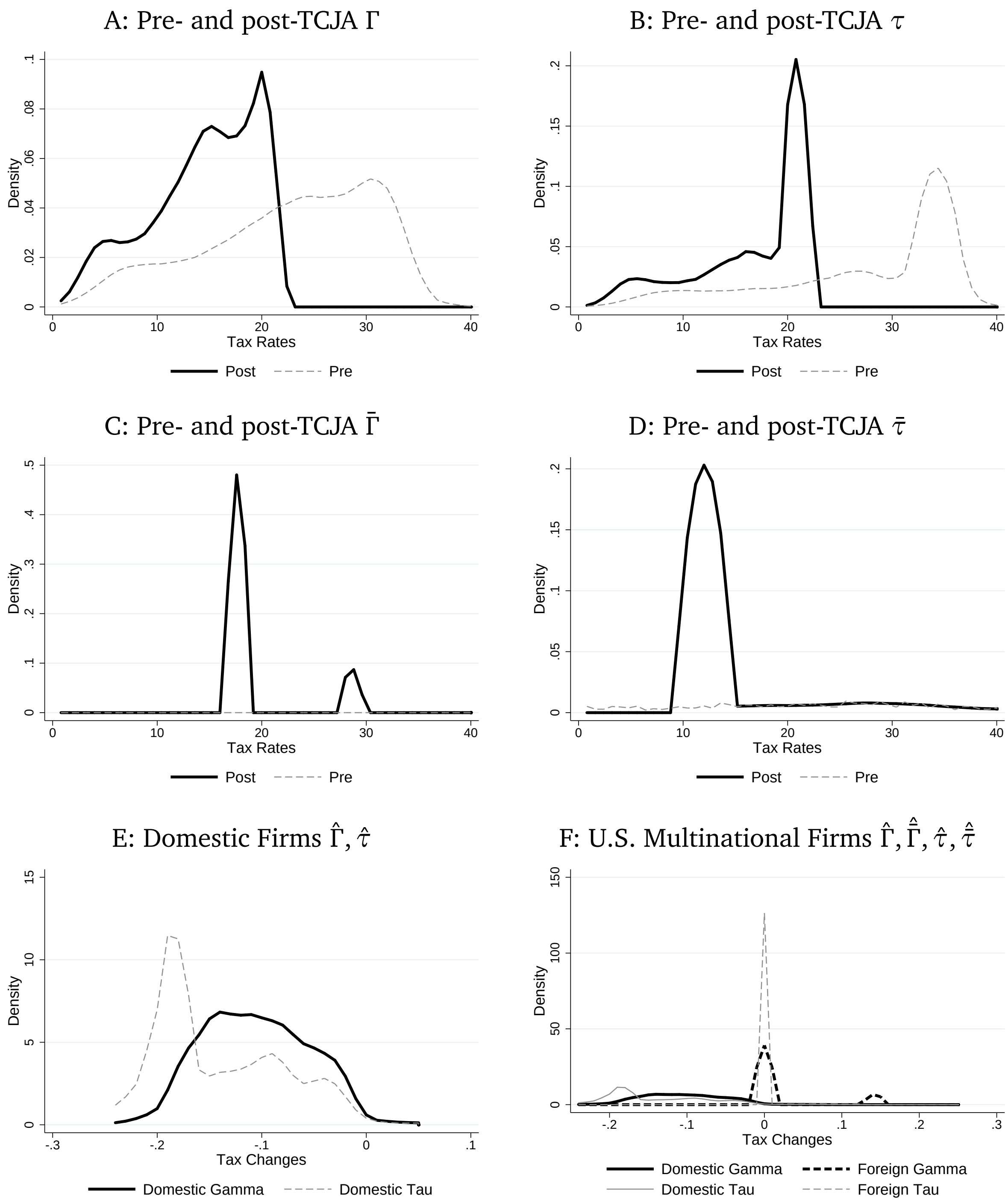
Exposure to FDII affects $\Gamma$ because the FDII deduction applies to the export share of income in excess of 10% of domestic tangible capital. As a result, increasing domestic tangible capital mechanically increases income taxes by reducing the amount of the FDII deduction. Appendix A.6 formally incorporates FDII into the firm's optimization problem in section 3 and shows that the implications for investment are isomorphic to a lower marginal tax rate and smaller $\Gamma$. Putting all of these elements together, using the FDII deduction of 0.375 of eligible income, the deemed intangible income threshold of 0.1, and denoting $\xi$ the share of domestic income from exports and $\tau^s$ the ex-FDII marginal tax rate, we define $\Gamma_t = \tau_{i,t}\zeta_{i,t} - \tau_{i,t}^s \times \xi_i \times 0.375 \times 0.1/(\rho + \delta)$. To implement this formula, we apply a common $\rho = 0.06$ and $\delta = 0.1$ and obtain $\xi_i$ by inverting the FDII deduction reported after TCJA on Form 1120.[22]

Panel A of figure 2 plots the pre- and post-TCJA distributions of $\Gamma$. Both exhibit substantial variation. Variation across asset types arises because equipment but not structures are bonus eligible and because of variation in depreciation lives within each category. Variation in $\Gamma$ then reflects the firm-level investment shares in each asset type. While these shares may relate to firm-specific technology, Curtis, Garrett, Ohrn, Roberts and Suárez Serrato (2021) argue that tax depreciation lives substantially reflect historical accident and do not closely correspond to economic depreciation. The variation in $\Gamma$ further reflects the firm-specific METR and FDII-eligibility. Panels E and F show substantial variation in $\hat{\Gamma} = d\Gamma/(1-\Gamma)$, the variable that enters into the regression, across both domestic and U.S. multinational firms.

[21] We expand on Zwick and Mahon (2017) by (1) incorporating investment shares and depreciation rules for investment ineligible for bonus depreciation and (2) relying on firm-level rather than industry-level measures of $\zeta$, allowing us to consider the impact of the reform on longer-lived investment and to identify causal effects using within-industry variation in exposure to the depreciation rules.

[22] Specifically, we define $\xi_i$ as the section 250 (FDII) deduction reported on 1120 schedule C divided by $0.375\times$ taxable income (1120 line 30) less $0.1\times$ capital (1120 schedule L line 10a less 10b).

Figure 2: Kernel Density Distribution of Tax Changes




*Notes:* Panels A-D depict kernel density estimates for the four tax terms of interest before and after the TCJA. Panel E provides kernel density estimates for $\hat{\Gamma}$ and $\hat{\tau}$ for Domestic Firms. Panel F provides kernel density estimates for $\hat{\Gamma}$, $\hat{\hat{\Gamma}}$, $\hat{\tau}$, and $\hat{\hat{\tau}}$ for U.S. multinationals.

**Domestic Marginal Tax Rate ($\tau$).** Changes to the effective marginal tax rate, $\tau_{i,t}$, reflect the reduction in the statutory rate, repeal of the Domestic Production Activities Deduction (DPAD) and corporate Alternative Minimum Tax (AMT), reform to the net operating loss (NOL) regime, and the introduction of FDII. Our translation of these components into changes in each firm's METR builds on Auerbach (1983), Shevlin (1990), and Graham (1996). As in this work, we simulate firm-level taxable income trajectories starting in year $t$ using a firm-specific standard deviation for income changes estimated using historical data. These trajectories determine the impact of the net operating loss regime, since carrybacks and carryforwards make the present value of taxes depend on past and future income in addition to current income. We go beyond past work by also simulating the future use (if available) of the foreign tax credit, DPAD, and AMT using the historical firm-specific propensity to use each credit or deduction (conditional on having positive taxable income) and the amount of the credit or deduction conditional on use.

Using these simulated paths of taxable income, credits, and deductions, we define the marginal rate $\tau^s_{i,t}$ as the change in the present value of taxes from an additional \$1000 of income, divided by \$1000. We compute $\tau^s_{i,t}$ under both pre- and post-TCJA statutory rates, credits, deductions, and NOL carryback and carryforward rules for income in $t = 2015$ and $t = 2016$ and average the rates for these two years to arrive at our pre- and post-TCJA $\tau^s_{i,t}$. Changes in $\tau^s_{i,t}$ therefore incorporate both the changes to the statutory rate and credits and deductions and the heterogeneous impact of these components depending on a firm's pre-TCJA taxes. For firms subject to FDII, the effective marginal rate further accounts for the FDII deduction and is $\tau_{i,t} = (1 - 0.375 \times \xi_i) \times \tau^s_{i,t}$. For other firms and prior to the TCJA we set $\tau_{i,t} = \tau^s_{i,t}$.

Panel B of figure 2 plots the pre- and post-TCJA distributions of $\tau$. Both have modes around their respective statutory rates of 35 and 21%. However, both also exhibit substantial mass below the modes, reflecting firm-specific use of deductions and credits as well as NOLs. As a result, panels E and F show substantial variation in how much different firms' METRs changed, with larger percent reductions for firms with higher pre-TCJA METRs and smaller reductions for firms directly affected by the repeal of DPAD or AMT.

**Foreign Cost of Capital ($\bar{\Gamma}$).** We measure the pre-TCJA foreign effective discount to the cost of capital, $\bar{\Gamma}_{i,t}$, using the OECD average present value of depreciation allowances from Foertsch (2022). TCJA affects this variable through the GILTI provision because the GILTI tax applies to foreign income in excess of 10% of foreign tangible capital. As a result, increasing foreign tangible capital mechanically reduces GILTI and hence reduces U.S. income tax. Appendix A.6 formally incorporates GILTI into the firm's optimization problem in section 3 and shows that the implications for investment are isomorphic to a lower marginal tax rate and larger $\Gamma$. Specifically, if a firm has any GILTI tax liability in either 2018 or 2019, we lower post-TCJA $\bar{\Gamma}_{i,t}$ by the present value of the savings on GILTI tax of $0.21 \times 0.5 \times 0.1/(\rho + \delta)$, where 0.21 is the U.S. post-TCJA statutory rate, 0.5 is the GILTI deduction, and 0.1 is the deemed intangible income threshold.[23] We assign GILTI liability if 0.21× GILTI income net of deductions exceeds deemed foreign taxes paid, where each of these variables is obtained from form 1118.

Panel C of figure 2 plots the pre- and post-TCJA distributions of $\bar{\Gamma}$. The distribution of $\bar{\Gamma}$ pre-TCJA is single-valued by construction since we do not have firm-level variation on foreign depreciation schedules. The second peak in the post-TCJA distribution reflects GILTI.

**Foreign Marginal Tax Rate ($\bar{\tau}$).** The tax rate on foreign profits, $\bar{\tau}_{i,t}$ has the following inputs: the pre-reform average tax rate on foreign income $\bar{t}_i$ and the GILTI rate. The foreign tax rate $\bar{t}_i$ is defined as the average of two tax rates computed using aggregated 5471 information at the firm level. We then take the average within firm over 2010 to 2016. The first tax rate uses Schedule E taxes divided by Schedule C net income, and the second tax rate uses Schedule E taxes divided by Schedule H earnings and profits. Both tax rates are censored to be between 0 and 100%. The latter rate is the rate used in Dowd, Landefeld and Moore (2017), whereas the former rate is better populated in the data.

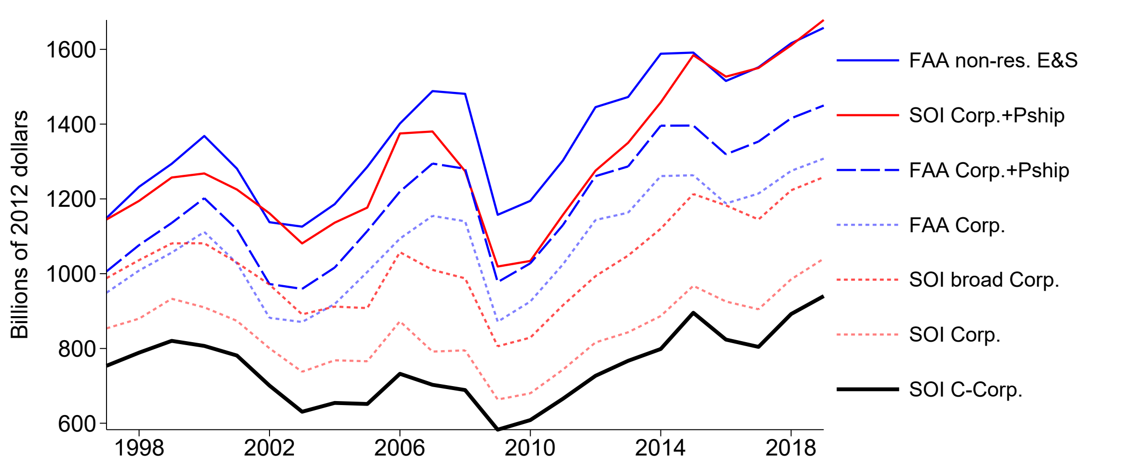
Our baseline specification for $\bar{\tau}_{i,t}$ is a myopic model, in which firms expected prior to the reform to continue paying the pre-TCJA foreign tax rate. In the post-TCJA regime, they continue to pay this rate if it exceeds the GILTI rate and otherwise pay the GILTI rate. Thus, $\bar{\tau}_{it}$ is defined as $\bar{t}_i$ prior to the reform and $\max\{GILTI, \bar{t}_i\}$ after the reform, where the GILTI tax rate is 10.5%.[24]

**Key Outcomes.** Our main outcome is *investment*. This variable includes expenditures for all equipment and structures investment put in place in the U.S. during the current year, obtained from Form 4562. In some specifications, we restrict attention to the expenditures for which

[23] Firms increasing foreign capital to avoid GILTI tax have a strong incentive to acquire capital with low economic depreciation so as to avoid recurring investment outlays. We therefore set $\delta = 0.04$ for the purpose of determining the impact of GILTI on $\bar{\Gamma}$.

[24] In robustness, we consider a perfect foresight model, in which firms expected prior to the reform that their future tax burden on foreign income would be the Section 965 "toll tax" rate on liquid deferred foreign income (15.5%). They only expected to be subject to this rate if their pre-reform foreign tax rate $\bar{t}_i$ was lower than this rate. In the post-TCJA regime, they pay the maximum of the GILTI rate and $\bar{t}_i$. Accordingly, $\bar{\tau}_{it}$ is defined as $\max\{15.5, \bar{t}_i\}$ prior to the reform and $\max\{GILTI, \bar{t}_i\}$ following the reform.

Figure 3: Investment Benchmark




*Notes:* Fixed Asset Accounts (FAA) non-res. E&S is investment in non-residential equipment and structures (FAA table 2.7 lines 3 and 36). FAA Corp. and Pship is private investment in non-residential equipment and structures by C or S corporations (FAA table 4.7 lines 18 and 19) or partnerships (FAA table 4.7 lines 62 and 63). SOI Corp.+Pship is total non-residential investment by SOI corporations or partnerships. SOI Corp. includes only investment by corporations and SOI C-Corp. investment by C corporations. SOI broad Corp. includes the part of partnership investment that can be allocated to direct corporate owners of the partnership.

bonus depreciation and Section 179 incentives apply, which we refer to as *equipment*. *Capital* includes the book value of tangible, depreciable assets net of accumulated depreciation per books. This measure includes the capital from consolidated domestic subsidiaries but typically excludes that from foreign subsidiaries. *Foreign capital* includes the total book value of tangible, depreciable assets reported for controlled foreign corporations on all Form 5471 filings attached to the firm's Form 1120 corporate filing, net of accumulated depreciation.

Figure 3 shows that investment as reported on tax forms closely tracks national accounts aggregates. The figure plots several measures of investment in non-residential equipment and structures, all deflated using the GDP price index. In 2016, our tax-based measure of investment by C-corporations accounted for 54% of total national accounts investment. Moreover, despite the series coming from completely separate source data, the correlation of annual changes in the logs of both series exceeds 0.7. The figure also shows that most of the gap between SOI C-Corporate and national accounts investment occurs because of investment in other sectors identifiable in SOI, including S-corporations and partnerships. Including investment by partnerships directly owned by corporations (the line labeled "SOI broad Corp." in the figure) increases the 2016 corporate share in the SOI data to 78%. Fully allocating partnership investment to corporate owners introduces substantial logistical hurdles due to multiple tiers of ownership and entities not in the SOI corporate sample, however, so our firm-level analysis focuses on investment directly attributable to C-corporations.[25]

Table 2 reports summary statistics. Panel A reports statistics for the full sample and the domestic sample, which includes firms with less than one percent of their income and capital from foreign operations. Panel B provides statistics for the multinationals with high and low levels of foreign activity. Specifically, multinational high includes U.S. multinationals that are not in the domestic sample and had at least 15% of their capital abroad before the TJCA (i.e., Pre-TCJA $\chi_K >= .15$). The multinational low sample are U.S. multinationals that are not domestic but had less than 15% of their capital abroad (i.e., Pre-TCJA $\chi_K < .15$).

The average change in the domestic composite tax term, which corresponds to $\hat{\Gamma} - \hat{\tau}$, is 4%. This number is smaller than the analogous prediction in Barro and Furman (2018). They report a change in the user cost of capital due to the TCJA being made permanent of 10% for equipment and 11% for structures. The difference between our estimate and theirs can be explained by their use of the statutory corporate tax rate and by our inclusion of 50% bonus depreciation in the pre-period.[26]

## 4.2 Compustat Data on North American and Global Firms

We use the Compustat North America and Compustat Global Databases to construct the sample for our synthetic controls research design. We begin with all non-financial publicly-traded firms in the Compustat North America database that are headquartered in the United States. We focus on a window around the 2017 tax reform that starts in 2011 and ends in 2020. Appendix Table C.2 describes the construction of the matched analysis sample. We keep firms with non-missing assets (AT), property plan and equipment (PPENT), and sales (SALE) for each of the four years before the tax reform. We apply analogous sample restrictions to the Compustat Global database in addition to keeping only firms that list non-US-based headquarters (LOC). We convert all currencies to U.S. dollars using the official exchange rates from Table 4.16 of the World Development Indicators of the World Bank.

## 4.3 Other Data Sets

To address concerns about investment effects due to other policy shocks related to rising trade tensions, we include controls from Flaaen and Pierce (2019). Specifically, we use three tariff

[25] Such arrangements concentrate in a few industries, including utilities (NAICS 22), pipeline transportation (NAICS 486), and real estate (NAICS 531).

[26] Barro and Furman (2018) also include state corporate taxes in their user cost model and adjust the user cost for debt finance. However, accounting for these factors is not necessary to explain the difference between our estimates.

Table 2: Summary Statistics by Sample

Panel A: Pooled and Domestic Samples

| | All Firms | | | | | | Domestic Firms | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Median | P10 | P90 | N | Mean | Std. Dev. | Median | P10 | P90 | N |
| Average Tax Rate | 0.05 | 0.06 | 0.02 | 0.00 | 0.13 | 9287 | 0.05 | 0.06 | 0.02 | 0.00 | 0.14 | 7028 |
| Pre-TCJA $\Gamma$ | 0.23 | 0.08 | 0.24 | 0.10 | 0.32 | 9305 | 0.23 | 0.08 | 0.24 | 0.11 | 0.33 | 7044 |
| Pre-TCJA $\bar{\Gamma}$ | 0.18 | 0.00 | 0.18 | 0.18 | 0.18 | 9307 | | | | | | |
| Pre-TCJA $\tau$ | 0.27 | 0.09 | 0.32 | 0.13 | 0.35 | 9307 | 0.28 | 0.09 | 0.33 | 0.14 | 0.35 | 7046 |
| Pre-TCJA $\bar{\tau}$ | 0.06 | 0.13 | 0.00 | 0.00 | 0.29 | 9307 | | | | | | |
| $d$ log(Investment) | -0.04 | 0.99 | 0.04 | -1.43 | 1.28 | 9307 | -0.05 | 1.03 | 0.02 | -1.52 | 1.35 | 7046 |
| $\hat{\Gamma} - \hat{\tau}$ | 0.04 | 0.03 | 0.04 | 0.00 | 0.08 | 9305 | 0.04 | 0.03 | 0.03 | 0.00 | 0.08 | 7044 |
| Relative Profit (EBITD) | 0.11 | 0.37 | 0.00 | 0.00 | 0.26 | 9307 | | | | | | |
| Form 5471: Rel. Profit | 0.18 | 0.60 | 0.00 | 0.00 | 0.39 | 9305 | | | | | | |
| Form 5471: Rel. Profit (EBITD) | 0.13 | 0.42 | 0.00 | 0.00 | 0.31 | 9307 | | | | | | |
| Lagged (2015-6 Average) Capital | 380.9 | 2999.2 | 15.5 | 2.1 | 350.0 | 9307 | 250.8 | 2193.3 | 10.9 | 1.8 | 164.1 | 7046 |
| Pre-TCJA $\chi_K$ | 0.10 | 0.30 | 0.00 | 0.00 | 0.28 | 9307 | | | | | | |
| Eq. 15: $\hat{\Gamma}$ | -0.11 | 0.05 | -0.11 | -0.17 | -0.03 | 9305 | -0.11 | 0.05 | -0.11 | -0.17 | -0.04 | 7044 |
| Eq. 15: $\hat{\bar{\Gamma}}$ | 0.02 | 0.05 | 0.00 | 0.00 | 0.14 | 9307 | | | | | | |
| Eq. 15: $\hat{\tau}$ | -0.14 | 0.07 | -0.17 | -0.21 | -0.05 | 9307 | -0.14 | 0.06 | -0.17 | -0.20 | -0.05 | 7046 |
| Eq. 15: $\hat{\bar{\tau}}$ | 0.10 | 0.05 | 0.13 | 0.00 | 0.13 | 9306 | | | | | | |
| Export Share | 0.07 | 0.20 | 0.00 | 0.00 | 0.28 | 9307 | | | | | | |

Panel B: Multinational Samples

| | Multinational-High | | | | | | Multinational-Low | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Median | P10 | P90 | N | Mean | Std. Dev. | Median | P10 | P90 | N |
| Average Tax Rate | 0.04 | 0.05 | 0.01 | 0.00 | 0.12 | 1113 | 0.04 | 0.05 | 0.02 | 0.00 | 0.12 | 1146 |
| Pre-TCJA $\Gamma$ | 0.21 | 0.08 | 0.23 | 0.08 | 0.31 | 1113 | 0.22 | 0.08 | 0.24 | 0.09 | 0.32 | 1148 |
| Pre-TCJA $\bar{\Gamma}$ | 0.18 | 0.00 | 0.18 | 0.18 | 0.18 | 1113 | 0.18 | 0.00 | 0.18 | 0.18 | 0.18 | 1148 |
| Pre-TCJA $\tau$ | 0.25 | 0.10 | 0.28 | 0.10 | 0.35 | 1113 | 0.26 | 0.10 | 0.30 | 0.11 | 0.35 | 1148 |
| Pre-TCJA $\bar{\tau}$ | 0.23 | 0.15 | 0.23 | 0.03 | 0.43 | 1113 | 0.22 | 0.16 | 0.23 | 0.00 | 0.43 | 1148 |
| $d$ log(Investment) | 0.02 | 0.84 | 0.08 | -1.04 | 1.08 | 1113 | -0.01 | 0.89 | 0.09 | -1.18 | 1.11 | 1148 |
| $\hat{\Gamma} - \hat{\tau}$ | 0.04 | 0.03 | 0.04 | 0.01 | 0.08 | 1113 | 0.04 | 0.03 | 0.04 | 0.01 | 0.08 | 1148 |
| Relative Profit (EBITD) | 0.61 | 0.72 | 0.26 | 0.00 | 1.85 | 1113 | 0.20 | 0.40 | 0.05 | 0.00 | 0.55 | 1148 |
| Form 5471: Rel. Profit | 0.91 | 1.09 | 0.42 | 0.00 | 2.79 | 1113 | 0.34 | 0.68 | 0.09 | 0.00 | 1.00 | 1147 |
| Form 5471: Rel. Profit (EBITD) | 0.69 | 0.76 | 0.36 | 0.00 | 2.00 | 1113 | 0.24 | 0.47 | 0.06 | 0.00 | 0.67 | 1148 |
| Lagged (2015-6 Average) Capital | 646.8 | 3002.6 | 72.9 | 4.4 | 1138.3 | 1113 | 921.5 | 5850.8 | 46.8 | 4.9 | 1065.5 | 1148 |
| Pre-TCJA $\chi_K$ | 0.66 | 0.56 | 0.48 | 0.08 | 1.66 | 1113 | 0.09 | 0.18 | 0.04 | 0.00 | 0.23 | 1148 |
| Eq. 15: $\hat{\Gamma}$ | -0.10 | 0.06 | -0.10 | -0.17 | -0.02 | 1113 | -0.11 | 0.05 | -0.11 | -0.17 | -0.03 | 1148 |
| Eq. 15: $\hat{\bar{\Gamma}}$ | 0.08 | 0.07 | 0.14 | 0.00 | 0.14 | 1113 | 0.06 | 0.07 | 0.00 | 0.00 | 0.14 | 1148 |
| Eq. 15: $\hat{\tau}$ | -0.14 | 0.08 | -0.15 | -0.24 | -0.03 | 1113 | -0.14 | 0.07 | -0.16 | -0.22 | -0.04 | 1148 |
| Eq. 15: $\hat{\bar{\tau}}$ | 0.02 | 0.04 | 0.00 | 0.00 | 0.11 | 1113 | 0.03 | 0.05 | 0.00 | 0.00 | 0.13 | 1148 |
| Export Share | 0.29 | 0.35 | 0.10 | 0.00 | 0.99 | 1113 | 0.14 | 0.24 | 0.00 | 0.00 | 0.50 | 1148 |

*Notes*: This table provides summary statistics for four samples. Panel A includes summary statistics for All Firms (Columns 1-5), and Domestic Firms (Columns 6-10). Panel B includes summary statistics for U.S. Multinationals with High Foreign-to-Domestic-Income (Columns 1-5), and U.S. Multinationals with Low Foreign-to-Domestic-Income (Columns 6-10). Capital is in millions of USD. We winsorize $d$ log(Investment) from above and below at the 5% level. For disclosure reasons, we do not report true medians (or other percentiles). Instead, we report the average of observations in neighboring percentile bins.

change measures, which are only available within manufacturing industries. They are import protection, rising input costs, and foreign retaliation measures.

# 5 Regression Estimates

In this section, we present our main empirical results of the effects of TCJA on investment of U.S. C-corporations. The regression specification mirrors model equation (15):

$$Y_{i,t} = b_0 + b_1 \times \hat{\Gamma}_{i,t} + b_2 \times \hat{\bar{\Gamma}}_{i,t} + b_3 \times \hat{\tau}_{i,t} + b_4 \times \hat{\bar{\tau}}_{i,t} + \mathbf{b}_5' \times \mathbf{x}_{i,t} + e_{i,t}, \tag{21}$$

where $Y_{i,t}$ is an outcome, $\Gamma, \bar{\Gamma}, \tau, \bar{\tau}$ are defined as in section 4, $\hat{q} = dq/(1-q)$ for a tax term $q$, and $\mathbf{x}$ contains any controls. The main outcome is investment growth, $Y_{i,t} = d \ln I_{i,t}$, measured as the log difference between pre-TCJA average investment over 2015-2016 and post-TCJA average investment over 2018-2019.[27] We winsorize $Y_{i,t}$ at the 5% level except where otherwise specified.

## 5.1 Identification

In the next section we will use the regression coefficients from specification (21) to recover the structural coefficients given in equation (15). Four issues merit mention now because they affect the empirical implementation.

First, across pre- and post-TCJA steady states where $I_i^* = \delta K_i^*$, investment growth and capital growth coincide. We prefer investment as an outcome because of superior measurement in the tax data.

Second, our baseline specification estimates the short-run elasticities of investment to tax changes, while equation (15) characterizes the long-run elasticities. Section 6 provides conditions under which the short-run elasticities all scale to the long-run elasticities by the same factor, preserving equation (21) as a valid representation of the structural data generating process.

Third, the elasticities in equation (15) depend on firm-specific factors. Most important, domestic-only firms have $\omega_{k,r} = \omega_{k,\tau} = 1$, implying $b_2 = b_4 = 0$ and $b_1 = -b_3$. We therefore

[27] This specification differs from the common approach of regressing the investment-capital ratio on the level of the tax terms and a proxy for $\lambda$ (see, e.g., Desai and Goolsbee, 2004; Edgerton, 2010). Besides the obvious fact that we cannot compute $\lambda$ using the stock market capitalization for the privately held firms in our sample, the benchmark result of Hayashi (1982) does not apply to our model with decreasing returns to scale. Moreover, we show in appendix A.9 that the common regression does not recover structural parameters unless $\lambda$ is properly measured, because $\lambda$ changes endogenously in response to a tax reform.

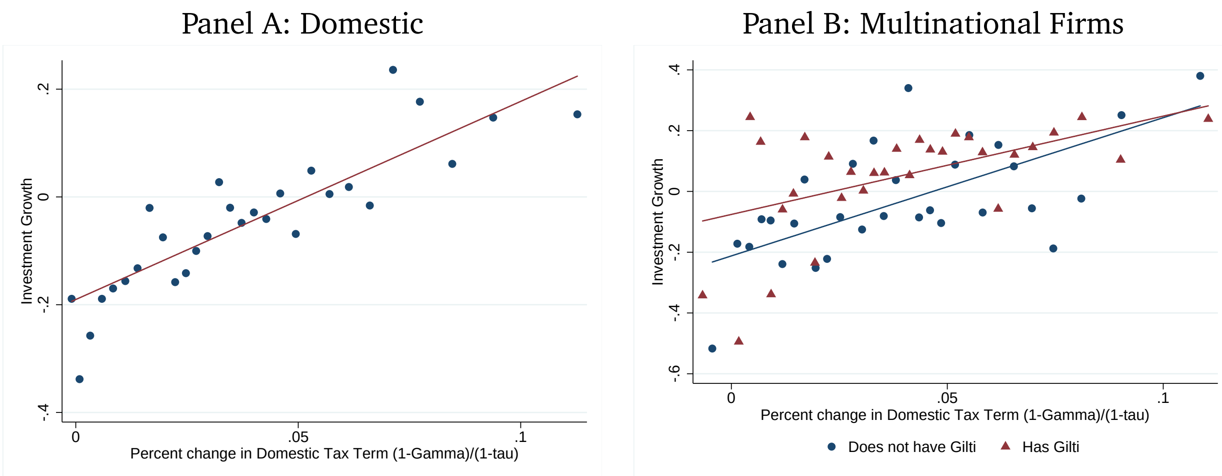
report regressions separately for domestic-only and multinational firms. Furthermore, within multinational firms the relative values of $b_1$ and $b_2$ depend on the degree of foreign presence. Intuitively, holding fixed the production function parameters, firms with very little foreign capital have a smaller domestic investment response to the foreign cost-of-capital. We therefore also report regressions splitting multinational firms by high and low foreign presence, defined as a ratio of foreign-to-domestic tangible capital, $\chi_K = \bar{K}/K$, above or below 15% (roughly the median within the multinational sample). These splits also allow the other structural coefficients to vary across these sets of firms.

Fourth, the residual $e_{i,t}$ contains non-tax determinants of investment growth such as changes in productivity or the price of the firm's capital goods. Since equation (21) estimates changes in investment on changes in taxes, causal interpretation of the estimated coefficients requires the usual difference-in-difference assumption that firms more exposed to TCJA were otherwise on parallel investment paths with firms less exposed. We present evidence of absence of pre-trends and several robustness exercises that control for potential confounds to bolster the plausibility of this assumption. Furthermore, since equation (21) contains multiple, non-binary right hand side variables, in the presence of treatment effect heterogeneity the estimated coefficients are not necessarily convex averages of the individual treatment effects. The sample splits help along this dimension as well.

## 5.2 Non-Parametric Evidence

We start with a non-parametric representation of the data. Figure 4 shows means of investment growth for different quantiles of the composite domestic tax term $\hat{\Gamma} - \hat{\tau}$ ("binned" scatter plots). For domestic-only firms plotted in Panel A, this composite tax term exactly comports with economic theory. The tight upward slope reveals a positive investment elasticity to taxation around TCJA. For multinational firms plotted in Panel B, our theory no longer dictates a single elasticity to $\hat{\Gamma}$ and $\hat{\tau}$. Nonetheless, the upward slope indicates a positive investment elasticity in this sample. Furthermore, Panel B shows the investment responses separately for firms with and without GILTI liability. For a given value of the composite domestic tax term, firms with GILTI liability have higher investment growth. This shift up in the schedule of GILTI versus non-GILTI firms will manifest as a positive value of $b_2$ in the regression. Our calibrated model will account for it by imposing complementarity between foreign and domestic capital in production.

Figure 4: Tax Term Binscatters for Domestic and Multinational Firms




*Notes:* This figure plots the binscatter for both domestic firms and U.S. multinationals where the x-axis is $\hat{\Gamma} - \hat{\tau}$ and the y-axis is $d \ln I$. We further categorized U.S. multinationals by whether or not they are GILTI firms.

## 5.3 Baseline Regressions

Table 3 reports the main regression results for the elasticities of domestic investment. Column (1) pools the entire sample and shows positive and highly statistically significant investment elasticities to the domestic and foreign costs-of-capital $\Gamma$ and $\bar{\Gamma}$ and a statistically significant negative elasticity to the domestic tax rate $\tau$. Evaluated at the mean policy changes (in $\Gamma$, $\bar{\Gamma}$, $\tau$, and $\bar{\tau}$ of -0.10, 0.02, -0.14, and 0.10, respectively), the coefficients imply a roughly 20% increase in domestic investment relative to non-exposed firms. Motivated by our theory, the remaining columns report results for various sub-samples. Columns (2) and (3) focus on domestic-only firms, which comprise about three-quarters of the sample. The elasticities of investment with respect to the domestic tax terms remain of similar magnitude and highly statistically significant in this group, with column (3) imposing the restriction that the coefficients on the domestic cost-of-capital and tax rate be equal and opposite by including only the composite tax term $\hat{\Gamma} - \hat{\tau}$ on the right hand side.

Column (4) reports results for multinational firms and columns (5) and (6) for sub-samples of multinational firms split by their degree of multinational activity. Multinational firms exhibit positive elasticities to $\Gamma$ and $\bar{\Gamma}$ and negative elasticities to $\tau$ across all three samples. In contrast, the elasticity to $\bar{\tau}$ is generally not significant, which may reflect the challenges of inferring firms' pre-TCJA expectations of the eventual U.S. tax rate on foreign earnings and of measur-

Table 3: Baseline Investment Growth Regression

| Dep. var.: | Log change in investment | | | | | |
|---|---|---|---|---|---|---|
| Sample: | Pooled | Domestic Firms | | Multinational firms | | |
| | | Unrestricted | Restricted | All | High | Low |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\hat{\Gamma}$ | 2.65*** | 2.59*** | 3.68*** | 2.96** | 3.74* | 1.92 |
| | (0.48) | (0.52) | (0.44) | (1.11) | (1.58) | (1.59) |
| $\hat{\hat{\Gamma}}$ | 0.65** | | | 0.56* | 1.01* | 0.08 |
| | (0.22) | | | (0.28) | (0.40) | (0.39) |
| $\hat{\tau}$ | −3.41*** | −3.56*** | −3.68*** | −3.35*** | −3.50** | −3.14** |
| | (0.39) | (0.44) | (0.44) | (0.85) | (1.20) | (1.20) |
| $\hat{\hat{\tau}}$ | −0.11 | | | −0.14 | 0.46 | −0.48 |
| | (0.23) | | | (0.43) | (0.70) | (0.56) |
| Constant | −0.25*** | −0.29*** | −0.19*** | −0.21*** | −0.19*** | −0.25*** |
| | (0.03) | (0.03) | (0.02) | (0.04) | (0.06) | (0.07) |
| Observations | 9,304 | 7,044 | 7,044 | 2,261 | 1,113 | 1,148 |

*Notes*: This table presents the results for regressions of the log change in investment on our tax terms across different samples. Column 1 presents the results for our pooled sample of both domestic firms and U.S. multinationals, while columns 2 and 3 report the results for domestic firms. Column 4 provides the results for all U.S. multinationals, while columns 4 and 5 partition U.S. multinationals into those with high and low foreign capital, where high foreign capital firms have a ratio of foreign to domestic capital above 15%. * $p < .05$, ** $p < .01$, *** $p < .001$

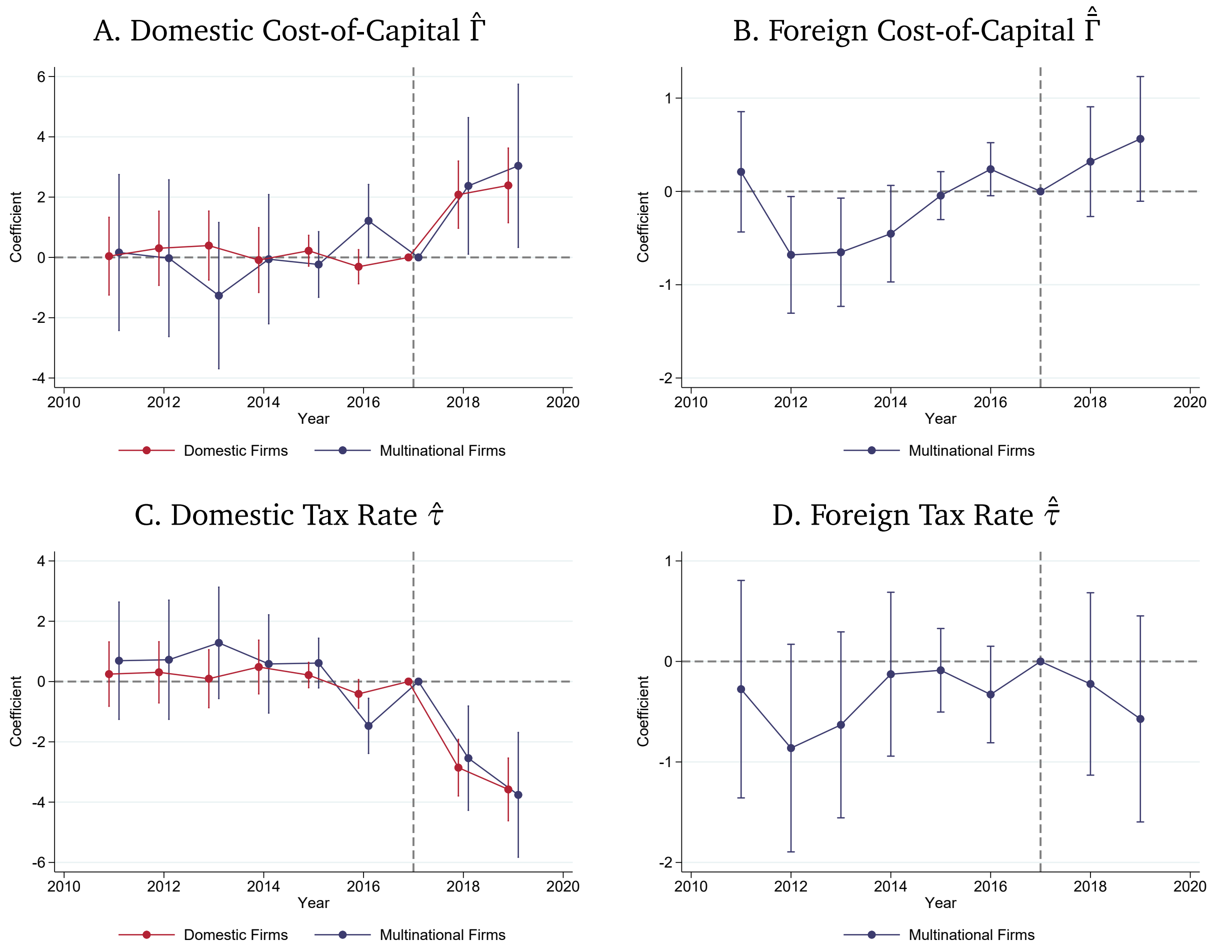
ing foreign tax liability in U.S. tax returns.[28] Consistent with the theory, firms with a larger multinational presence display a greater response of domestic investment to $\bar{\Gamma}$.

Figure 5 displays the evolution of the regression coefficients as the horizon for investment growth changes, holding the right hand side parameters fixed at their pre-to-post TCJA change. These dynamic plots therefore trace out the impulse responses of investment using local projections. For each plot, we report separately the paths of coefficients in the domestic-only and the multinational firm samples. Firms with larger and smaller changes in $\Gamma$ or $\tau$ from TCJA have very similar investment trajectories over the pre-TCJA period, supporting a causal interpretation of the post-TCJA responses. The coefficients for $\bar{\Gamma}$ bounce around a little more in the pre-TCJA period but display no evidence of pre-trends in the years immediately before passage.

Table 4 turns to another key outcome, the response of foreign tangible capital. Through the lens of our theory, the short-run elasticity of foreign capital to $\bar{\Gamma}$ must be positive for complementarity to rationalize the positive $\bar{\Gamma}$ coefficients in table 3. Panel A reports our baseline

[28] If $\hat{\hat{\tau}}$ does not correlate with the domestic tax terms, any classical measurement error will not contaminate those coefficients. Measurement error would tend to attenuate the coefficient on $\hat{\hat{\Gamma}}$, since it implies that the dampening component of GILTI due to higher $\bar{\tau}$ is also attenuated.

Figure 5: Regression Coefficient Plots




*Notes:* These figures plot the tax-term coefficients between 2011-2019 from the regression specified in equation equation (21) using our firm-level corporate tax data. The outcome variable for this regression is log investment growth, and the 2017 coefficient for each tax term is set to zero.

specification in the pooled multinational firm sample but with the log change in foreign capital as the dependent variable. The $\bar{\Gamma}$ coefficient of 1.0 is highly statistically significant and implies an increase in foreign capital of roughly 14% for firms subject to GILTI. Panel B reports the location of foreign capital before and after TCJA. The foreign capital stock of U.S. multinationals grew in all regions, but grew fastest in the G7, BRIC, and other countries. The share of foreign tangible capital in tax havens, and especially in the small island havens, already relatively low before TCJA, fell. This geographic pattern suggests that the reported accumulation reflects actual foreign investment and not simply accounting gimmicks in response to GILTI and hence could plausibly complement domestic capital at home.

Table 4: Foreign Capital Growth

Panel A: Regression

| Regressor: | $\hat{\Gamma}$ | $\hat{\hat{\Gamma}}$ | $\hat{\tau}$ | $\hat{\hat{\tau}}$ | N |
|---|---|---|---|---|---|
| log(Foreign Capital) | $-1.10$ | $1.00^{**}$ | $-0.45$ | 0.17 | 2102 |
| | (1.32) | (0.36) | (1.03) | (0.64) | |

Panel B: Changes in Foreign Capital

| Region: | Pre-Period $\bar{K}$ | Post-Period $\bar{K}$ | Share Pre | Share Post | Change in Share | Capital Growth |
|---|---|---|---|---|---|---|
| Total | \$589,132 | \$704,082 | | | | 20% |
| G7 | \$106,731 | \$131,341 | 18% | 19% | 0.5% | 23% |
| OECD (excluding G7) | \$154,591 | \$179,196 | 26% | 25% | -0.8% | 16% |
| BRIC | \$65,938 | \$82,624 | 11% | 12% | 0.5% | 25% |
| Developing (Non-Bric) | \$24,405 | \$30,775 | 4% | 4% | 0.2% | 26% |
| Tax Haven Non-Islands | \$121,471 | \$143,457 | 21% | 20% | -0.2% | 18% |
| Tax Haven Islands | \$73,794 | \$79,428 | 13% | 11% | -1.2% | 8% |
| Other | \$42,202 | \$57,261 | 7% | 8% | 1.0% | 36% |

*Notes*: Standard errors appear in parentheses. Panel A presents the results of regressing log(Foreign Capital) on our tax terms. The sample for this regression consists of all U.S. multinational firms. Foreign capital in Panel A is winsorized at the 1% level. Panel B summarizes how foreign capital investment (by region) changed after the TCJA. Foreign capital investment (Columns 1-2) is in millions of USD. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

## 5.4 Robustness of Investment Results

Table 5 collects several robustness exercises designed to further support a causal interpretation of the baseline regressions. For compactness, we report coefficients for the restricted domestic and pooled foreign specifications. The first row repeats the baseline coefficients.

The next several rows add different covariates. Rows 2 and 3 show that the estimates are very similar with NAICS 3 or 4 digit fixed effects. These industry controls absorb many possible alternative influences of investment. Row 4 addresses the particular concern of the "trade war" in 2017 by including three trade war exposure measures from Flaaen and Pierce (2019), again with little impact on the tax elasticities. Row 5 controls for size bins and row 6 for lagged investment, again with little impact.

The remaining rows perturb the specification or sample. Row 7 weights the regression by lagged log capital. The tax elasticities remain broadly similar, albeit slightly smaller. Row 8 drops industries with high investment through partnerships that our investment measure may

Table 5: Regression Robustness Checks

| Sample: | Domestic | | Multinational Firms | | | | |
|---|---|---|---|---|---|---|---|
| Regressor | $\hat{\Gamma} - \hat{\tau}$ | N | $\hat{\Gamma}$ | $\hat{\hat{\Gamma}}$ | $\hat{\tau}$ | $\hat{\hat{\tau}}$ | N |
| Specification: | | | | | | | |
| 1. Baseline | 3.68*** | 7044 | 2.96** | 0.56* | −3.36*** | −0.14 | 2261 |
| | (0.44) | | (1.12) | (0.28) | (0.85) | (0.43) | |
| 2. Industry FE (NAICS 3D) | 3.32*** | 7044 | 2.35* | 0.57* | −2.86*** | −0.25 | 2261 |
| | (0.44) | | (1.08) | (0.28) | (0.84) | (0.40) | |
| 3. Industry FE (NAICS 4D) | 3.36*** | 7044 | 2.12 | 0.67* | −2.52** | −0.28 | 2261 |
| | (0.45) | | (1.13) | (0.30) | (0.87) | (0.42) | |
| 4. Trade Controls | 3.72*** | 7044 | 2.90** | 0.53 | −3.31*** | −0.07 | 2261 |
| | (0.44) | | (1.12) | (0.28) | (0.85) | (0.43) | |
| 5. Size Controls | 3.68*** | 7044 | 2.96** | 0.56* | −3.36*** | −0.13 | 2261 |
| | (0.44) | | (1.12) | (0.28) | (0.85) | (0.43) | |
| 6. Lagged Investment | 3.31*** | 7044 | 2.11 | 0.50 | −2.67** | −0.02 | 2261 |
| | (0.49) | | (1.11) | (0.27) | (0.85) | (0.46) | |
| 7. Weighted | 3.70*** | 6827 | 2.92** | 0.55* | −3.36*** | −0.14 | 2241 |
| | (0.45) | | (1.12) | (0.28) | (0.85) | (0.43) | |
| 8. Drop Industries | 3.42*** | 7044 | 2.68* | 0.63* | −3.03*** | −0.17 | 2261 |
| | (0.41) | | (1.07) | (0.28) | (0.83) | (0.43) | |
| 9. Simulated IV | 3.68*** | 7044 | 2.94** | 0.55* | −3.35*** | −0.13 | 2261 |
| | (0.44) | | (1.12) | (0.28) | (0.85) | (0.43) | |

*Notes*: This table presents the results for regressions of the log change in investment on our four tax terms for domestic firms and U.S. multinationals under different robustness specifications. Row 1 presents our baseline results. Rows 2 and 3 include 3-digit and 4-digit NAICS fixed effects. Row 4 includes controls for trade shocks. Row 5 controls for pre-period capital, while row 6 controls for pre-period investment. Row 7 weighs by the log of the mean capital from 2015-2016. Row 8 drops industries with high baseline investment from partnerships (2-digit NAICS 22 and 3-digit NAICS 486 and 531, which represent utilities, pipeline transportation, and real estate). Lastly, row 9 presents a simulated IV using post-TCJA tax rates. * $p < .05$, ** $p < .01$, *** $p < .001$

miss, with small changes in the coefficients. Row 9 drops firms that have at least 50% of their foreign income in tax havens [awaiting disclosure].[29] The results are essentially unchanged, suggesting firms likely to be active profit-shifters are not driving the results.

The final row reports coefficients from a simulated IV regression. In our baseline regression, $\hat{\tau}$ comes from applying pre and post-TCJA tax law to the projected income path starting from a firm's 2015 and 2016 tax returns to generate METRs for 2015 and 2016 with and without TCJA. The row 10 specification instead uses this measure as an excluded instrument, with the endogenous variable the difference between the average METR in 2015 and 2016, obtained by

[29] For this categorization, we consider both income in dot havens like Bermuda and the Cayman Islands and non-dot havens like Ireland and the Netherlands. Within the sample of multinational firms, these firms account for 7% of the sample of firms and 30% of foreign and domestic capital.

applying pre-TCJA tax law to the firm's 2015 and 2016 tax returns and simulated income paths, and in 2018 and 2019, obtained by applying post-TCJA tax law to the firm's 2018 and 2019 tax returns and simulated income paths. Differences between the excluded instrument and endogenous variable arise because of changes in firms' taxable income statuses or deductions and credits between these years. In practice these inputs are very persistent and the simulated IV yields very similar coefficients.[30]

### 5.5 Other Outcomes

Table 6, Panel A shows results for other firm outcomes: the investment to capital ratio, log domestic capital accumulation, log investment by subcomponent, log tax revenue, log labor compensation, log salaries and wages, and log officer compensation.[31] The investment-to-capital ratio increases strongly with the tax term, $\hat{\Gamma} - \hat{\tau}$ in the domestic sample. The effects on domestic capital mirror those on investment. Both equipment and structures investment increase by a comparable magnitude, indicating that the total tangible investment response in the main specifications comes from a combination of both types of investment. We also report R&D investment effects for completeness although we did not include the effects of amortization changes in the tax terms, so the full policy change and full effect is not captured in this specification. The log tax revenue term declines with the policy change and the wage bill measures all increase in the domestic sample. The labor market effects in the multinational sample are less precise.

## 6 Structural Parameters

This section estimates the key model parameters.

### 6.1 Estimated Parameters

We use the method of moments to recover the parameters $\alpha, \sigma, a, \bar{a}$ and $\chi_K$. We obtain separate sets of parameters for domestic-only, multinational with high foreign presence, and multinational with low foreign presence firms. We start from six empirical moments in our data: the regression coefficients $b_1, b_2, b_3, b_4$, the ratio of capital at foreign subsidiaries to the domestic

[30]The simulated IV also addresses the possible role of attenuation coming from constructing the METRs using firm-level income simulations.

[31]Labor compensation is the sum of the following line items on the corporate tax form: salaries and wages, officer compensation, pension benefits and profit sharing plans, and employee benefit programs.

Table 6: Additional Outcomes

| Sample: | Domestic Firms | | Multinational Firms (Pooled) | | | | |
|---|---|---|---|---|---|---|---|
| Regressor: | $\hat{\Gamma} - \hat{\tau}$ | N | $\hat{\Gamma}$ | $\hat{\hat{\Gamma}}$ | $\hat{\tau}$ | $\hat{\hat{\tau}}$ | N |
| Outcome: | | | | | | | |
| $\frac{\text{Investments}}{\text{Capital}}$ | 0.49*** | 6963 | 0.34 | 0.07 | −0.50* | −0.04 | 2244 |
| | (0.08) | | (0.27) | (0.07) | (0.20) | (0.10) | |
| log(Domestic Capital) | 1.72*** | 6955 | 1.33* | 0.59*** | −1.96*** | 0.23 | 2214 |
| | (0.20) | | (0.60) | (0.17) | (0.47) | (0.26) | |
| log(Equipment) | 3.85*** | 7008 | 2.68* | 0.49 | −3.13*** | −0.16 | 2255 |
| | (0.40) | | (1.05) | (0.26) | (0.80) | (0.41) | |
| log(R&D) | 1.18* | 1336 | 1.31 | 0.39 | −1.63* | −0.53 | 1398 |
| | (0.56) | | (0.92) | (0.22) | (0.70) | (0.34) | |
| log(Structures) | 3.23** | 3579 | −0.69 | 1.57* | −0.87 | 0.95 | 1477 |
| | (1.18) | | (2.92) | (0.73) | (2.20) | (1.14) | |
| log(Tax Revenue) | −2.55*** | 4145 | 1.58 | 2.43*** | 4.88** | 2.45* | 1336 |
| | (0.72) | | (1.92) | (0.68) | (1.66) | (1.01) | |
| log(Labor Comp.) | 0.73*** | 6029 | −0.26 | 0.15 | −0.11 | 0.19 | 1989 |
| | (0.11) | | (0.34) | (0.09) | (0.26) | (0.14) | |
| log(Salaries & Wages) | 0.86*** | 5892 | 0.17 | 0.16 | −0.51 | 0.31 | 1982 |
| | (0.14) | | (0.39) | (0.11) | (0.30) | (0.17) | |
| log(Officer Comp.) | 0.45* | 5046 | −1.14 | 0.03 | 0.89 | 0.32 | 1813 |
| | (0.20) | | (0.65) | (0.18) | (0.50) | (0.26) | |

*Notes*: Standard errors appear in parentheses. This table contains coefficients from running regressions after restricting the sample to domestic firms (Columns 1-2), and U.S. multinational firms (Columns 3-7). Outcome variables appear as row names. Domestic capital and tax revenue are winsorized at the 1% level. All other outcomes are winsorized at the 5% level. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

parent, $\chi_K$, and the ratio of after-tax profits, denoted $\chi_\tau \chi_F$. We measure $\chi_K$ as the ratio of foreign tangible capital from Form 5471 to domestic tangible capital from Form 1120, Schedule L. We measure $\chi_F$ by summing all foreign non-dividend income reported on Form 5471.[32]

If the regression coefficients had come from specifications with long-run changes in capital or investment as the dependent variable, these moments would suffice to identify the parameters, as we show shortly. In our setting where the coefficients correspond to short-run elasticities, identification requires also determining the ratios of short-run to long-run elasticities, which in turn depend on the capital adjustment costs.[33] We proceed in two steps, first describ-

[32]The exclusion of dividend income avoids double-counting of income generated by tiered ownership structures, partly addressing the concerns of Blouin and Robinson (2020). Per conversations with experts, double-counting of tangible capital in these data is less of a concern due to fixed asset consolidation practices.

[33]Appendix A.7 gives the linearized solution for the transition path from the old to new steady state and provides formulas for the short-run and long-run elasticities.

ing our procedure for handling adjustment costs and then the identification of the parameters of interest conditional on the short-to-long-run ratios.

In the first step, we show in appendix A.7 that with no foreign adjustment costs, the four tax term elasticities $b_1, b_2, b_3, b_4$ all scale by approximately the same ratio of short-run to long-run investment, denoted $\chi_{SR}$.[34] This ratio therefore serves as a sufficient and portable statistic for the effect of domestic adjustment costs on the empirical moments. Furthermore, the large positive value of the $\bar{\Gamma}$ elasticity effectively *requires* no foreign adjustment costs, because domestic investment responds to $\bar{\Gamma}$ only through its impact on foreign capital.[35] Our preferred value for $\chi_{SR}$ of 1.3 comes from Winberry (2021) and we next apply this value directly to each short-run elasticity.[36] Figure A.1 shows that the model-implied path of capital varies little over the first several years across values of $\chi_{SR}$ ranging from 1 to 1.6, which highlights the difficulty of estimating this parameter internally and the benefit of calibrating it transparently.

In the second step, we choose parameters to minimize the distance between the data and model-implied moments. Let $\theta = (\alpha, \sigma, a, \bar{a}, \chi_K)'$ denote the set of parameters. Using equation (15) and appendix A.2.5, equations (22) to (27) illustrate identification by giving closed-form formulas for the set of model moments in terms of only $\theta$, $\chi_{SR}$, and $\chi_R$:

$$b_1(\theta) = \chi_{SR}\omega_{k,r}/(1-\alpha), \tag{22}$$

$$b_2(\theta) = \chi_{SR}\left(1-\omega_{k,r}\right)/(1-\alpha), \tag{23}$$

$$b_3(\theta) = \chi_{SR}\omega_{k,\tau}/(1-\alpha), \tag{24}$$

$$b_4(\theta) = \chi_{SR}\left(1-\omega_{k,\tau}\right)/(1-\alpha), \tag{25}$$

[34] Specifically, in general the dynamic system governing the transition path has two non-explosive roots that determine the speed of convergence and the tax terms depend heterogeneously on each root. With no foreign adjustment costs, the dynamic system has only one root, in which case the elasticities all scale by the same amount up to terms involving third derivatives of the production function, which are small. We verify this equivalence numerically at our estimated parameter values. Intuitively, the difference between the ratio of short-run to long-run elasticities to e.g. $\Gamma$ and $\bar{\Gamma}$ arises primarily because both ratios depend on the magnitude of domestic adjustment costs but the short-run elasticity to $\bar{\Gamma}$ also depends on the foreign adjustment cost. When $\bar{\phi} \to 0$, the only remaining difference occurs because foreign capital does not quite jump immediately to its long-run value, because of the feedback from growing domestic capital to foreign capital. This feedback effect is small.

[35] More precisely, the magnitude of the $\bar{\Gamma}$ coefficient relative to the $\Gamma$ coefficient requires much larger domestic than foreign adjustment costs, because domestic investment responds directly to changes in $\Gamma$ but only indirectly to changes in $\bar{\Gamma}$ through the accumulation of foreign capital and production complementarity. The prevalence of mergers and acquisitions (M&A) rather than acquisition of newly built capital may explain low foreign adjustment costs. Since our main model outcomes concern domestic rather than foreign capital, whether U.S. firms increase their foreign capital stock through new investment or M&A does not matter to aggregation.

[36] Winberry (2021) estimates a rich model of fixed and convex adjustment costs using moments of the investment distribution from Zwick and Mahon (2017) that come from the same SOI sample as our data set. We use his replication code to construct impulse responses of investment in his model to nearly permanent domestic tax changes and compute the ratio of the response at 10 years to the average response over the first two years. See appendix A.8 for details.

$$\chi_K(\theta) = \chi_K, \tag{26}$$

$$\chi_\tau \chi_F(\theta) = \left( \frac{(1-a)\,\chi_K^{-\frac{1}{\sigma}} - a\chi_R}{(1-\bar{a})\,\chi_R - \bar{a}\chi_K^{-\frac{1}{\sigma}}} \right) \left( \frac{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}} + (1-\bar{a})}{a + (1-a)\,\chi_K^{\frac{\sigma-1}{\sigma}}} \right), \tag{27}$$

where $\omega_{k,r}$ and $\omega_{k,\tau}$ are functions of $\alpha, \sigma, a, \bar{a}$ and $\chi_K$ only, as given in equations (11) to (14), (16) and (17).[37]

Equations (22) to (27) contain the following intuition for parameter identification. For domestic firms, $\omega_{k,r} = \omega_{k,\tau} = 1$ and hence the coefficients on $\tau$ and $\Gamma$ have opposite signs of equal magnitude, each of which equals the inverse of $1-\alpha$. We impose this condition already in the regression in column (3) of table 3. For multinational firms, instead the sums of the coefficients on $\Gamma$ and $\bar{\Gamma}$ and on $\tau$ and $\bar{\tau}$ equate, with each sum equaling the inverse of $1-\alpha$. Furthermore, given the profit elasticity $\alpha$, the requirement that domestic capital responds positively to a subsidy to foreign capital (the coefficients on $\bar{\Gamma}$ in table 3 are positive) bounds the admissible elasticity of substitution between foreign and domestic capital $\sigma$. The magnitudes of the regression coefficients and the profit ratio inform the relative magnitudes of $\sigma, a$, and $\bar{a}$.

We operationalize the estimation as follows. We exclude $b_4$ from the set of data moments because of the difficulty in measuring the tax change $\hat{\bar{\tau}}$ given unobserved expectations about pre-TCJA unrepatriated profits and because the moment itself is redundant given $b_1, b_2$ and $b_3$. Thus for domestic firms we have the set of data moments $\hat{m}^D = (b_1, b_3)'$ and for each group of multinational firms the set of data moments $\hat{m}^M = (b_1, b_2, b_3, \chi_K, \chi_\tau \chi_F)'$. Let $m^D(\theta) = (b_1(\theta), b_3(\theta))'$and $m^M(\theta) = (b_1(\theta), b_2(\theta), b_3(\theta), \chi_K(\theta), \chi_\tau \chi_F(\theta))'$ denote the corresponding model-implied moments. Let $V^g$ denote the covariance matrix of the data for group $g$, where the variances of $\chi_K$ and $\chi_\tau \chi_F$ come from the cross-sectional distribution in the appropriate sample of firms. We obtain $\hat{\theta}$ to minimize $(m(\theta) - \hat{m})' W (m(\theta) - \hat{m})$ for a weight matrix $W = (\text{diag}(V))^{-1}$.[38]

Panels A and B of table 7 list the moments and resulting parameters. For domestic firms, the value of $\alpha$ follows directly from the value of $b_1 = -b_3$ and $\chi_{SR}$. The fitted model moments for the multinational firms with high foreign presence match their data counterparts almost exactly, indicating that the point estimates of the data coefficients satisfy the cross-equation restrictions imposed by the model. For the multinational firms with low foreign presence, the

[37]Since we do not have firm-by-firm information on foreign expensing, we set $\chi_R = 1$ and do not discuss this parameter further.

[38]We perform the minimization in two steps to ensure a global optimum. In the first step, we find a candidate $\hat{\theta}$ by searching over a wide grid of values for the parameters. In the second step, we use a numerical solver starting from this candidate value.

Table 7: Moments and Parameters

| Panel A: Moments | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $b_1$ | | $b_2$ | | $b_3$ | | $\chi_K$ | | $\chi_\tau \chi_F$ | |
| | Data | Model | Data | Model | Data | Model | Data | Model | Data | Model |
| Group: | | | | | | | | | | |
| Domestic | 2.83 | 2.83 | | | −2.83 | −2.83 | | | | |
| Multinat. high | 2.88 | 2.88 | 0.78 | 0.78 | −2.69 | −2.69 | 0.57 | 0.57 | 0.62 | 0.62 |
| Multinat. low | 1.48 | 2.14 | 0.06 | 0.05 | −2.42 | −2.02 | 0.05 | 0.05 | 0.12 | 0.11 |

| Panel B: Parameters chosen to match moments | | | | | |
|---|---|---|---|---|---|
| | $\chi_K$ | $\alpha$ | $\sigma$ | $a$ | $\bar{a}$ |
| Group: | | | | | |
| Domestic | | 0.65 | | | |
| Multinat. high | 0.57 | 0.73 | 0.76 | 0.95 | 0.82 |
| Multinat. low | 0.05 | 0.54 | 0.78 | 1.00 | 0.26 |

| Panel C: Other parameters | | |
|---|---|---|
| Symbol | Name | Value |
| $\rho$ | Discount rate | 0.06 |
| $\delta$ | Depreciation rate | 0.1 |
| $\alpha_L$ | Labor share of revenue | 0.65 |
| $\phi$ | Adjustment cost | {1.5,1.1,1.8} |

model regression coefficients $b_1$ and $b_3$ do not exactly match the data. These firms are "almost domestic" both in their values of $\chi_K$ and $\chi_\tau \chi_F$ and in the small regression coefficient $b_2$; as a result, the model requires the absolute values of $b_1$ and $b_3$ to be closer than they are in the data.

Turning to parameters, the multinational firms with high foreign presence have the highest estimated $\alpha$. The values of $\sigma$ in the multinational high and low groups are quite similar, despite the value of $b_2$ being much smaller in the multinational-low group. As discussed already, the low multinational presence implies less responsiveness of domestic capital to the foreign cost-of-capital even for the same value of $\sigma$. To interpret the values of $a$ and $\bar{a}$, note that $\chi_K = 1 \Rightarrow a/(1-a) = F_1(K,\bar{K})/F_2(K,\bar{K})$, that is, for a firm with equal foreign and domestic capital, $a/(1-a)$ equals the ratio of the marginal product of domestic earnings with respect to domestic and foreign capital. A value of $a = 0.95$ thus implies that incrementing domestic capital would increase domestic earnings by roughly 19 times as much as incrementing foreign capital would. Interestingly, while we estimate the foreign subsidiaries of firms with a large multinational presence to be relatively intensive in foreign capital, for those firms with a small multinational presence their foreign productivity depends more on domestic than on foreign capital.

## 6.2 Tax Changes and Other Parameters

We set several other parameters using external information, shown in panel C of table 7. We set the discount rate $\rho$ to 0.06 and the depreciation rate $\delta$ to 0.1, consistent with our measurement of the tax shocks. We set the labor share of revenue $\alpha_L$ to 0.65, as in Winberry (2021). This parameter matters only for translating changes in capital into changes in wages and output. We ignore materials inputs and markups for simplicity, $\alpha_M = 0, \mathscr{M} = 1$. We internally set the adjustment cost parameter $\phi$ for each group to match the value of $\chi_{SR}$ (see appendix A.7).

We group firms into "portfolios" based on their domestic/multinational high/low status and their tax changes. Table C.6 shows these portfolios, the share of capital in each, average capital per firm from SOI, and the pre- and post-TCJA tax rates. The "low-tax" firms had pre-TCJA domestic rates as low as 15% while the "high-tax" firms essentially face the statutory rate. Accordingly, the low-tax firms had smaller tax changes. For multinational firms, we further divide by whether GILTI was binding on the firm or not. In addition to the firms representing the SOI, we add a domestic non C-corporate sector calibrated using figure 3 to be 29% of private sector capital.[39] Since we study the effects of the provisions of TCJA affecting C-corporations, we assign no tax changes to this sector and including it matters only for general equilibrium labor market clearing.[40]

Finally, we need to assign productivities $A$ and $\bar{A}$ to each firm. Given $\alpha, \sigma, a, \chi_K$, and $\alpha_L$, the ratio $\chi_A = \bar{A}/A$ follows immediately from equation (A.35). We choose $A$ to match the capital-per-firm shown in table C.6. This procedure assigns higher productivity to the larger multinational firms than the domestic-only firms.

[39] Since the top line in figure 3 is private investment, this calibration implicitly segments the private sector from government. We assume the non-corporate sector has the same capital-per-firm as the domestic-only C-corporation sector, although this assumption matters little to our results.

[40] The expensing provisions applied to non C-corporations as well. However, these entities also were affected by several other changes in the TCJA such as reductions in personal income tax rates, making it conceptually cleaner to consider exercises affecting taxation of C-corporations only.

### 6.3 Parameter Validation

An important untargeted moment is the response of foreign capital to changes in $\bar{\Gamma}$. Were the model to imply a much larger elasticity than in the data, it would suggest the possibility of forces beyond capital complementarity in driving the relationship between domestic investment and the foreign cost of capital. We construct this elasticity in the model by perturbing the value of post-TCJA $\bar{\Gamma}$ around its mean value and calculating the log deviation of foreign capital $\bar{K}$ averaged over the first two years. This exercise yields elasticities of 1.00 and 0.65 for multinational-high and low firms, respectively, which compares well to the elasticity of 1.00 in table 6.

## 7 Model Quantification

This section summarizes and decomposes the effects of TCJA on capital, investment, and revenue.

### 7.1 Capital and Investment

We start with a (nearly) "model-free" quantification. Column (1) of table 8 reports the steady state partial equilibrium change in domestic capital (or equivalently investment), computed as the capital-weighted fitted values using the regressions reported in table 3, adjusted by $\chi_{SR}$. These changes correspond to partial equilibrium because we compute the fitted values without the constant term and hence omit any GE effects, such as changes in wages that affect all firms. The regression coefficients directly imply capital rises by 11.8% for domestic-only firms, 18-20% for multinational firms, and 15.7% for the corporate sector as a whole. The standard errors provide tight bounds around these values.

Imposing the model structure allows us to move from partial to general equilibrium, decompose the role of different tax changes, and explore policy counterfactuals. Column (2) of table 8 reports the partial equilibrium effects in the model for comparison with the model-free estimates. That is, we use the estimated parameters from table 7 and the tax changes by group from table C.6 to compute the steady-state change for each group if wages remain fixed. For domestic-only firms, the model imposes no additional restrictions beyond those already imposed on the data by combining the $\hat{\Gamma}$ and $\hat{\tau}$ into a single regressor $\hat{\Gamma} - \hat{\tau}$. The partial equilibrium responses from the data and the model therefore nearly agree by construction. For multinational-high firms, the data and model partial equilibrium effects also nearly agree, but

Table 8: Long-run $K$ and $I$ by Group

| | PE Data | PE Model | GE Model |
|---|---|---|---|
| Group: | | | |
| Domestic | 11.76 | 11.08 | 6.01 |
| | (1.41) | (1.41) | (1.74) |
| Multinat. high | 18.76 | 19.19 | 14.05 |
| | (3.73) | (4.52) | (4.92) |
| Multinat. low | 20.30 | 6.89 | 3.38 |
| | (4.82) | (6.84) | (6.59) |
| Total | 15.65 | 12.14 | 7.43 |
| | (1.68) | (2.16) | (2.45) |

*Notes:* The table shows long-run changes in domestic corporate capital (or equivalently investment) for domestic-only firms, multinational firms with high foreign presence, multinational firms with low foreign presence, and in total. Column (1) directly applies the regression coefficients in table 3 to the tax changes by group in table C.6. Column (2) uses the parameters estimated in table 7 to compute the model-implied change when the aggregate economy faces perfectly elastic labor supply and the wage remains fixed. Column (3) repeats the exercise from column (2) but when the aggregate economy faces inelastic labor supply. Standard errors in parentheses are computed via the Delta method.

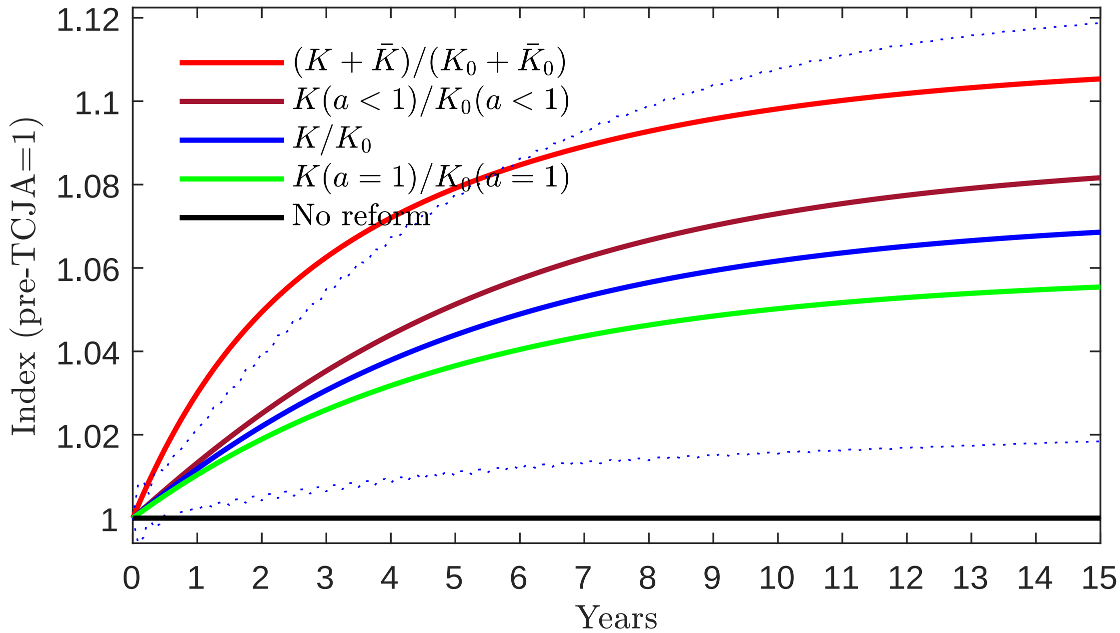
in this case because the multinational-high regression coefficients obey the additional cross-equation restrictions in the model. For the multinational-low group, the data response exceeds the model response, because the model's cross-equation restrictions yield parameters that imply a larger response to $\hat{\Gamma}$ and smaller response to $\hat{\tau}$ than the regression coefficients (see table 7). The total corporate sector model-implied partial equilibrium response increase in capital is 12.1% with a standard error of 2.2%.[41]

Column (3) of table 8 shows the general equilibrium change in domestic capital in the model, meaning when wages rise and the total supply of labor to the domestic corporate and non-corporate sector remains fixed. In general equilibrium, the corporate provisions of the TCJA increase total corporate capital by 7.4% in the long-run, with a standard error of 2.4p.p. The general equilibrium dampening of 4.7p.p. relative to partial equilibrium stems from an increase in the domestic wage of about 0.9%.[42]

[41] We compute standard errors for the model partial and general equilibrium values using the parameter covariance matrix and the Delta method. These standard errors therefore account for sampling variation in the target moments of the parameter estimation. Specifically, let the superscripts $D, H, L$ refer to parameters estimated for the domestic, multionational-high, and multinational-low firms, respectively, and define the full parameter vector as $\theta \equiv \{\alpha^D, \alpha^H, \sigma^H, a^H, \bar{a}^H, \chi_K^H, \alpha^L, \sigma^L, a^L, \bar{a}^L, \chi_K^L\}$. For each parameter $\theta_p \in \theta$, we recompute the steady state response $K/K_0$ replacing $\theta_p$ with $\theta_p^+ = \theta_p + \epsilon$ and with $\theta_p^- = \theta_p - \epsilon$ for $\epsilon = 10^{-4}$. The Jacobian is then $J(p) = \left(K^*\left(\theta_p^+\right)/K_0\left(\theta_p^+\right) - K^*\left(\theta_p^-\right)/K_0\left(\theta_p^-\right)\right)/(2\epsilon)$. The variance is $J(p)'V(\theta)J(p)$, where $V(\theta)$ is the covariance matrix of the parameters computed as in Chamberlain (1982).

[42] Roughly, an increase of 0.9% reduces the multiplicative factor in the earnings function $Z$ by about $\alpha_L/(1-\alpha_L) \times 0.9 = 1.8\%$ (see equation (A.3)). The capital-weighted elasticity of capital to $Z$ or $\tau$ of roughly 2.6 ($b_3$

Figure 6: TCJA and Model-Implied Capital



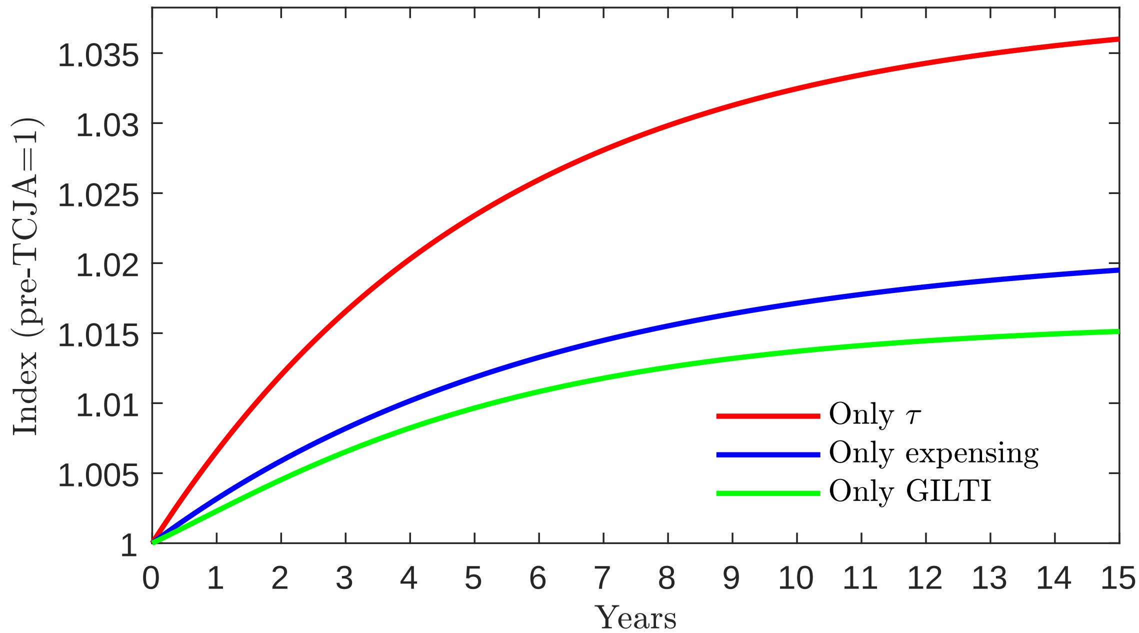

*Notes:* The figure shows the model-implied paths of total domestic and foreign capital of domestic corporations (solid red line), total domestic corporate capital (solid blue line), and total domestic corporate capital of multinational (solid brown line) and domestic-only firms (solid green line). The dotted blue lines show the 95% confidence interval for the response of domestic corporate capital.

Figure 6 plots the model-implied general equilibrium transition paths of domestic and total corporate capital. The solid blue line shows that total domestic corporate capital achieves a 7% increase after 15 years. For this series, we also report 95% confidence interval bands.[43] The red line shows the path of total domestic and foreign capital owned by the domestic corporate sector. This measure corresponds to total capital in a data set such as Compustat that does not separate domestic from foreign capital. Total capital owned by domestic firms rises by proportionately more than domestic capital, primarily due to the strong incentive in the GILTI rule for firms to accumulate foreign capital. Due to the complementarity between foreign and domestic capital, total domestic capital at multinational firms (brown line) therefore also rises by more than total domestic capital at domestic-only firms (green line).

in table 7) then accounts for the 4.7p.p. dampening. Of course, the size of the wage response, and hence the general equilibrium dampening and the impact on labor tax revenue discussed shortly, depends in general on the elasticity of substitution between capital and labor, which we set to 1.

[43]We compute confidence intervals using the same method to report standard errors in table 8. Specifically, for each parameter $\theta_p \in \theta$, we recompute the impulse response of $K/K_0$ replacing $\theta_p$ with $\theta_p^+ = \theta_p + \epsilon$ and with $\theta_p^- = \theta_p - \epsilon$ for $\epsilon = 10^{-4}$. The $p$th row of the horizon $h$ Jacobian is then $J(h,p) = \left(K_{t+h}\left(\theta_p^+\right)/K_0\left(\theta_p^+\right) - K_{t+h}\left(\theta_p^-\right)/K_0\left(\theta_p^-\right)\right)/(2\epsilon)$. The horizon $h$ variance is $J(h,p)'V(\theta)J(h,p)$, where $V(\theta)$ is the covariance matrix of the parameters computed as in Chamberlain (1982).

Figure 7: Model-Implied Capital by TCJA Provision




The figure shows the model-implied paths of domestic corporate capital applying only the TCJA changes to the METR $\tau$ (red line), to expensing (blue line), or GILTI (green line).

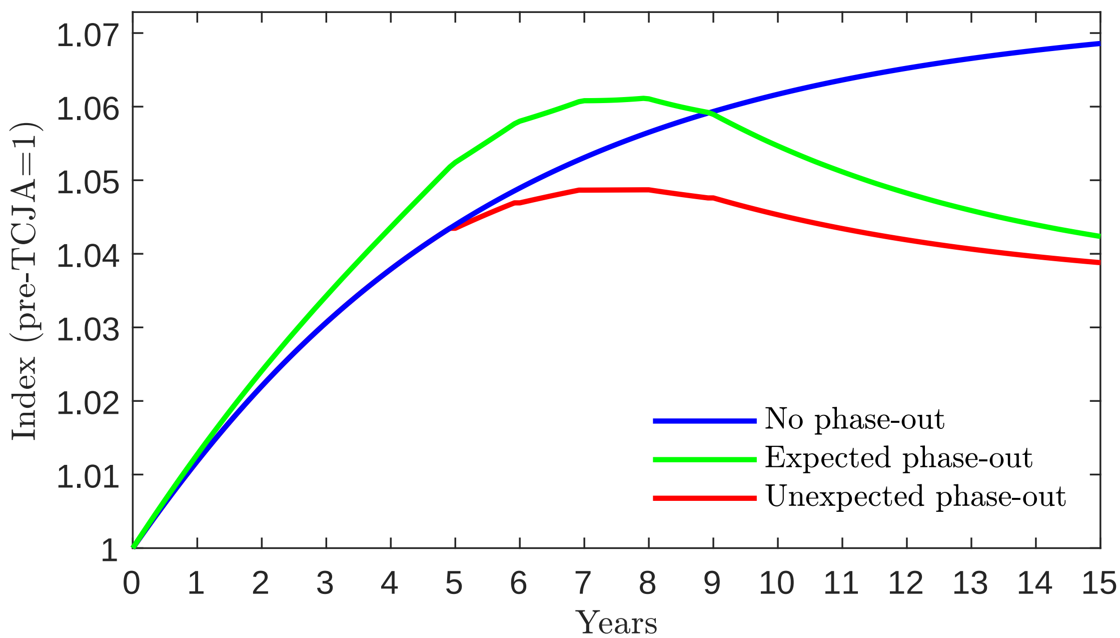
## 7.2 Role of Different Shocks and Phase-out

Figure 7 shows the role of the different tax variables in the response of total domestic capital. Changes in the METR $\tau$ alone would have increased capital by about 3.5% after 15 years, or about half of the total response. Moving from 50% to 100% bonus depreciation by itself would have increased capital by about 2%.[44] Strikingly, the incentive to accumulate foreign capital through GILTI and the induced increase in domestic capital alone account for about a 1.5% increase in domestic capital. We stress these calculations do not imply that one provision was more effective than another because they do not account for differences in the costs. For example, the corporate rate reduction was also expected to reduce tax revenues the most.

Figure 8 explores the importance of our baseline assumption that 100% bonus depreciation would become a permanent feature of tax policy and that firms anticipated this change. The green line shows the path of capital in a scenario where firms expected phase-out of expensing as written into the TCJA law, namely a decline of 100% to 80% in 2023 and further declines of 20p.p. per year thereafter until reaching 0. In the short-run, these expectations increase

[44]Throughout this section, exercises labeled expensing-only also include the effect of the FDII 10% threshold, which amounts to an additional tax change of 37.5% × the marginal rate × the export share × 10% of domestic tangible capital.

Figure 8: Role of Expensing Phase-out




*Notes:* The figure shows the model-implied paths of domestic corporate capital under the baseline assumption of no phase-out or expected phase-out of the expensing provisions (blue line), when firms fully anticipate phase-out of expensing as written into the TCJA law (green line), or when firms are surprised each year that bonus depreciation ratchets down (red line).

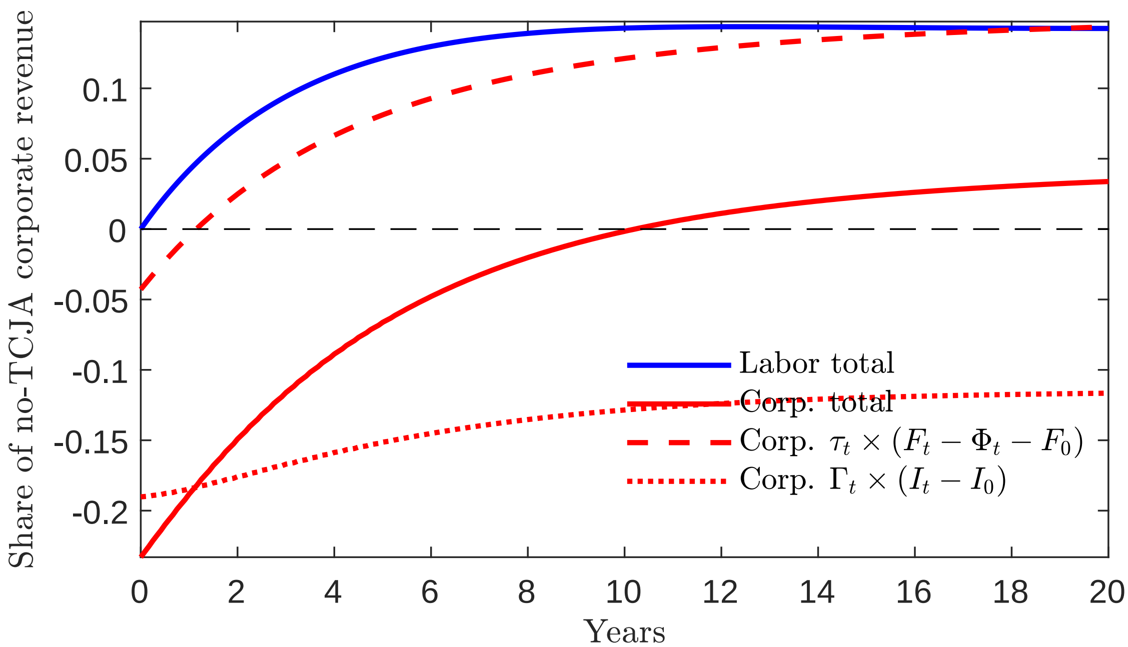
investment and capital relative to the permanent case. The short-run overreaction occurs because our values for discount and depreciation rates yield intertemporal substitution toward investment in periods with higher expensing that outweighs the dampening effect of a lower terminal capital stock.[45] The red line shows the path of capital if firms did not expect phase-out but it occurs anyway. This scenario results in the same short-run behavior of capital by construction but a lower terminal capital stock.

## 7.3 Tax Revenue

The total effect of the TCJA's corporate provisions on tax revenue combines two forces: (i) the static revenue effect of the tax changes holding the capital stock fixed, and (ii) the revenue consequences of the dynamic changes in capital induced by the law. The last column of table 1 shows the JCT's estimates of (i). Our empirical analysis and general equilibrium model of the

[45] In this sense, our conclusions about the overall investment effects of the TCJA's corporate provisions provide an upper bound if firms expected the expensing provisions to expire, since some of the short-run investment response would then stem from the intertemporal incentive rather than the long-run tax policy changes to which we ascribe it.

Figure 9: Dynamic Revenue Effects




*Notes:* The figure shows the effect of changes in capital, investment, and wages on tax revenue in the model, expressed as a share of no-TCJA corporate tax revenue. The dashed red red line shows the change in corporate revenue due to changes in the tax base before depreciation deductions, $\tau_t \times \left(F\left(K_t, \bar{K}_t; Z_t\right) - \Phi\left(I_t, K_t\right) - F\left(K_0, \bar{K}_0; Z_0\right)\right)$. The dotted red line shows the change in corporate revenue due to greater depreciation deductions as investment rises, $\Gamma_t \times (I_t - I_0)$. The solid red line combines these two changes as well as the dynamic effects of FDII and GILTI, which are small. The blue line shows the change in labor taxes, $\tau^L \times \left(P_t^L L^* - P_0^L L^*\right)$.

dynamic changes are instead well-suited to address (ii).

The solid red line in figure 9 shows the total change in corporate taxes as a result of the dynamic changes in capital, expressed as a ratio of pre-TCJA corporate tax revenue. The dashed and dotted red lines decompose the change in corporate tax revenue into a part coming from changes in the tax base before depreciation, $\tau_t \times \left(F\left(K_t, \bar{K}_t; Z_t\right) - \Phi\left(I_t, K_t\right) - F\left(K_0, \bar{K}_0; Z_0\right)\right)$, and a part coming from greater depreciation deductions as investment rises, $\Gamma_t \times (I_t - I_0)$, where date 0 denotes a pre-TCJA value. (The solid red line also includes the dynamic effects of FDII and GILTI, which are small.) The denominator calculates pre-TCJA corporate revenue as $\tau_0 \times \left(F\left(K_0, \bar{K}_0; Z_0\right) - B_0\right)$, where $B_0$ denotes a lump-sum deduction that includes all credits and deductions inframarginal for determining investment and is calibrated to match the average tax rate in our sample. For comparison with the revenue estimates in table 1, CBO (2017) forecast \$3.9 trillion of corporate income taxes over the 10-year 2018-2027 window in the absence of TCJA.

The dynamic response of capital reduces corporate tax revenue on impact and has a small positive long-run effect. The impact reduction occurs because capital does not jump at the time of the law change, but the immediate increase in investment incurs adjustment costs that depress taxable income and also increases depreciation deductions. Over time, rising domestic and foreign capital increase domestic corporate income. Higher capital quickly overcomes the higher adjustment costs and the effect on taxable income turns positive by year 2 and by itself would result in revenue increases of 15% of pre-TCJA revenue by year 30. However, because the negative revenue impact of higher depreciation deductions persists, total dynamic corporate revenue effects remain negative until year 12 and never exceed 5% of pre-TCJA revenue. While we are not aware of other estimates of the dynamic revenue effects of corporate tax and depreciation changes in isolation, the JCT notes the offsetting revenue impacts of higher depreciation allowances when they discuss their dynamic scoring methodology.[46]

The explanation for a muted total corporate tax revenue dynamic response goes beyond the details of our model. To see why, it helps to consider the case of a domestic-only firm with all bonus-eligible investment, so that $\Gamma = \tau$ post-TCJA (see section 4.1), and to focus on the long-run. This firm chooses $K$ to maximize $(1-\tau)F(K) - (1-\Gamma)P^K I = (1-\tau)\left(F(K) - P^K \delta K\right)$, so that the optimal $K$ maximizes pre-tax net income. In addition to illustrating the well-known result (Hall and Jorgenson, 1971) that when $\tau = \Gamma$ changes in taxes do not distort capital, this expression also has an envelope implication: changes in $K$ have second-order effects on net income and hence revenue. This result does not hold exactly in our model because some investment remains bonus-ineligible and because of the international provisions, but it shows why evaluating the revenue implications of changes in $K$ at post-TCJA tax rates yields small effects.

The solid blue line in figure 9 shows the effect of changes in labor taxes, defined as $\tau^L \times \left(P_t^L L^* - P_0^L L^*\right)$, where $\tau^L = 0.25$. Since the wage depends on the capital stock, it does not jump at the time of the law change but instead rises over time. By year 10, the increase in wages generates additional labor tax revenue of almost 15% of the pre-TCJA corporate tax revenue. Any overall long-run increase in tax revenue due to changes in capital therefore largely arises from higher labor rather than corporate tax payments. Furthermore, summing together the solid blue and red lines, the combined dynamic revenue effects in the first 10 years average less than 2% of pre-TCJA corporate revenue per year, or about \$7 billion per year, well short of erasing the static revenue decline shown in table 1.

[46] "The extension of bonus depreciation in the bill is an important contributor to increased investment incentives created by the bill. Because of the more generous deduction created for new investment by this provision, the increased investment reduces the taxable base during the time period when this provision is in force, thus reducing the amount of revenue feedback associated with the increase in GDP" (JCT, 2017, footnote 8).

# 8 Validation

## 8.1 Synthetic Controls Evidence for Publicly-traded Firms

We validate our investment effect estimates using an alternative approach that does not impose any model structure or tax shock measurement. To do so, we use synthetic controls to estimate how investment would have evolved in the United States in the absence of the TCJA. Specifically, let $Y_{i,t}^R$ and $Y_{i,t}^N$ denote the reform and no-reform outcome for a variable $Y$ for firm $i$ in year $t$. We estimate $\hat{Y}_{i,t}^N = \sum_n^N w_i Y_{n,t}$ as a weighed average of outcomes $Y_{n,t}$ of public firms headquartered outside the United States.

We begin with the universe of non-financial firms from Compustat North America and Compustat Global that have their headquarters in the U.S. from 2011 to 2021. The panel of firms is then balanced by dropping firms that are missing capital expenditure (capx) data at any point during our window, and we further restrict the sample to firms with data on total assets, sales, and property plant and equipment in at least 4 years.

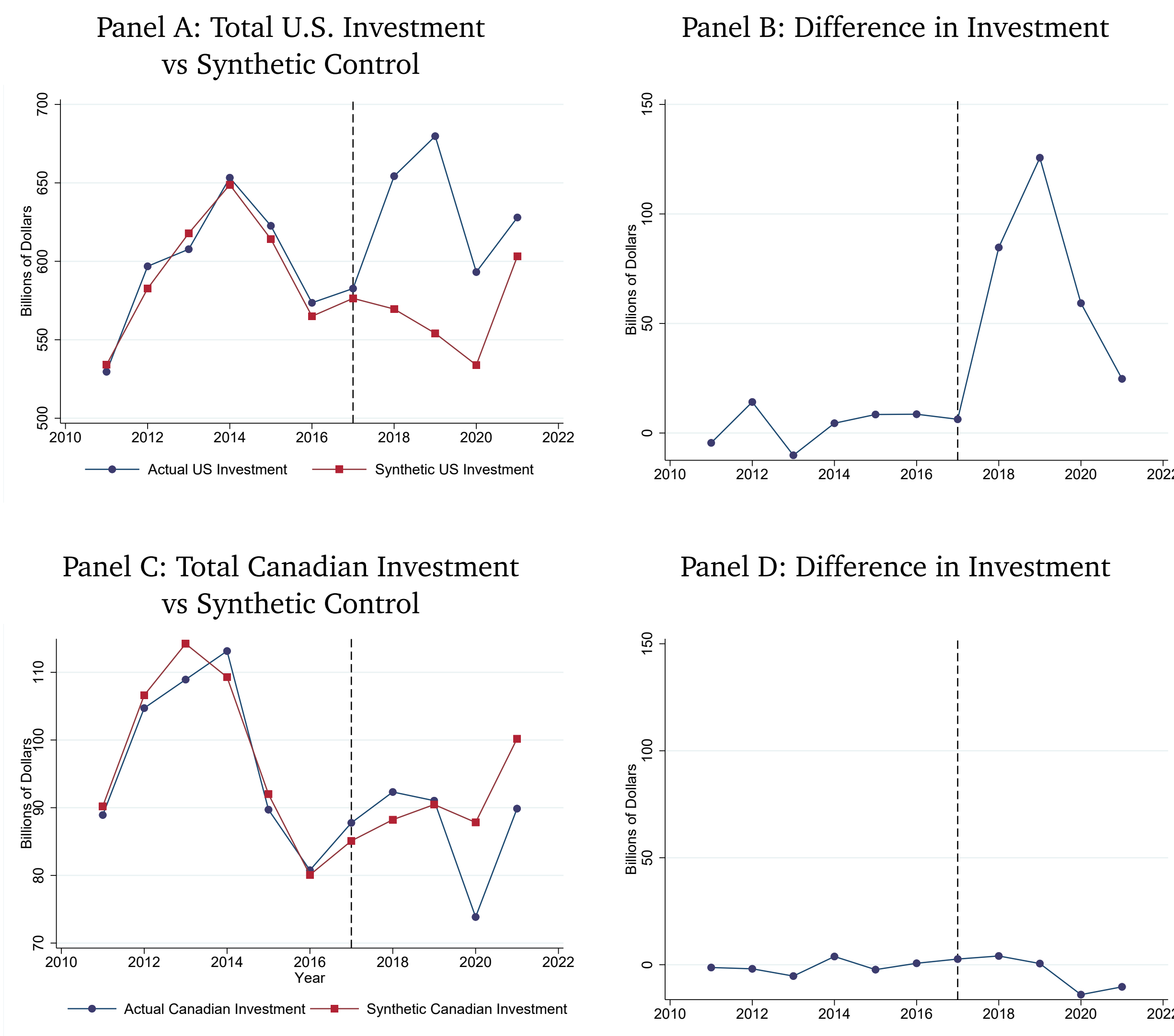
For each of the remaining firms, we estimate a firm-specific set of weights $w_i$, which are restricted to be non-negative and sum to one. We restrict the pool of potential "donors" for each U.S. firm to global firms in the same 4-digit NAICS industry.[47] We then assign weights to minimize the mean squared prediction error between the following variables during the pre-reform period of 2011-2017: annual investment, annual sales, and the pre-period mean of property plant and equipment (ppent).[48]

Appendix table C.3 provides summary statistics for four samples: matched U.S. firms, matched global firms, closely matched U.S. firms, and closely matched global firms. We define a firm as closely matched if the average pre-reform capital expenditure of the synthetic firm is within 10% of the U.S. firm. All subsequent analyses are conducted using the closely matched sample. The rows represent different outcomes and firm characteristics of interest in either the pre-reform years from 2011-2017 or the post-reform years 2018-2019. The table provides means and medians for each. All values are inflation adjusted to be in 2021 dollars. Comparing the pre-reform means to the post-reform means of capital expenditures shows that the capital expenditures of U.S. firms in both the matched and closely matched samples increased,

[47] Appendix table C.2 presents a waterfall table of our sample.

[48] See Abadie (2021) equation (7) and the surrounding discussion for additional details. We use the average ppent to account for differences in physical assets, and annual sales to help account for growth trajectories. Our results are not especially sensitive to the selection of these pre-period controls. We establish this assertion by documenting raw investment effects in a simple difference-in-difference regression that uses pre-period ppent, annual sales, four-digit-industry fixed effects and other pre-period various as controls in the pooled sample of US-based and non-US-based public firms.

Figure 10: Investment of Public Firms in the United States and Similar Foreign Firms




*Notes:* The figure plots aggregate investment (capital expenditure) of U.S. publicly-traded firms and compares it to the investment of synthetically matched global firms. Panel A shows the two series separately, and Panel B plots the difference. Panels C and D show the analogous plots when we create synthetic matches for Canadian firms instead of U.S. firms. This figure does not contain data from tax returns.

whereas they decreased among global firms. Specifically, the average capital expenditure for a closely matched U.S. firm increased from $402 million to $435 million.

Panel A of figure 10 plots the evolution of the aggregate annual capital expenditure of U.S. firms in our closely matched analysis sample as well as the aggregate annual capital expenditure of their synthetic controls. The aggregate capital expenditure of the matched controls

Table 9: DID Estimates of the Effect of TCJA on Investment (Matched Sample)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Post | 0.163*** | 0.153*** | 0.163*** | 0.153*** |
| | (0.026) | (0.007) | (0.006) | (0.007) |
| Observations | 13,275 | 12,222 | 13,275 | 12,222 |
| Controls | No | Yes | No | Yes |
| NAICS 4-digit FEs | No | No | Yes | Yes |

*Notes:* Standard errors in parentheses are clustered at the firm level. The outcome variable is ln(capx of treated firms) - ln(capx of synthetic firms). The controls include the mean pre-period (2011-17) values of capx, assets, sales and property, plant and equipment (PPENT) of treated firms. All regressions are weighted by the mean pre-period capx of treated firms. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

closely tracks that of the U.S. firms in the pre-reform period before sharply increasing in 2018. The aggregate capital expenditure of U.S. firms in 2018 and 2019 greatly exceeds the aggregate capital expenditure of the control group.[49] Panel C validates our approach by plotting the evolution of the capital expenditures of Canadian firms relative to closely matched synthetic controls in a placebo analysis. The sharp increase around the TCJA is not present for our sample of Canadian firms and only occurs in the U.S. series.

We further validate our results with a backdating approach that uses earlier years, 2011 to 2015, in the pre-period to estimate the weights. This enables us to compare the outcomes from 2016-2017 to see if the treatment and control groups still evolve similarly in the pre-reform period. Appendix figure B.2 presents the results from this approach. The figure shows both that the US firms evolve similarly, and that there is a still a sharp increase in the TCJA period in the U.S. firms relative to the controls. We also conduct leave-one out analyses that drop countries from the donor pool of synthetic controls to ensure that foreign shocks are not driving the results. Finally, we also include controls for other contemporaneous shocks such as tariff changes.

Table 9 summarizes these effects by reporting difference-in-difference estimates within the analysis sample, weighted by pre-period average capital expenditures. Capital expenditures increase by around 15% across specifications that do and do not control for pre-reform firm characteristics as well as four-digit industry fixed effects. For comparison, global investment

[49]Appendix table C.4 decomposes these aggregate differences by two-digit NAICS industry codes. We sum each firm and its synthetic control in a given industry, and report these totals and their difference. The table shows that Utilities ($68 billion), Manufacturing ($21 billion), and Mining ($18 billion) were the three largest contributors to the total difference in investment among public firms in our matched sample and their synthetic control counterparts.

in the estimated model is roughly 20-25% higher over the first years following the reform and the 95% confidence interval cannot reject a 15% increase. Furthermore, the model measure includes mergers and acquisitions that Compustat does not include in capital expenditure, making it plausible that the difference between the synthetic control estimates and the model are smaller than they appear.

# 9 Conclusion

This paper combines administrative tax data and a model of global investment behavior to investigate the effects of the TCJA—the largest corporate tax cut in U.S. history—on the level and location of investment and capital. We use a model to characterize and measure four channels through which this tax policy affected investment: domestic and foreign cost-of-capital subsidies and domestic and foreign corporate tax rates. Both domestic and foreign investment of U.S. multinationals increased due to the TCJA, with the increase in domestic investment larger both at firms experiencing more favorable domestic tax changes as well as at firms with larger incentives to accumulate foreign capital. Our model interprets the latter increase as evidence of complementarity between domestic and foreign capital in production. Overall, we estimate a long-run increase in domestic corporate capital of roughly 7.4% due to the TCJA's corporate provisions.

Despite the dynamic response of capital, our model contains small dynamic revenue effects. While higher investment increases corporate income and labor payments, the extra tax revenue from this activity is offset by the higher cost of depreciation deductions, which can be immediately expensed in the years following the enactment of the tax reform. Consequently, the total effect on corporate tax revenue is close to the mechanical effects, which are large given the 14-percentage-point tax rate cut and immediate expensing.

Many of the provisions of TCJA remain contested in the political arena. Our quantitative model enables an analysis of policy counterfactuals. We decompose the effect of the reform into its constituent parts, such as expensing, lower rates, and international provisions, but much more can be done. For example, future research might use our estimates and model to consider alternative policy proposals such as the effect of global minimum tax rates, county-by-country provisions, or other reforms. Our results highlight the potentially unintended consequences of including deductions for the normal return to tangible capital in the GILTI and FDII provisions. Our framework is well suited to consider the impacts of policy reforms that change this deduction.

A second avenue for further research concerns the relationship between tangible capital accumulation, our paper's focus, and intangible capital. While we do explore the impact of the TCJA provisions on R&D spending, much more could be done to understand what kind of activity is responding and the longer-term impacts. We also leave the study of the transition to amortization of R&D deductions to future work. Separately, more work could be done using administrative data to assess whether the TCJA affected profit-shifting behavior by both U.S. multinationals and foreign multinationals with U.S. presence.

Finally, there is considerable interest in the effects of the TCJA on the level and distribution of income for workers. We document large impacts on both domestic and foreign capital accumulation. To what extent do the productivity gains from this investment pass on to workers, and which workers benefit most?

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# Tax Policy and Investment in a Global Economy

## Online Appendix

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# A Model Appendix

## A.1 Derivation of Profit Function

The static optimization is $\max_{L,M} P_t Q_t - P^L_t L_t - P^M_t M_t$, with the demand constraint $Q_t = Q^* P_t^{-\frac{\mathscr{M}}{\mathscr{M}-1}}$. Let $Y_t = P_t Q_t = Q_t^{\frac{1}{\mathscr{M}}} Q^{*\frac{\mathscr{M}-1}{\mathscr{M}}} = A_t \mathscr{K}_t^{\alpha_{\mathscr{K}}} L_t^{\alpha_L} M_t^{\alpha_M}$, where to keep notation simple we have redefined $A_t$ to absorb the demand intercept $Q^*$. The FOC are:

$$\text{FOC } (L_t): \qquad P^L_t = \frac{\alpha_L Y_t}{L_t},$$
$$\text{FOC } (M_t): \qquad P^M_t = \frac{\alpha_M Y_t}{M_t}.$$

By definition and substituting the FOC gives:

$$F(\mathscr{K}_t; Z_t) \equiv Y_t - P^L_t L_t - P^M_t M_t = (1-\alpha_L-\alpha_M) Y_t. \tag{A.1}$$

Using

$$M_t = \left(\frac{\alpha_M}{P^M_t}\right)\left(\frac{\alpha_L}{P^L_t}\right)^{-1} L_t$$

and the FOC for $L_t$ we get an expression for revenue as a function of capital:

$$\begin{aligned}
\text{Def.:} \qquad & Y_t = A_t \mathscr{K}_t^{\alpha_{\mathscr{K}}} L_t^{\alpha_L} M_t^{\alpha_M} \\
\text{Subst. prev. line:} \qquad & = \left(\frac{\alpha_M}{P^M_t}\right)^{\alpha_M} \left(\frac{\alpha_L}{P^L_t}\right)^{-\alpha_M} A_t \mathscr{K}_t^{\alpha_{\mathscr{K}}} L_t^{\alpha_L+\alpha_M} \\
\text{Subst. FOC } (L): \qquad & = \left(\frac{\alpha_M}{P^M_t}\right)^{\alpha_M} \left(\frac{\alpha_L}{P^L_t}\right)^{-\alpha_M} A_t \mathscr{K}_t^{\alpha_{\mathscr{K}}} \left(\frac{\alpha_L}{P^L_t} Y_t\right)^{\alpha_L+\alpha_M} \\
& = \left(\frac{\alpha_M}{P^M_t}\right)^{\frac{\alpha_M}{1-(\alpha_L+\alpha_M)}} \left(\frac{\alpha_L}{P^L_t}\right)^{\frac{\alpha_L}{1-(\alpha_L+\alpha_M)}} A_t^{\frac{1}{1-(\alpha_L+\alpha_M)}} \mathscr{K}_t^{\frac{\alpha_{\mathscr{K}}}{1-(\alpha_L+\alpha_M)}}.
\end{aligned}$$

We then have:

$$F(\mathscr{K}_t; Z_t) = (1-\alpha_L-\alpha_M) Y_t = Z_t \mathscr{K}_t^{\alpha}, \tag{A.2}$$

$$\text{where: } Z_t \equiv (1-\alpha_L-\alpha_M)\left(\frac{\alpha_M}{P^M_t}\right)^{\frac{\alpha_M}{1-(\alpha_L+\alpha_M)}} \left(\frac{\alpha_L}{P^L_t}\right)^{\frac{\alpha_L}{1-(\alpha_L+\alpha_M)}} A_t^{\frac{1}{1-(\alpha_L+\alpha_M)}}, \tag{A.3}$$

$$\alpha \equiv \frac{\alpha_{\mathscr{K}}}{1-(\alpha_L+\alpha_M)}. \tag{A.4}$$

## A.2 Log-linearization details with structures and equipment

This appendix extends our model to allow for multiple types of domestic and international capital and provides details of the log-linearization. Let $K_{s,t}$ and $K_{e,t}$ denote structures and equipment capital. We assume:

$$K_t = g\left(K_{s,t}, K_{e,t}\right)$$

and likewise for international capital. Each type of capital has its own price and depreciation schedule and obeys its own dynamic evolution equation. The firm maximizes the present value of dividends with a discount rate $\rho$, subject to initial conditions and the dynamic evolution equations for each type of domestic and international capital.

### A.2.1 First Order Conditions and Steady State

We write the Hamiltonian:

$$\mathcal{H}\left(I_{s,t}, K_{s,t}, I_{e,t}, K_{e,t}, \bar{I}_{s,t}, \bar{K}_{s,t}, \bar{I}_{e,t}, \bar{K}_{e,t}\right) = D_t + \sum_{i\in\{s,e\}} \left(\lambda_{i,t}\left(I_{i,t} - \delta^i K_{i,t}\right) + \bar{\lambda}_{i,t}\left(\bar{I}_{i,t} - \bar{\delta}^i \bar{K}_{i,t}\right)\right).$$

Necessary conditions for $i \in \{s, e\}$:

$$I_{i,t}: \qquad (1-\tau_t)\,\Phi_1\left(I_{i,t}, K_{i,t}\right) + \left(1-\Gamma_{i,t}\right) P^K_{i,t} = \lambda_{i,t}, \tag{A.5}$$

$$\bar{I}_{i,t}: \qquad (1-\bar{\tau}_t)\,\bar{\Phi}_1\left(\bar{I}_{i,t}, \bar{K}^i_t\right) + \left(1-\bar{\Gamma}_{i,t}\right) P^{\bar{K}}_{i,t} = \bar{\lambda}_{i,t}, \tag{A.6}$$

$$K_{i,t}: \quad \frac{(1-\tau_t)\left(F_1\left(\partial K_t/\partial K_{i,t}\right) - \Phi_2\left(I_{i,t}, K_{i,t}\right)\right) + (1-\bar{\tau}_t)\,\bar{F}_2\left(\partial K_t/\partial K_{i,t}\right) - \delta^i \lambda_{i,t} + \dot{\lambda}_{i,t}}{\lambda_{i,t}} = \rho, \tag{A.7}$$

$$\bar{K}_{i,t}: \quad \frac{(1-\bar{\tau}_t)\left(\bar{F}_1\left(\partial \bar{K}_t/\partial \bar{K}_{i,t}\right) - \bar{\Phi}_2\left(\bar{I}_{i,t}, \bar{K}_{i,t}\right)\right) + (1-\tau_t)\,F_2\left(\partial \bar{K}_t/\partial \bar{K}_{i,t}\right) - \bar{\delta}^i \bar{\lambda}_{i,t} + \dot{\bar{\lambda}}_{i,t}}{\bar{\lambda}_{i,t}} = \rho. \tag{A.8}$$

Substituting the adjustment costs:

$$\text{FOC } (I_{i,t}): \quad \dot{K}_{i,t}/K_{i,t} = \left[\frac{1}{\phi}\left(\frac{\lambda_{i,t} - P^K_{i,t}\left(1-\Gamma_{i,t}\right)}{(1-\tau_t)}\right)\right]^{\frac{1}{\gamma}}, \tag{A.9}$$

$$\text{FOC}(K_{i,t}): \quad \dot{\lambda}_{i,t} = \left(\rho + \delta^i\right)\lambda_{i,t} - (1-\tau_t)\left(F_1\left(\partial K_t/\partial K_{i,t}\right) - \Phi_2\left(I_{i,t}, K_{i,t}\right)\right) - (1-\bar{\tau}_t)\,\bar{F}_2\left(\partial K_t/\partial K_{i,t}\right).$$

The analogous equations hold for foreign capital.

In steady state, $\dot{K}_{i,t} = \dot{\lambda}_{i,t} = 0$, giving:

$$\lambda^*_i = (1-\Gamma_i)\,P^K_i. \tag{A.10}$$

Let $R^*_i \equiv \left(\rho + \delta^i\right)\lambda^*_i$ and likewise for foreign. From FOC($K$) we have the system of equations for the steady state:

$$\left((1-\tau)\,F^*_1 + (1-\bar{\tau})\,\bar{F}^*_2\right)\left(\partial K^*/\partial K^*_s\right) = R^*_s, \tag{A.11}$$

$$\left((1-\tau)F_1^*+(1-\bar{\tau})\bar{F}_2^*\right)\left(\partial K^*/\partial K_e^*\right)=R_e^*, \tag{A.12}$$
$$\left((1-\bar{\tau})\bar{F}_1^*+(1-\tau)F_2^*\right)\left(\partial \bar{K}^*/\partial \bar{K}_s^*\right)=\bar{R}_s^*, \tag{A.13}$$
$$\left((1-\bar{\tau})\bar{F}_1^*+(1-\tau)F_2^*\right)\left(\partial \bar{K}^*/\partial \bar{K}_e^*\right)=\bar{R}_e^*. \tag{A.14}$$

Recognizing that $F_1^*=F_1\left(K^*,\bar{K}^*;Z^*\right), F_2^*=F_2\left(K^*,\bar{K}^*;Z^*\right), \bar{F}_1^*=\bar{F}_1\left(\bar{K}^*,K^*;Z^*\right), \bar{F}_2^*=\bar{F}_2\left(\bar{K}^*,K^*;Z^*\right)$, this is a system of four non-linear equations in four unknowns $K_s^*,K_e^*,\bar{K}_s^*,\bar{K}_e^*$.

We assume that structures and equipment combine according to:

$$K=g\left(K_s,K_e\right)=\left(a_s^{\frac{1}{\nu}}K_s^{\frac{\nu-1}{\nu}}+a_e^{\frac{1}{\nu}}K_e^{\frac{\nu-1}{\nu}}\right)^{\frac{\nu}{\nu-1}} \tag{A.15}$$

and define $R^*\equiv\left(a_s\left(R_s^*\right)^{1-\nu}+a_e\left(R_e^*\right)^{1-\nu}\right)^{\frac{1}{1-\nu}}$, and likewise for international capital. Standard CES derivations give:

$$\frac{\partial K^*}{\partial K_i^*}=a_i^{\frac{1}{\nu}}\left(\frac{K_i^*}{K^*}\right)^{-\frac{1}{\nu}}=\left(\frac{R_i^*}{R^*}\right). \tag{A.16}$$

Equation (A.16) allows us to collapse the four steady state conditions into two, as in the main text:

$$(1-\tau)F_1^*+(1-\bar{\tau})\bar{F}_2^*=R^*, \tag{A.17}$$
$$(1-\bar{\tau})\bar{F}_1^*+(1-\tau)F_2^*=\bar{R}^*. \tag{A.18}$$

### A.2.2 Log Linearization

Substituting functional forms:

$$R^*=\alpha\left[(1-\tau^*)aZ^*\left(\mathscr{K}^*\right)^{\alpha+1/\sigma-1}+(1-\bar{\tau}^*)(1-\bar{a})\bar{Z}^*\left(\bar{\mathscr{K}}^*\right)^{\alpha+1/\sigma-1}\right](K^*)^{-\frac{1}{\sigma}}, \tag{A.19}$$
$$\bar{R}^*=\alpha\left[(1-\bar{\tau}^*)\bar{a}\bar{Z}^*\left(\bar{\mathscr{K}}^*\right)^{\alpha+1/\sigma-1}+(1-\tau^*)(1-a)Z^*\left(\mathscr{K}^*\right)^{\alpha+1/\sigma-1}\right]\left(\bar{K}^*\right)^{-\frac{1}{\sigma}}, \tag{A.20}$$

where recall $\mathscr{K}=\left(aK^{\frac{\sigma-1}{\sigma}}+(1-a)\bar{K}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$ and $\bar{\mathscr{K}}=\left(\bar{a}\bar{K}^{\frac{\sigma-1}{\sigma}}+(1-\bar{a})K^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$.

Let $\tilde{\alpha}\equiv\sigma\alpha+(1-\sigma)=1-\sigma(1-\alpha)\subseteq[1-\sigma,1]$ be the elasticity-adjusted returns to scale, i.e. $\alpha=1\Rightarrow\tilde{\alpha}=1$ and $\alpha=0\Rightarrow\tilde{\alpha}=1-\sigma$, with $\tilde{\alpha}=\alpha$ if $\sigma=1$. Let $\mathbb{E}_w(x,y)\equiv wx+(1-w)y$ denote the weighted average of $x$ and $y$.[1] Defining $\hat{\tau}=d\tau/(1-\tau)$ and $\hat{\Gamma}=d\Gamma/(1-\Gamma)$ and using equations (11) to (14), the log-linearization around the steady state gives:

[1]Note the following properties which we use in the derivation that follows:

$$\begin{aligned}\mathbb{E}_w(1-x,y)&=1-\mathbb{E}_w(x,1-y),\\ \mathbb{E}_w(x,1-y)+\mathbb{E}_{\bar{w}}(y,1-x)-1&=(1-w-\bar{w})(1-x-y),\\ \mathbb{E}_{\bar{w}}(y,1-x)&=1-x-\bar{w}(1-x-y),\\ (1-\bar{w})(1-\mathbb{E}_w(x,1-y))-w\mathbb{E}_{\bar{w}}(y,1-x)&=(1-w-\bar{w})y.\end{aligned}$$

$$(A.19): \quad r+(1/\sigma)k = s_{F_1}\left(z-\hat{\tau}+\left(\frac{\tilde{\alpha}}{\sigma}\right)\left(s_1 k+(1-s_1)\bar{k}\right)\right)+\left(1-s_{F_1}\right)\left(\bar{z}-\hat{\bar{\tau}}+\left(\frac{\tilde{\alpha}}{\sigma}\right)\left(\bar{s}_1\bar{k}+(1-\bar{s}_1)k\right)\right),$$

$$\sigma r+k = -\sigma\mathbb{E}_{s_{F_1}}\left(\hat{\tau}-z,\hat{\bar{\tau}}-\bar{z}\right)+\tilde{\alpha}\left(\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)k+\left(1-\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)\right)\bar{k}\right),$$

$$k=\frac{\left(1-\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)\right)\tilde{\alpha}\bar{k}-\sigma\left(r+\mathbb{E}_{s_{F_1}}\left(\hat{\tau}-z,\hat{\bar{\tau}}-\bar{z}\right)\right)}{1-\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)\tilde{\alpha}}, \tag{A.21}$$

$$(A.20): \quad \bar{k}=\frac{\left(1-\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)\right)\tilde{\alpha}k-\sigma\left(\bar{r}+\mathbb{E}_{s_{\bar{F}_1}}\left(\hat{\bar{\tau}}-\bar{z},\hat{\tau}-z\right)\right)}{1-\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)\tilde{\alpha}}. \tag{A.22}$$

Substituting equation (A.22) into equation (A.21):

$$\begin{aligned}
&\left(1-\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)\tilde{\alpha}\right)k \\
&=\left(1-\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)\right)\tilde{\alpha}\left(\frac{\left(1-\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)\right)\tilde{\alpha}k-\sigma\left(\bar{r}+\mathbb{E}_{s_{\bar{F}_1}}\left(\hat{\bar{\tau}}-\bar{z},\hat{\tau}-z\right)\right)}{1-\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)\tilde{\alpha}}\right) \\
&-\sigma\left(r+\mathbb{E}_{s_{F_1}}\left(\hat{\tau}-z,\hat{\bar{\tau}}-\bar{z}\right)\right).
\end{aligned}$$

Grouping terms and simplifying:

$$k=-\frac{\omega_{k,r}r+\left(1-\omega_{k,r}\right)\bar{r}+\omega_{k,\tau}(\hat{\tau}-z)+\left(1-\omega_{k,\tau}\right)\left(\hat{\bar{\tau}}-\bar{z}\right)}{1-\alpha}, \tag{A.23}$$

$$\begin{aligned}
\text{where: } \omega_{k,r} &\equiv \frac{1-\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)\tilde{\alpha}}{1-\left(\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)+\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)-1\right)\tilde{\alpha}} \\
&=\frac{1-\left((1-s_1)-s_{\bar{F}_1}(1-s_1-\bar{s}_1)\right)\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\tilde{\alpha}}, \\
\omega_{k,\tau} &\equiv \frac{\left(\left(1-\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)\right)\tilde{\alpha}\right)\left(1-s_{\bar{F}_1}\right)+\left(1-\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)\tilde{\alpha}\right)s_{F_1}}{1-\left(\mathbb{E}_{s_{F_1}}(s_1,1-\bar{s}_1)+\mathbb{E}_{s_{\bar{F}_1}}(\bar{s}_1,1-s_1)-1\right)\tilde{\alpha}} \\
&=\frac{s_{F_1}+\left(1-s_{F_1}-s_{\bar{F}_1}\right)\bar{s}_1\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\tilde{\alpha}}.
\end{aligned}$$

Equation (15) in the main text follows from the definition of $R$ and $\bar{R}$ and re-grouping terms to isolate the tax variables. Note in particular that $r = a_s r_s + a_e r_e$ is a weighted average of the change in user cost of different types of capital, with the weights given by steady state expenditure shares.

The expressions for $\bar{k}$ follow from symmetry of the setup and are given by:

$$\bar{k} = \frac{\omega_{\bar{k},\bar{r}}\hat{\bar{\Gamma}} + \left(1-\omega_{\bar{k},\bar{r}}\right)\hat{\Gamma} - \omega_{\bar{k},\bar{\tau}}\hat{\bar{\tau}} - \left(1-\omega_{\bar{k},\bar{\tau}}\right)\hat{\tau} + \bar{\epsilon}}{1-\alpha}, \tag{A.24}$$

$$\text{where: } \omega_{\bar{k},\bar{r}} \equiv \frac{1-\left((1-\bar{s}_1) - s_{F_1}(1-s_1-\bar{s}_1)\right)\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\tilde{\alpha}}, \tag{A.25}$$

$$\omega_{\bar{k},\bar{\tau}} \equiv \frac{s_{\bar{F}_1} + \left(1-s_{F_1}-s_{\bar{F}_1}\right)s_1\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\tilde{\alpha}}, \tag{A.26}$$

$$\bar{\epsilon} \equiv \omega_{\bar{k},\bar{\tau}}\bar{z} + \left(1-\omega_{\bar{k},\bar{\tau}}\right)z - \omega_{\bar{k},\bar{r}}\left(\frac{d\bar{\rho}+d\bar{\delta}}{\bar{\rho}+\bar{\delta}} + p^{\bar{K}}\right) - \left(1-\omega_{\bar{k},\bar{r}}\right)\left(\frac{d\rho+d\delta}{\rho+\delta} + p^{K}\right). \tag{A.27}$$

Finally, let $s_K = K/\left(K+\bar{K}\right)$. The total capital response (scaled by the returns to scale) is:

$$\begin{aligned}(1-\alpha)\left(s_K k + (1-s_K)\bar{k}\right) &= s_K\left(\omega_{k,r}\hat{\Gamma} + \left(1-\omega_{k,r}\right)\hat{\bar{\Gamma}} - \omega_{k,\tau}\hat{\tau} - \left(1-\omega_{k,\tau}\right)\hat{\bar{\tau}} + \epsilon\right) \\ &\quad + (1-s_K)\left(\omega_{\bar{k},\bar{r}}\hat{\bar{\Gamma}} + \left(1-\omega_{\bar{k},\bar{r}}\right)\hat{\Gamma} - \omega_{\bar{k},\bar{\tau}}\hat{\bar{\tau}} - \left(1-\omega_{\bar{k},\bar{\tau}}\right)\hat{\tau} + \bar{\epsilon}\right) \\ &= \omega^T_{k,r}\hat{\Gamma} + \left(1-\omega^T_{k,r}\right)\hat{\bar{\Gamma}} - \omega^T_{k,\tau}\hat{\tau} - \left(1-\omega^T_{k,\tau}\right)\hat{\bar{\tau}} + \epsilon^T,\end{aligned} \tag{A.28}$$

$$\text{with: } \omega^T_{k,r} \equiv s_K\omega_{k,r} + (1-s_K)\left(1-\omega_{\bar{k},\bar{r}}\right) = \omega_{k,r} - (1-s_K)\left(\frac{1-\tilde{\alpha}}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\tilde{\alpha}}\right), \tag{A.29}$$

$$\omega^T_{k,\tau} \equiv s_K\omega_{k,\tau} + (1-s_K)\left(1-\omega_{\bar{k},\bar{\tau}}\right) = \omega_{k,\tau} + (1-s_K)\left(\frac{\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-\tilde{\alpha})}{1-\left(1-s_{F_1}-s_{\bar{F}_1}\right)(1-s_1-\bar{s}_1)\tilde{\alpha}}\right). \tag{A.30}$$

### A.2.3 Derivations of equations (11) to (14)

Let $\chi_K \equiv \bar{K}^*/K^*$ denote the steady state ratio of international to domestic capital, $\chi_{\mathscr{K}} \equiv \bar{\mathscr{K}}^*/\mathscr{K}^*$, and $\chi_\tau \equiv (1-\bar{\tau})/(1-\tau)$, $\chi_Z \equiv \bar{Z}^*/Z^*$, $\chi_R = \bar{R}^*/R^*$, $\chi_a = \bar{a}/a$. Then:

$$s_1 = \frac{a}{a + (1-a)\chi_K^{\frac{\sigma-1}{\sigma}}}, \tag{A.31}$$

$$\bar{s}_1 = \frac{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}}}{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}} + (1-\bar{a})}. \tag{A.32}$$

Moreover:

$$F_1^* = \alpha a Z^*(K^*)^{-\frac{1}{\sigma}}(\mathscr{K}^*)^{\alpha+1/\sigma-1},$$

$$\bar{F}_1^* = \alpha\bar{a}\bar{Z}^*\left(\bar{K}^*\right)^{-\frac{1}{\sigma}}\left(\bar{\mathscr{K}}^*\right)^{\alpha+1/\sigma-1} = \chi_Z\chi_K^{-\frac{1}{\sigma}}\chi_{\mathscr{K}}^{\alpha+1/\sigma-1}\chi_a F_1^*,$$
$$F_2^* = \alpha(1-a)Z^*\left(\bar{K}^*\right)^{-\frac{1}{\sigma}}\left(\mathscr{K}^*\right)^{\alpha+1/\sigma-1} = \left(\frac{1-a}{a}\right)\chi_K^{-\frac{1}{\sigma}}F_1^*,$$
$$\bar{F}_2^* = \alpha(1-\bar{a})\bar{Z}^*\left(K^*\right)^{-\frac{1}{\sigma}}\left(\bar{\mathscr{K}}^*\right)^{\alpha+1/\sigma-1} = \left(\frac{1-\bar{a}}{\bar{a}}\right)\chi_K^{\frac{1}{\sigma}}\bar{F}_1^* = \left(\frac{1-\bar{a}}{a}\right)\chi_Z\chi_{\mathscr{K}}^{\alpha+1/\sigma-1}F_1^*,$$

giving:

$$s_{F_1} = \frac{(1-\tau^*)F_1^*}{(1-\tau^*)F_1^* + (1-\bar{\tau}^*)\bar{F}_2^*} = \frac{a}{a+(1-\bar{a})\chi_\tau\chi_Z\chi_{\mathscr{K}}^{\alpha+1/\sigma-1}}, \tag{A.33}$$

$$1-s_{\bar{F}_1} = \frac{(1-\tau^*)F_2^*}{(1-\bar{\tau}^*)\bar{F}_1^* + (1-\tau^*)F_2^*} = \frac{\left(\frac{1-a}{a}\right)\chi_K^{-\frac{1}{\sigma}}}{\chi_\tau\chi_Z\chi_K^{-\frac{1}{\sigma}}\chi_{\mathscr{K}}^{\alpha+1/\sigma-1}\chi_a + \left(\frac{1-a}{a}\right)\chi_K^{-\frac{1}{\sigma}}}$$
$$= \frac{1-a}{(1-a)+\bar{a}\chi_\tau\chi_Z\chi_{\mathscr{K}}^{\alpha+1/\sigma-1}}. \tag{A.34}$$

Finally, multiplying equation (A.17) by $\chi_R$ , dividing the resulting expression and equation (A.18) by $(1-\tau)$, and equating, we have that $\chi_R\left(F_1^* + \chi_\tau\bar{F}_2^*\right) = \chi_\tau\bar{F}_1^* + F_2^*$. Substituting the derivatives and manipulating gives:

$$\chi_\tau\chi_Z\chi_{\mathscr{K}}^{\alpha+1/\sigma-1} = \frac{(1-a)\chi_K^{-\frac{1}{\sigma}} - a\chi_R}{(1-\bar{a})\chi_R - \bar{a}\chi_K^{-\frac{1}{\sigma}}}, \tag{A.35}$$

which shows that $s_{F_1}$ and $s_{\bar{F}_1}$ are functions of $a, \chi_R, \chi_K$. Moreover, this expression implicitly defines $\chi_K$ as a function of $a, \sigma, \alpha, \chi_Z$, and $\chi_\tau$. Repeating equations (A.31) and (A.32) and substituting equation (A.35) into equations (A.33) and (A.34), the four share terms that enter into the elasticity formulae are:

$$s_1 = \frac{a}{a+(1-a)\chi_K^{\frac{\sigma-1}{\sigma}}}, \tag{A.36}$$

$$\bar{s}_1 = \frac{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}}}{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}} + (1-\bar{a})}, \tag{A.37}$$

$$s_{F_1} = \frac{a\left((1-\bar{a})\chi_R - \bar{a}\chi_K^{-\frac{1}{\sigma}}\right)}{(1-\bar{a}-a)\chi_K^{-\frac{1}{\sigma}}}, \tag{A.38}$$

$$1-s_{\bar{F}_1} = \frac{(1-a)\left((1-\bar{a})\chi_R - \bar{a}\chi_K^{-\frac{1}{\sigma}}\right)}{(1-\bar{a}-a)\chi_R}. \tag{A.39}$$

### A.2.4 Linearizing elastiticities

We linearize the elasticities around $\chi_K = \chi_R = 1$:

$$\omega_{k,r} = \omega_{k,r}(1) + c_{k,r,\chi_R}(\chi_R - 1) + c_{k,r,\chi_K}(\chi_K - 1) + h.o.t,$$

$$\omega_{k,\tau} = \omega_{k,\tau}(1) + c_{k,\tau,\chi_R}(\chi_R - 1) + c_{k,\tau,\chi_K}(\chi_K - 1) + h.o.t$$

$$\text{where: } \omega_{k,r}(1) = \omega_{k,r}(\chi_R = \chi_K = 1) = \frac{2a(1-a)\tilde{\alpha} + 1 - \tilde{\alpha}}{1-(1-2a)^2\tilde{\alpha}}, \tag{A.40}$$

$$\omega_{k,\tau}(1) = \omega_{k,\tau}(\chi_R = \chi_K = 1) = \frac{(2(1-a)\tilde{\alpha} + 1 - \tilde{\alpha})a}{1-(1-2a)^2\tilde{\alpha}}, \tag{A.41}$$

$$c_{k,r,\chi_R} = c_{k,r,\chi_K} = -\frac{a(1-a)\tilde{\alpha}}{1-(1-2a)^2\tilde{\alpha}}, \tag{A.42}$$

$$c_{k,\tau,\chi_R} = -\frac{c_{k,r,\chi_R}}{(1-2a)\tilde{\alpha}}, \tag{A.43}$$

$$c_{k,\tau,\chi_K} = \left(\frac{(1-2a)^2\tilde{\alpha}(\sigma-1)+1}{\sigma}\right)c_{k,\tau,\chi_R}. \tag{A.44}$$

### A.2.5 Steady-state Relative Profits

Let $\chi_F = \bar{F}\left(\bar{K}_t, K_t; \bar{Z}_t\right)/F\left(K_t, \bar{K}_t; Z_t\right)$ denote the ratio of foreign to domestic taxable income. Then:

$$\chi_F = \chi_Z \chi_{\mathscr{K}}^{\alpha},$$

$$\textbf{where: } \chi_{\mathscr{K}} = \left(\frac{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}} + (1-\bar{a})}{a + (1-a)\chi_K^{\frac{\sigma-1}{\sigma}}}\right)^{\frac{\sigma}{\sigma-1}}.$$

Using this definition together with equation (A.35) gives the moment:

$$\chi_\tau \chi_F = \left(\frac{(1-a)\chi_K^{-\frac{1}{\sigma}} - a\chi_R}{(1-\bar{a})\chi_R - \bar{a}\chi_K^{-\frac{1}{\sigma}}}\right)\chi_{\mathscr{K}}^{1-1/\sigma} = \left(\frac{(1-a)\chi_K^{-\frac{1}{\sigma}} - a\chi_R}{(1-\bar{a})\chi_R - \bar{a}\chi_K^{-\frac{1}{\sigma}}}\right)\left(\frac{\bar{a}\chi_K^{\frac{\sigma-1}{\sigma}} + (1-\bar{a})}{a + (1-a)\chi_K^{\frac{\sigma-1}{\sigma}}}\right).$$

Under the interpretation that adjustment costs are paid in units of labor (so total paid labor is split between production labor $L$ and capital installation labor), we can associate $F$ and $\bar{F}$ with taxable income before credits and deductions.

## A.3 Dynamic Accumulation of Intangible Capital

This extension shows that a dynamic choice of intangible capital provides one possible microfoundation for complementarity between domestic and foreign capital.

We introduce intangible capital by augmenting the domestic and foreign production functions to include the factor $\mathscr{H}_t$:

$$Q_t = \left(A_t \mathscr{H}_t^{\alpha_{\mathscr{H}}} \mathscr{K}_t^{\alpha_{\mathscr{K}}} L_t^{\alpha_L} M_t^{\alpha_M}\right)^{\mathscr{M}}, \tag{A.45}$$

$$\bar{Q}_t = \left(\bar{A}_t \mathscr{H}_t^{\alpha_{\mathscr{H}}} \bar{\mathscr{K}}_t^{\alpha_{\mathscr{K}}} \bar{L}_t^{\alpha_L} \bar{M}_t^{\alpha_M}\right)^{\mathscr{M}}. \tag{A.46}$$

Importantly, the same quantity $\mathscr{H}_t$ enters into both the domestic and foreign production functions; the non-rivalry of $\mathscr{H}_t$ distinguishes it as intangible capital. The domestic concentrated earnings function becomes:

$$F\left(K_t, \bar{K}_t, \mathcal{H}_t; Z_t\right) = Z_t \mathcal{H}_t^{\alpha_{\mathcal{H}}\alpha/\alpha_{\mathcal{K}}} \mathcal{K}_t^{\alpha}, \tag{A.47}$$

and likewise for the foreign operation. We assume $\alpha_{\mathcal{H}} < \alpha_{\mathcal{K}}/\alpha = 1 - \alpha_L - \alpha_M$, so that there are not increasing returns to intangible capital in the earnings function. A natural benchmark is that intangible capital is tangible capital-augmenting, so that $\alpha_H = \alpha_{\mathcal{K}}$. Intangible capital obeys the law of motion $\dot{\mathcal{H}}_t = I_{\mathcal{H},t} - \delta^{\mathcal{H}} \mathcal{H}_t$, with adjustment costs $\Phi^{\mathcal{H}}\left(I_{\mathcal{H},t}, \mathcal{H}_t\right)$. We assume for simplicity that all intangible investment (i.e. R&D) occurs domestically.[2]

The necessary conditions for tangible investment and capital remain unaltered in this setup. With convex adjustment costs, the new necessary conditions relating to the accumulation of intangible capital are:

$$\text{FOC } (I_{\mathcal{H},t}): \qquad \dot{\mathcal{H}}_t / \mathcal{H}_t = \left[ \frac{1}{\phi^{\mathcal{H}}} \left( \frac{\lambda_{\mathcal{H},t} - P_t^{\mathcal{H}}\left(1 - \Gamma_{\mathcal{H},t}\right)}{(1-\tau_t)} \right) \right]^{\frac{1}{\gamma}}, \tag{A.48}$$

$$\text{FOC}(\mathcal{H}_t): \qquad \dot{\lambda}_{\mathcal{H},t} = \left(\rho + \delta^{\mathcal{H}}\right) \lambda_t^{\mathcal{H}} - (1-\tau_t)\left(F_3 - \Phi_2^{\mathcal{H}}\right) - (1-\bar{\tau}_t)\bar{F}_3. \tag{A.49}$$

Combining these equations, the steady state has the additional condition:

$$R^*_{\mathcal{H}} = (1-\tau) F_3^* + (1-\bar{\tau}) \bar{F}_3 \tag{A.50}$$

$$= \frac{\alpha_{\mathcal{H}}\alpha}{\alpha_{\mathcal{K}}} \left[ (1-\tau) F\left(K^*, \bar{K}^*, \mathcal{H}^*; Z^*\right) + (1-\bar{\tau}) \bar{F}\left(\bar{K}^*, K^*, \mathcal{H}^*; \bar{Z}^*\right) \right] (\mathcal{H}^*)^{-1}, \tag{A.51}$$

with $R^*_{\mathcal{H}} = \left(\rho + \delta^{\mathcal{H}}\right) P^{\mathcal{H}} (1 - \Gamma_{\mathcal{H}})$ being the user cost of intangible capital.

As in the baseline model, we derive the long-run response of capital to changes in tax policy. As a preliminary step, define the revenue shares:

$$s_{RK} = \frac{R^* K^*}{(1-\tau) F\left(K^*, \bar{K}^*, \mathcal{H}^*; Z^*\right) + (1-\bar{\tau}) \bar{F}\left(\bar{K}^*, K^*, \mathcal{H}^*; \bar{Z}^*\right)},$$

$$s_{\bar{R}\bar{K}} = \frac{\bar{R}^* \bar{K}^*}{(1-\tau) F\left(K^*, \bar{K}^*, \mathcal{H}^*; Z^*\right) + (1-\bar{\tau}) \bar{F}\left(\bar{K}^*, K^*, \mathcal{H}^*; \bar{Z}^*\right)},$$

and note:

$$\frac{\alpha_{\mathcal{H}}\alpha}{\alpha_{\mathcal{K}}} = \frac{R^*_{\mathcal{H}} \mathcal{H}^*}{(1-\tau) F\left(K^*, \bar{K}^*, \mathcal{H}^*; Z^*\right) + (1-\bar{\tau}) \bar{F}\left(\bar{K}^*, K^*, \mathcal{H}^*; \bar{Z}^*\right)}.$$

Let $\hbar = d \ln \mathcal{H}$. It is straightforward to show that the numerators in the expressions for $k$ and $\bar{k}$ in equations (A.21) and (A.22) gain the new term $-\alpha_{\mathcal{H}}\alpha\hbar/\alpha_{\mathcal{K}}$. In addition, linearizing equation (A.51) gives:

$$\alpha_{\mathcal{H}}\alpha\hbar/\alpha_{\mathcal{K}} = \zeta_{\mathcal{H}}\left(s_{RK} k + s_{\bar{R}\bar{K}} \bar{k} - r_{\mathcal{H}}\right), \tag{A.52}$$

[2]This assumption is inessential to the results characterizing how the presence of intangible capital affects the responses of domestic and foreign tangible capital to the main tax terms.

$$\text{where:} \qquad \zeta_{\mathscr{H}} = \frac{\alpha_{\mathscr{H}}\alpha/\alpha_{\mathscr{K}}}{1-\alpha_{\mathscr{H}}\alpha/\alpha_{\mathscr{K}}} = \frac{\alpha_{\mathscr{H}}}{1-\alpha_L-\alpha_M-\alpha_{\mathscr{H}}} \subseteq [0,\infty].$$

Substituting equation (A.52) into the augmented equations (A.21) and (A.22) and solving gives the result for the response of tangible capital in the presence of dynamic accumulation of intangible capital:

$$k = -\frac{\omega_{k,r}r + \left(1-\omega_{k,r}\right)\bar{r} + \omega_{k,\tau}\left(\hat{\tau}-z\right) + \left(1-\omega_{k,\tau}\right)\left(\hat{\bar{\tau}}-\bar{z}\right) + \zeta_{\mathscr{H}}r_{\mathscr{H}}}{1-\alpha-\zeta_{\mathscr{H}}\left(s_{RK}+s_{\bar{R}\bar{K}}\right)}, \tag{A.53}$$

$$\text{where:}\ \omega_{k,r} \equiv \frac{1-\zeta_{\mathscr{H}}\sigma s_{\bar{R}\bar{K}} - \mathbb{E}_{s_{\bar{F}_1}}\left(\bar{s}_1, 1-s_1\right)\tilde{\alpha}}{1-\left(\mathbb{E}_{s_{F_1}}\left(s_1,1-\bar{s}_1\right)+\mathbb{E}_{s_{\bar{F}_1}}\left(\bar{s}_1,1-s_1\right)-1\right)\tilde{\alpha}},$$

$$\omega_{k,\tau} \equiv \frac{s_{F_1} + \left(1-s_{F_1}-s_{\bar{F}_1}\right)\left(\zeta_{\mathscr{H}}\sigma s_{\bar{R}\bar{K}}+\bar{s}_1\tilde{\alpha}\right)}{1-\left(\mathbb{E}_{s_{F_1}}\left(s_1,1-\bar{s}_1\right)+\mathbb{E}_{s_{\bar{F}_1}}\left(\bar{s}_1,1-s_1\right)-1\right)\tilde{\alpha}}.$$

In particular, equation (A.53) shows that intangible capital introduces a force akin to complementarity between $K$ and $\bar{K}$. Indeed, setting $a = \bar{a} = s_1 = \bar{s}_1 = s_{F_1} = s_{\bar{F}_1} = \mathbb{E}_{s_{F_1}}\left(s_1, 1-\bar{s}_1\right) = \mathbb{E}_{s_{\bar{F}_1}}\left(\bar{s}_1, 1-s_1\right) = 1$ so that foreign capital does not directly enter the domestic production function, we have:

$$\omega_{k,r}\left(a=\bar{a}=1\right) = \frac{1-\zeta_{\mathscr{H}}\sigma s_{\bar{R}\bar{K}}-\tilde{\alpha}}{1-\tilde{\alpha}} = \frac{1-\alpha-\zeta_{\mathscr{H}}s_{\bar{R}\bar{K}}}{1-\alpha} < 1. \tag{A.54}$$

The positive response of domestic capital to the foreign cost of capital occurs because the accumulation of foreign tangible capital induces more intangible investment, which also benefits domestic tangible capital. In addition to this force on $\omega_{k,r}$, the additional term in the denominator of the expression for $k$ tends to increase the capital elasticities, because of the crowding in of intangible investment.

## A.4 Intangible Capital Location Choice Extension

This extension augments our baseline environment to allow the firm to choose the location of intangible capital in order to shift profits into low tax jurisdictions. The firm has a stock of intangible capital of $\mathscr{H}_t$, divided into intangible capital booked domestically $H_t$ and booked abroad $\bar{H}_t$. To focus on the location choice, we now take the overall stock $\mathscr{H}$ as exogenous. Intangible capital is non-rival and multiplicatively scales $Z_t$ and $\bar{Z}_t$; since it is now exogenous, the precise elasticity of earnings to intangible capital does not matter.

The firm applies a transfer price $p_t^H$ to the use of intangible capital located in a different jurisdiction. Let $\Delta_{H,t} = \bar{H}_t - H_t$ denote the stock located abroad in excess of the domestic stock. Hence the domestic branch receives net royalties $p_t^H\left(H_t-\bar{H}_t\right) = -p_t^H\Delta_{H,t}$ and the foreign branch receives net royalties $p_t^H\Delta_{H,t}$. The firm may pay a cost from too-aggressive transfer pricing, given by $\Psi^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right)$. This cost represents the legal risk and compliance cost of locating intangible capital differently from the location of tangible capital. Total cash flows are thus augmented by transfer pricing profits net of costs $\left(\tau_t-\bar{\tau}_t\right)p_t^H\Delta_{H,t} - \Psi^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right)$.

With this setup, equation (6) and its foreign counterpart remain unchanged. The necessary conditions for $K$ and $\bar{K}$ and the new necessary condition for $\Delta_H$ become:

$$K_t: \qquad \dot{\lambda}_t = (\rho+\delta)\lambda_t - (1-\tau_t)(F_1 - \Phi_2) - (1-\bar{\tau}_t)\bar{F}_2 + \Psi_2^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right), \tag{A.55}$$

$$\bar{K}_t: \qquad \dot{\bar{\lambda}}_t = (\rho+\delta)\bar{\lambda}_t - (1-\bar{\tau}_t)\left(\bar{F}_1 - \bar{\Phi}_2\right) - (1-\tau_t)F_2 + \Psi_3^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right), \tag{A.56}$$

$$\Delta_{H,t}: \qquad \Psi_1^H = (\tau_t - \bar{\tau}_t)p_t^H. \tag{A.57}$$

The FOC ($\Delta_{H,t}$) says that at the margin increasing foreign intangible assets generates tax savings $(\tau_t - \bar{\tau}_t)p_t^H$ and increases the transfer pricing burden by $\Psi_1^H$.

Define the steady state user cost as $R^* = (\rho+\delta)(1-\Gamma^*)P^K + \Psi_2^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right)$. The following linearized relationship still holds with the parameters $\omega_{k,r}, \omega_{k,\tau}$ defined as in equations (16) and (17):

$$k = \frac{-\omega_{k,r}r - \left(1-\omega_{k,r}\right)\bar{r} - \omega_{k,\tau}\hat{\tau} - \left(1-\omega_{k,\tau}\right)\hat{\bar{\tau}} + \epsilon}{1-\alpha}.$$

Immediately, if the decision to shift profits via the location of intangible capital does not depend on physical capital, $\Psi_2^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right) = 0$, then nothing changes in the firm's physical capital decision.

To understand the implications for investment when the location choice depends on physical capital, we parameterize $\Psi^H\left(\Delta_{H,t}, K_t, \bar{K}_t\right) = \left(\psi_1^H/2\right)\left(\Delta_{H,t} - \psi_2^H\left(\bar{K}_t - K_t\right)\right)^2$. With this functional form, we have:

$$\Delta_{H,t} - \psi_2^H\left(\bar{K}_t - K_t\right) = \frac{(\tau_t - \bar{\tau}_t)p_t^H}{\psi_1^H}. \tag{A.58}$$

The difference between the allocation of intangible and tangible capital is increasing in the tax gap and decreasing in the intercept of the cost term $\psi_1^H$. The parameter $\psi_2^H$ specifies how the allocation of intangibles moves with tangible capital. The domestic user cost becomes: $R^* = (\rho+\delta)(1-\Gamma^*)P^K + \psi_2^H(\tau_t - \bar{\tau}_t)p_t^H > (\rho+\delta)(1-\Gamma^*)P^K$. The additional term arises because an additional unit of domestic capital requires an additional $\psi_2^H$ of reallocation of intangibles, which costs $(\tau_t - \bar{\tau}_t)p_t^H$ of total profits. Thus, a reduction in $\tau$ reduces the user cost and stimulates investment above the usual effect, because the lost profits from reduced intangible-shifting that come with higher $K$ are smaller when $\tau$ falls, so there is less disincentive to accumulate $K$. At the same time, the steady state user cost is larger, which implies a larger coefficient on $\hat{\Gamma}$. The foreign user cost becomes: $\bar{R}^* = \left(\bar{\rho}+\bar{\delta}\right)\left(1-\bar{\Gamma}^*\right)P^K - \psi_2^H(\tau_t - \bar{\tau}_t)p_t^H < \left(\bar{\rho}+\bar{\delta}\right)\left(1-\bar{\Gamma}^*\right)P^K$ .

To see how these changes modify equation (15), define the share contributions of the intangible terms to the user cost:

$$s_H = \frac{\psi_2^H(\tau - \bar{\tau})p^H}{R^*} \subseteq [0,1], \qquad \bar{s}_H = \frac{\psi_2^H(\tau - \bar{\tau})p^H}{\bar{R}^*}.$$

Then:

$$r = -(1-s_H)\hat{\Gamma} + s_H \frac{d(\tau-\bar{\tau})}{\tau-\bar{\tau}}, \qquad \bar{r} = -(1+\bar{s}_H)\hat{\bar{\Gamma}} - \bar{s}_H \frac{d(\tau-\bar{\tau})}{\tau-\bar{\tau}}$$

and hence:

$$k = \frac{\omega_{k,r}(1-s_H)\hat{\Gamma} + \left(1-\omega_{k,r}\right)(1+\bar{s}_H)\hat{\bar{\Gamma}} - \omega_{k,\tau}\hat{\tau} - \left(1-\omega_{k,\tau}\right)\hat{\bar{\tau}} + \left(\left(1-\omega_{k,r}\right)\bar{s}_H - \omega_{k,r}s_H\right)\frac{d(\tau-\bar{\tau})}{\tau-\bar{\tau}} + \epsilon}{1-\alpha}. \tag{A.59}$$

## A.5 Interest Deduction Extension

A firm with debt of $B_t$ can deduct interest $i_t B_t$ from its taxable earnings. We assume the firm also pays a cost (i.e. insurance) that is increasing in its (domestic) leverage and given by $\Psi^B(B_t, K_t)$. Cash flows are therefore augmented by $\tau_t i_t B_t - \Psi^B(B_t, K_t)$. The changes to the necessary conditions are:

$$K_t: \qquad \dot{\lambda}_t = (\rho+\delta)\lambda_t - (1-\tau_t)(F_1 - \Phi_2) - (1-\bar{\tau}_t)\bar{F}_2 + \Psi_2^B(B_t, K_t), \tag{A.60}$$

$$B_t: \qquad \tau_t i_t = \Psi_1^B. \tag{A.61}$$

Define the steady state user cost as $R^* = (\rho+\delta)(1-\Gamma^*)P^K - \Psi_2^B(B_t, K_t)$. The following linearized relationship still holds with the parameters $\omega_{k,r}, \omega_{k,\tau}$ defined as in equations (16) and (17):

$$k = \frac{-\omega_{k,r}r - \left(1-\omega_{k,r}\right)\bar{r} - \omega_{k,\tau}\hat{\tau} - \left(1-\omega_{k,\tau}\right)\hat{\bar{\tau}} + \epsilon}{1-\alpha}.$$

Immediately, if the financial capital structure decision does not depend on physical capital, $\Psi_2^B\left(\Delta_{B,t}, K_t\right) = 0$, then nothing changes in the firm's physical capital decision.

To understand the implications for investment when the financial capital structure decision does depend on physical capital, we follow Barro and Furman (2018) and parameterize $\Psi^B(B_t, K_t) = \psi^B\left(B_t/\left(P_t^K K_t\right)\right)^{1+\theta} P_t^K K_t/(1+\theta)$. With this functional form, the steady state domestic user cost becomes $R^* = (\rho+\delta)(1-\Gamma^*)P^K - \frac{\theta\left(\psi^B\right)^{-1/\theta}P^K}{1+\theta}(\tau^* i^*)^{1+1/\theta}$. Defining $s_B \equiv \frac{\frac{\theta}{1+\theta}\tau_t i_t B_t/K_t}{R^*}$, we have:

$$k = \frac{\omega_{k,r}(1-s_B)\hat{\Gamma} + \left(1-\omega_{k,r}\right)\hat{\bar{\Gamma}} - \left(\omega_{k,\tau} - s_B\left(\frac{1+\theta}{\theta}\right)\left(\frac{\tau}{1-\tau}\right)\right)\hat{\tau} - \left(1-\omega_{k,\tau}\right)\hat{\bar{\tau}} + \epsilon}{1-\alpha}. \tag{A.62}$$

## A.6 FDII and GILTI

Let $\tau^s, \bar{\tau}^s, \Gamma^s, \bar{\Gamma}^s$ denote the ex-FDII and ex-GILTI domestic and foreign marginal tax rates and present values of allowances ("s" for statutory), which we now distinguish from the GILTI and FDII-inclusive effective marginal tax rates and costs-of-capital.

The GILTI (Global Intangible Low Taxed Income) tax applies to foreign income. The TCJA defines global deemed intangible income as foreign income in excess of $\theta_t^{\text{GILTI-T}} = 0.1$ of foreign tangible property ("T" for tangible), i.e. GILTI $= \bar{F}\left(\bar{K}_t, K_t, \bar{Z}_t\right) - \Phi\left(\bar{I}_t, \bar{K}_t\right) - \theta_t^{\text{GILTI-T}} \bar{K}_t$. A corporation can deduct $\theta_t^{\text{GILTI-D}} = 0.5$ of global intangible income ("D" for deduction) and claim a credit for $\theta_t^{\text{GILTI-C}} = 0.8$ of foreign taxes paid ("C" for credit). The tax rate on the remainder is set at the U.S. rate of $\tau^s$. Thus, after-tax foreign profits for a GILTI-taxed firm are:

$$
\begin{aligned}
&\overbrace{\left(1-\bar{\tau}_t^s\right)\left(\bar{F}\left(\bar{K}_t, K_t, \bar{Z}_t\right) - \Phi\left(\bar{I}_t, \bar{K}_t\right)\right)}^{\text{Profits net of foreign taxes}} \\
&-\underbrace{\tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)\left(\bar{F}\left(\bar{K}_t, K_t, \bar{Z}_t\right) - \Phi\left(\bar{I}_t, \bar{K}_t\right) - \theta_t^{\text{GILTI-T}} \bar{K}_t\right)}_{\text{GILTI tax}} + \underbrace{\theta_t^{\text{GILTI-C}} \bar{\tau}_t^s \left(\bar{F}\left(\bar{K}_t, K_t, \bar{Z}_t\right) - \Phi\left(\bar{I}_t, \bar{K}_t\right)\right)}_{\text{Foreign tax credit}} \\
&= \left(1-\bar{\tau}_t\right)\left(\bar{F}\left(\bar{K}_t, K_t, \bar{Z}_t\right) - \Phi\left(\bar{I}_t, \bar{K}_t\right)\right) + \tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)\theta_t^{\text{GILTI-T}} \bar{K}_t,
\end{aligned}
$$

where: $\bar{\tau}_t \equiv \bar{\tau}_t^s\left(1-\theta_t^{\text{GILTI-C}}\right) + \tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)$.

The GILTI tax is often described as a minimum tax because at $\bar{\tau}_t^s = 0$ it nonetheless implies $\bar{\tau}_t = \tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)$. It ceases to apply when $\bar{\tau}_t^s \geq \tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)/\theta_t^{\text{GILTI-C}} = 0.1312$.

The FDII (Foreign Derived Intangible Income) deduction applies to domestic income derived from foreign sources, i.e. exports. Let $\xi$ denote the (fixed) share of a firm's domestic income attributable to exports. The TCJA defines DII (deemed intangible income) as domestic income in excess of $\theta_t^{\text{FDII-T}} = 0.1$ of domestic tangible property, i.e. DII $= F\left(K_t, \bar{K}_t, Z_t\right) - \Phi\left(I_t, K_t\right) - \theta_t^{\text{FDII-T}} K_t$, and FDII as the foreign part of DII, i.e. FDII $= \xi\left(F\left(K_t, \bar{K}_t, Z_t\right) - \Phi\left(I_t, K_t\right) - \theta_t^{\text{FDII-T}} K_t\right)$. A corporation can deduct $\theta_t^{\text{FDII-D}} = 0.375$ of FDII against domestic taxable income. Thus, after-tax domestic profits for a firm with domestic income exceeding $\theta_t^{\text{FDII-T}} K_t$ are:

$$
\begin{aligned}
&F\left(K_t, \bar{K}_t, Z_t\right) - \Phi\left(I_t, K_t\right) - \tau_t^s \left(F\left(K_t, \bar{K}_t, Z_t\right) - \Phi\left(I_t, K_t\right) - \underbrace{\theta_t^{\text{FDII-D}} \xi \left(F\left(K_t, \bar{K}_t, Z_t\right) - \Phi\left(I_t, K_t\right) - \theta_t^{\text{FDII-T}} K_t\right)}_{\text{FDII deduction}}\right) \\
&= \left(1-\tau_t\right)\left(F\left(K_t, \bar{K}_t, Z_t\right) - \Phi\left(I_t, K_t\right)\right) - \tau_t^s \xi \theta_t^{\text{FDII-D}} \theta_t^{\text{FDII-T}} K_t,
\end{aligned}
$$

where: $\tau_t = \tau_t^s\left(1-\theta_t^{\text{FDII-D}}\xi\right)$.

Putting FDII and GILTI together, the necessary conditions become:

$$
\begin{aligned}
I_t: &\quad \lambda_t = \left(1-\tau_t\right)\Phi_1\left(I_t, K_t\right) + \left(1-\Gamma_t^s\right)P_t^K, && \text{(A.63)} \\
\bar{I}_t: &\quad \bar{\lambda}_t = \left(1-\bar{\tau}_t\right)\bar{\Phi}_1\left(\bar{I}_t, \bar{K}_t\right) + \left(1-\bar{\Gamma}_t^s\right)P_t^{\bar{K}}, && \text{(A.64)} \\
K_t: &\quad \dot{\lambda}_t = R_t - \left(1-\tau_t\right)\left(F_1 - \Phi_2\left(I_t, K_t\right)\right) - \left(1-\bar{\tau}_t\right)\bar{F}_2, && \text{(A.65)} \\
\bar{K}_t: &\quad \dot{\bar{\lambda}}_t = \bar{R}_t - \left(1-\bar{\tau}_t\right)\left(\bar{F}_1 - \bar{\Phi}_2\left(\bar{I}_t, \bar{K}_t\right)\right) - \left(1-\tau_t\right)F_2, && \text{(A.66)} \\
\text{where:} &\quad R_t = \left(\rho+\delta\right)\lambda_t + \tau_t^s \xi \theta_t^{\text{FDII-D}} \theta_t^{\text{FDII-T}}, && \text{(A.67)} \\
&\quad \bar{R}_t = \left(\rho+\delta\right)\bar{\lambda}_t - \tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)\theta_t^{\text{GILTI-T}}. && \text{(A.68)}
\end{aligned}
$$

In particular, equations (A.63) to (A.66) characterize exactly the same dynamic system as equations (6) and (7) and their foreign counterparts, but with the redefined effective marginal tax rates and user costs. The user cost terms can be rewritten as:

$$R_t = (\rho+\delta)\left((1-\tau_t)\Phi_1(I_t,K_t) + (1-\Gamma_t)P_t^K\right),\ \Gamma_t \equiv \Gamma_t^s - \frac{\tau_t^s \xi \theta_t^{\text{FDII-D}}\theta_t^{\text{FDII-T}}}{(\rho+\delta)P_t^K},$$
$$\bar{R}_t = (\rho+\delta)\left((1-\bar{\tau}_t)\bar{\Phi}_1\left(\bar{I}_t,\bar{K}_t\right) + \left(1-\bar{\Gamma}_t\right)P_t^{\bar{K}}\right),\ \bar{\Gamma}_t \equiv \bar{\Gamma}_t^s + \frac{\tau_t^s\left(1-\theta_t^{\text{GILTI-D}}\right)\theta^{\text{GILTI-T}}}{(\rho+\delta)P_t^{\bar{K}}}.$$

In this sense, FDII has the same effect on investment incentives as a decline in the domestic corporate rate and depreciation allowance, while GILTI has the same effect as an increase in the foreign corporate rate and depreciation allowance. The impacts on the effective allowances arise because both FDII and GILTI exempt profits up to 10% of tangible capital, which implies that marginal changes in the tangible capital stock directly impact taxes owed.

## A.7 Transition Dynamics and Short Versus Long-Run Investment Response

This appendix shows that in the case of no foreign adjustment costs, $\bar{\phi} \to 0$, the short-run and long-run elasticities of investment to the four tax terms all scale by approximately the same factor, denoted $\chi_{SR}$. Furthermore, $\chi_{SR}$ is a sufficient statistic for the role of domestic adjustment costs.

**Linearized dynamic system.** We show these results using a linear approximation of the transition dynamics with quadratic adjustment costs ($\gamma = 1$). Define:

$$h\left(\lambda;\tau,\Gamma,P^K,\phi,\gamma\right) = \left[\frac{1}{\phi}\left(\frac{\lambda - P^K(1-\Gamma)}{(1-\tau)}\right)\right]^{\frac{1}{\gamma}}, \tag{A.69}$$
$$\text{with: } h(\lambda^*) = 0,$$
$$h'(\lambda^*) = 0^{\frac{1}{\gamma}-1}\frac{1}{\phi\gamma(1-\tau^*)}. \tag{A.70}$$

The dynamic system then takes the form:

$$\text{FOC }(I_t):\quad \dot{K}_t/K_t = h\left(\lambda_t;\tau_t,\Gamma_t,P_t^K,\phi,\gamma\right), \tag{A.71}$$
$$\text{FOC }(K_t):\quad \dot{\lambda}_t = (\rho+\delta)\lambda_t - (1-\tau_t)(F_1 + ((\gamma/(1+\gamma))h(\lambda_t)+\delta)\phi h(\lambda_t)^\gamma) - (1-\bar{\tau}_t)\bar{F}_2, \tag{A.72}$$
$$\text{FOC }(\bar{I}_t):\quad \dot{\bar{K}}_t/\bar{K}_t = h\left(\bar{\lambda}_t;\bar{\tau}_t,\bar{\Gamma}_t,P_t^{\bar{K}},\bar{\phi},\bar{\gamma}\right), \tag{A.73}$$
$$\text{FOC }(\bar{K}_t):\quad \dot{\bar{\lambda}}_t = (\rho+\delta)\bar{\lambda}_t - (1-\bar{\tau}_t)\left(\bar{F}_1 + \left((\bar{\gamma}/(1+\bar{\gamma}))h\left(\bar{\lambda}_t\right)+\delta\right)\bar{\phi}h\left(\bar{\lambda}_t\right)^{\bar{\gamma}}\right) - (1-\tau_t)F_2. \tag{A.74}$$

We take a Taylor expansion in the neighborhood of the steady state. Let $k_{t,s} = (K_t - K_s)/K_s \approx \ln(K_t/K_s)$ denote the percent deviation of $K_t$ from $K_s$. In particular, $k_{t,*} = (K_t - K^*)/K^*$ is the deviation from the new steady state and $k_{*,0} = (K^* - K_0)/K_0$ is the long-run percent change, simply denoted by $k$ elsewhere in the manuscript. Note that $\dot{k}_{t,*} = \dot{K}_t/K^*$. The linear system associated with the Taylor expansion is:[3]

$$\begin{pmatrix} \dot{k}_{t,*} \\ \dot{\lambda}_t \\ \dot{\bar{k}}_{t,*} \\ \dot{\bar{\lambda}}_t \end{pmatrix} = \mathbf{A} \begin{pmatrix} k_{t,*} \\ \lambda_t - \lambda^* \\ \bar{k}_{t,*} \\ \bar{\lambda}_t - \bar{\lambda}^* \end{pmatrix}, \tag{A.75}$$

with:

$$\mathbf{A} = \begin{pmatrix} 0 & h'(\lambda^*) & 0 & 0 \\ a_{21} & \rho+\delta & a_{23} & 0 \\ 0 & 0 & 0 & h'\left(\bar{\lambda}^*\right) \\ a_{41} & 0 & a_{43} & \rho+\delta \end{pmatrix},$$

$$a_{21} = -(1-\tau^*)K^*F_{11}\left(K^*,\bar{K}^*;Z^*\right) - (1-\bar{\tau}^*)K^*\bar{F}_{22}\left(\bar{K}^*,K^*;\bar{Z}^*\right) > 0,$$
$$a_{23} = -(1-\tau^*)\bar{K}^*F_{12}\left(K^*,\bar{K}^*;Z^*\right) - (1-\bar{\tau}^*)\bar{K}^*\bar{F}_{21}\left(\bar{K}^*,K^*;\bar{Z}^*\right),$$
$$a_{41} = -(1-\bar{\tau}^*)K^*\bar{F}_{12}\left(\bar{K}^*,K^*;\bar{Z}^*\right) - (1-\tau^*)K^*F_{21}\left(K^*,\bar{K}^*;Z^*\right) = a_{23}\chi_K^{-1},$$
$$a_{43} = -(1-\bar{\tau}^*)\bar{K}^*\bar{F}_{11}\left(\bar{K}^*,K^*;\bar{Z}^*\right) - (1-\tau^*)\bar{K}^*F_{22}\left(K^*,\bar{K}^*;Z^*\right) > 0.$$

The two stable eigenvalues of $\mathbf{A}$ are:

$$d_1 = \frac{\rho+\delta}{2} - \sqrt{\left(\frac{\rho+\delta}{2}\right)^2 + \frac{\left(h'(\lambda^*)a_{21} + h'\left(\bar{\lambda}^*\right)a_{43}\right) + \sqrt{\left(h'(\lambda^*)a_{21} + h'\left(\bar{\lambda}^*\right)a_{43}\right)^2 - 4h'(\lambda^*)h'\left(\bar{\lambda}^*\right)\left(a_{21}a_{43} - a_{23}a_{41}\right)}}{2}},$$
$$d_2 = \frac{\rho+\delta}{2} - \sqrt{\left(\frac{\rho+\delta}{2}\right)^2 + \frac{\left(h'(\lambda^*)a_{21} + h'\left(\bar{\lambda}^*\right)a_{43}\right) - \sqrt{\left(h'(\lambda^*)a_{21} + h'\left(\bar{\lambda}^*\right)a_{43}\right)^2 - 4h'(\lambda^*)h'\left(\bar{\lambda}^*\right)\left(a_{21}a_{43} - a_{23}a_{41}\right)}}{2}},$$

with the eigenvector associated with the $n^{\text{th}}$ eigenvalue:

$$\mathbf{f}_n = \begin{pmatrix} 1 \\ \frac{d_n}{h'(\lambda^*)} \\ -\left(a_{43}h'\left(\bar{\lambda}^*\right) + (\rho+\delta-d_n)d_n\right)^{-1} a_{41}h'\left(\bar{\lambda}^*\right) \\ -\left(a_{43}h'\left(\bar{\lambda}^*\right) + (\rho+\delta-d_n)d_n\right)^{-1} a_{41}d_n \end{pmatrix}.$$

The linearized solution is:

$$k_{t,*} = \frac{c_1}{k_{0,*}}k_{0,*}e^{d_1 t} + \frac{c_2}{k_{0,*}}k_{0,*}e^{d_2 t} = \left(s_{k,d}e^{d_1 t} + \left(1-s_{k,d}\right)e^{d_2 t}\right)k_{0,*}, \tag{A.76}$$
$$\bar{k}_{t,*} = \frac{c_1\mathbf{f}_1(3)}{\bar{k}_{0,*}}\bar{k}_{0,*}e^{d_1 t} + \frac{c_2\mathbf{f}_2(3)}{\bar{k}_{0,*}}\bar{k}_{0,*}e^{d_2 t} = \left(s_{\bar{k},d}e^{d_1 t} + \left(1-s_{\bar{k},d}\right)e^{d_2 t}\right)\bar{k}_{0,*}, \tag{A.77}$$
$$\text{where: } s_{k,d} \equiv \frac{c_1}{k_{0,*}} = \frac{\mathbf{f}_2(3) - \chi_{k_{0,*}}}{\mathbf{f}_2(3) - \mathbf{f}_1(3)} = \left(\frac{a_{23}h'(\lambda^*)}{d_2d_3 - d_1d_4}\right)\left(\frac{a_{41}h'\left(\bar{\lambda}^*\right)}{a_{43}h'\left(\bar{\lambda}^*\right) + d_2d_3} + \chi_{k_0}\right),$$

[3] To ease notation, we omit general equilibrium terms relating to changes in $Z$. These do not change the conclusions of this section.

$$s_{\bar{k},d} \equiv \frac{c_1 \mathbf{f}_1(3)}{\bar{k}_{0,*}} = \frac{\mathbf{f}_1(3)\left(\mathbf{f}_2(3)\chi_{k_{0,*}}^{-1} - 1\right)}{\mathbf{f}_2(3) - \mathbf{f}_1(3)}.$$

Thus, the weighted average $s_{k,d}e^{d_1 t} + \left(1 - s_{k,d}\right)e^{d_2 t}$ determines the speed of convergence of domestic capital. Furthermore:

$$\dot{k}_{t,0} = \frac{\dot{K}_t}{K_0} = \left(\frac{K^*}{K_0}\right)\dot{k}_{t,*} = \left(\frac{K^*}{K_0}\right)\left(s_{k,d}d_1 e^{d_1 t} + \left(1 - s_{k,d}\right)d_2 e^{d_2 t}\right)k_{0,*} = -\left(s_{k,d}d_1 e^{d_1 t} + \left(1 - s_{k,d}\right)d_2 e^{d_2 t}\right)k_{*,0}.$$

For example, the short-run response of net investment is:

$$\dot{k}_{0,0} = \dot{K}_0/K_0 = -\left(s_{k,d}d_1 + \left(1 - s_{k,d}\right)d_2\right)k_{*,0}. \tag{A.78}$$

**Short-run versus long-run elasticities.** We now relate the tax elasticities of short-run investment, $I_0/K_0$, to the long-run change, $dk_{*,0}$, where:

$$dk_{*,0} = \frac{\omega_{k,r}d\hat{\Gamma} + \left(1 - \omega_{k,r}\right)d\hat{\bar{\Gamma}} + \omega_{k,\tau}d\hat{\tau} + \left(1 - \omega_{k,\tau}\right)d\hat{\bar{\tau}}}{1 - \alpha} = b_1 d\hat{\Gamma} + b_2 d\hat{\bar{\Gamma}} + b_3 d\hat{\tau} + b_4 d\hat{\bar{\tau}}.$$

Totally differentiating $I_0/K_0$ and letting $**$ denote the steady state at the base values of the tax changes, we obtain:

$$d\dot{k}_{0,0} = dI_0/K_0 = \delta dI_0/I_0 = -\left(s_{k,d}^{**}d_1^{**} + \left(1 - s_{k,d}^{**}\right)d_2^{**}\right)dk_{*,0} - \sum_{x \in \left\{\hat{\tau},\hat{\Gamma},\hat{\bar{\tau}},\hat{\bar{\Gamma}}\right\}} k_{**,0}\frac{\partial\left[s_{k,d}d_1 + \left(1 - s_{k,d}\right)d_2\right]}{\partial x}dx. \tag{A.79}$$

The first term scales the long-run change by a common factor $\left(s_{k,d}^{**}d_1^{**} + \left(1 - s_{k,d}^{**}\right)d_2^{**}\right)$. The second term implies possibly different short-run speeds of adjustments to different tax terms.

Equation (A.79) usefully simplifies in the case of no foreign adjustment costs, $\bar{\phi} \to 0$. In particular, while $d_1 \to -\sqrt{h'\left(\bar{\lambda}^*\right)a_{43}} \to -\infty$, an application of L'Hopital's rule yields that $\lim_{\bar{\phi}\to 0} s_{k,d}d_1 + \left(1 - s_{k,d}\right)d_2 = d_2$. Thus, the second term of equation (A.79) only involves derivatives of $d_2$. These involve third derivatives of the production function and hence are small relative to the first term. Intuitively, the difference between the ratio of short-run to long-run elasticities to e.g. $\Gamma$ and $\bar{\Gamma}$ arises primarily because both ratios depend on the magnitude of domestic adjustment costs but the short-run elasticity to $\bar{\Gamma}$ also depends on the foreign adjustment cost. When $\bar{\phi} \to 0$, the only remaining difference occurs because foreign capital does not quite jump immediately to its long-run value, because of the feedback from growing domestic capital to foreign capital. This feedback effect is small. In our calibration, the ratio of the short-to-long run elasticity varies by less than 10% across the tax variables.

**Ratio $\chi_{SR}$.** The average deviation of of investment over period 0 to $T$ relative to date 0 is:

$$\begin{aligned}
\int_0^T \left(\frac{\dot{K}_t + \delta\left(K_t - K_0\right)}{T\delta K_0}\right) dt &= \frac{1}{\delta T}\int_0^T \left(\delta k_{t,0} - \left(s_{k,d} d_1 e^{d_1 t} + \left(1 - s_{k,d}\right) d_2 e^{d_2 t}\right) k_{*,0}\right) dt \\
&\approx \frac{1}{\delta T}\int_0^T \left(\delta\left(k_{t,*} + k_{*,0}\right) - \left(s_{k,d} d_1 e^{d_1 t} + \left(1 - s_{k,d}\right) d_2 e^{d_2 t}\right) k_{*,0}\right) dt \\
&\approx k_{*,0} - \frac{k_{*,0}}{\delta T}\int_0^T \left(\delta\left(s_{k,d} e^{d_1 t} + \left(1 - s_{k,d}\right) e^{d_2 t}\right) + \left(s_{k,d} d_1 e^{d_1 t} + \left(1 - s_{k,d}\right) d_2 e^{d_2 t}\right)\right) dt \\
&= k_{*,0}\left(1 - s_{k,d}\left(1 + \frac{\delta}{d_1}\right)\left(\frac{e^{d_1 T} - 1}{\delta T}\right) - \left(1 - s_{k,d}\right)\left(1 + \frac{\delta}{d_2}\right)\left(\frac{e^{d_2 T} - 1}{\delta T}\right)\right).
\end{aligned}$$

The long run deviation of investment is:

$$\frac{\delta\left(K^* - K_0\right)}{\delta K_0} = k_{*,0}.$$

Thus, the ratio is:

$$\chi_{SR} = 1 - s_{k,d}\left(1 + \frac{\delta}{d_1}\right)\left(\frac{e^{d_1 T} - 1}{\delta T}\right) - \left(1 - s_{k,d}\right)\left(1 + \frac{\delta}{d_2}\right)\left(\frac{e^{d_2 T} - 1}{\delta T}\right).$$

In particular, as $\bar{\phi} \to 0$, $\chi_{SR} \to 1 - \left(1 + \frac{\delta}{d_2}\right)\left(\frac{e^{d_2 T} - 1}{\delta T}\right)$. Inverting this expression gives the domestic adjustment cost as a function of $\chi_{SR}$.

## A.8 Adjustment Cost Moments

This appendix describes our analysis of the Winberry (2021) calibration. Winberry (2021) estimates a rich model of fixed and convex adjustment costs to match interest rate dynamics and, crucially, three targets of the firm-level investment distribution based on the SOI sample over 1998-2010, drawn from Zwick and Mahon (2017): the average investment rate, the standard deviation of investment rates, and the fraction of firm-years with an investment rate above 20%.

Using the Winberry (2021) replication code, we produce impulse responses of investment to a TFP shock and to an investment stimulus shock, similar to those shown in figures 5 and 7 of his paper. In partial equilibrium, the TFP shock has the same effect on investment as a change in $1-\tau$ and the investment stimulus shock the same as a shock to $1-\Gamma$. We start each impulse response at the model steady state and set the quarterly persistence of each shock to 0.999. We report in table A.1 the average response of investment over the first 8 quarters of the impulse response, the same horizon over which we measure the effects of TCJA, and after 10 years, which we equate with the long-run, as well as the ratio of these responses.

Our preferred value of $\chi_{SR} = 1.3$ falls in the middle of the ratios in partial equilibrium, shown in the first two rows. We target the partial equilibrium impulse responses because we do not incorporate an upward supply of capital in our model. For completeness, the next two rows show the responses and ratios in Winberry's general equilibrium environment. Because

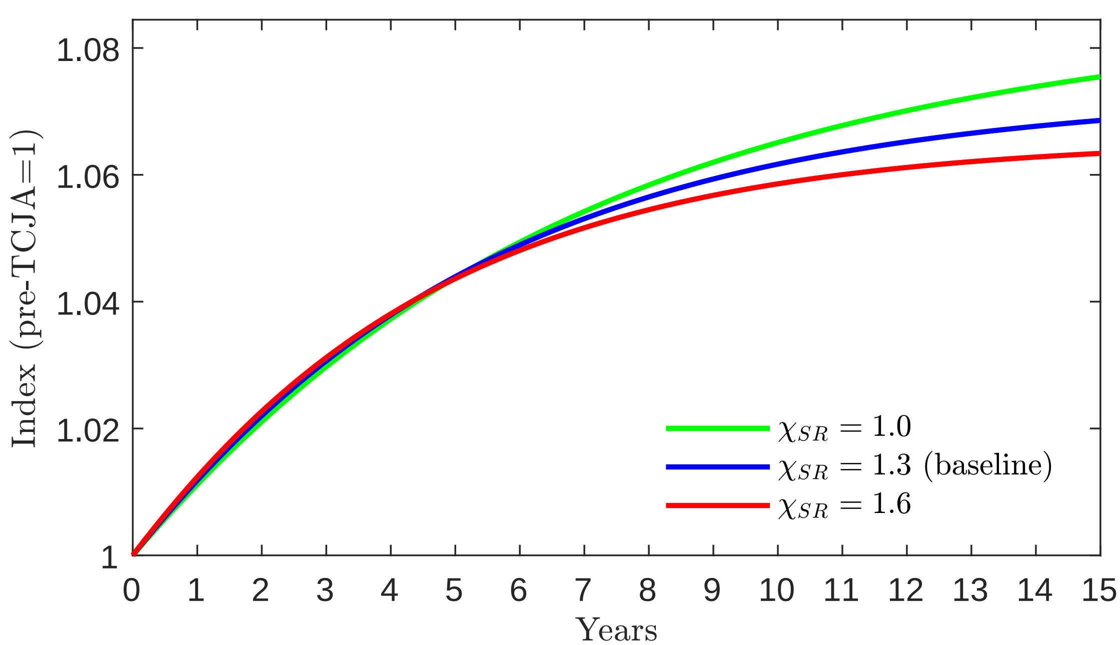
Table A.1: Ratio of Short-run to Long-run

| Exercise | Quarters 0-8 | Quarter 40 | Ratio |
|---|---|---|---|
| Winberry; TFP; PE | 13.50 | 9.09 | 1.49 |
| Winberry; Invest Stim.; PE | 7.81 | 6.55 | 1.19 |
| Winberry; TFP; GE | 3.09 | 2.74 | 1.13 |
| Winberry; Invest Stim.; GE | 1.64 | 2.33 | 0.70 |
| BCE; TFP; GE | 2.66 | 1.48 | 1.80 |
| BCE; Invest Stim.; GE; Implied rate | 1.44 | 1.26 | 1.14 |

his is a real business cycle model with time-to-build, output is fixed in the short-run and there is instantaneous GE dampening of investment stimulus shocks despite the presence of adjustment costs. The last two rows report the ratios from performing the same exercise in another leading estimate of adjustment costs, Bachmann, Caballero and Engel (2013).

Figure A.1 shows the robustness of the response of domestic capital in the model to values of $\chi_{SR}$ ranging from 1 to 1.6. For each value, we re-estimate the parameters $\theta$ and set the domestic adjustment cost parameter $\phi$ such that short-run to long-run ratio of investment matches the value. The response of capital at year 15 varies by less than 1.5p.p. across values of $\chi_{SR}$. This small difference partly reflects the larger adjustment costs required to rationalize a smaller value of $\chi_{SR} = 1$, as the path with $\chi_{SR} = 1.6$ has essentially converged to its long-run value by year 15 while the path with $\chi_{SR} = 1$ has a steeper slope. In the short-run, the smaller adjustment costs required to generate a larger $\chi_{SR}$ offset the smaller terminal value and the trajectory of capital is nearly indistinguishable across a range of values of $\chi_{SR}$.

Figure A.1: Robustness of $K/K_0$ to $\chi_{SR}$



## A.9 Interpretation of a Levels Regression

This appendix considers the common regression specification of the investment-capital ratio on the level of the "tax term" in the context of our model. For simplicity, we restrict attention to domestic-only firms.

A common regression specification is:

$$\frac{I_{j,t}}{K_{j,t}} = c_1 TT_{j,t} + \alpha_j + \nu_t + e_{j,t},$$

where $TT_{j,t} = \left(1-\Gamma_{j,t}\right)/\left(1-\tau_{j,t}\right)$ denotes the "tax term." It simplifies matters to take first differences and consider the specification around a tax change at date 0:

$$\frac{I_{j,0^+}}{K_{j,0}} - \frac{I_{j,0}}{K_{j,0}} = c_0 + c_1\left(TT_j^* - TT_{j,0}\right) + \Delta e_{j,t}, \tag{A.80}$$

where $X_{j,0^+}$ denotes the value of a variable just after the tax change. We now provide an expression for $c_1$.

In the case of domestic-only firms, the system (A.75) becomes:

$$\begin{pmatrix} \dot{k}_{t,*} \\ \dot{\lambda}_t \end{pmatrix} = \mathbf{A}\begin{pmatrix} k_{t,*} \\ \lambda_t - \lambda^* \end{pmatrix}, \tag{A.81}$$

with:

$$\mathbf{A} = \begin{pmatrix} 0 & h'(\lambda^*) \\ a_{21} & \rho+\delta \end{pmatrix},$$
$$a_{21} = -(1-\tau^*)K^* F_{11}(K^*; Z^*) > 0.$$

The solution is:

$$k_{t,*} = k_{0,*}e^{d_1 t}, \tag{A.82}$$
$$\lambda_t - \lambda^* = k_{0,*} d_1 \phi (1-\tau^*) e^{d_1 t}, \tag{A.83}$$

where $d_1 = \frac{\rho+\delta}{2} - \sqrt{\left(\frac{\rho+\delta}{2}\right)^2 - \phi^{-1}K^* F_{11}(K^*; Z^*)}$ is the stable eigenvalue. Furthermore, the steady state of the (domestic-only version of the) system equations (6) and (7) gives $k_{0,*} = \left(\frac{1}{1-\alpha}\right)\ln(TT^*/TT_0)$, $\lambda_0 = 1-\Gamma_0$, $\lambda^* = 1-\Gamma^*$.

We now obtain an expression for $c_1$. Using equation (A.83) and the steady-state conditions gives an expression for the impact change in after-tax $\lambda$:

$$\frac{\lambda_{0^+}}{1-\tau^*} - \frac{\lambda_0}{1-\tau_0} = (TT^* - TT_0) + \left(\frac{d_1\phi}{1-\alpha}\right)\ln(TT^*/TT_0). \tag{A.84}$$

FOC (6) relates equation (A.80) to the model:

$$\frac{I_{0^+}}{K_0} - \frac{I_0}{K_0} = \frac{1}{\phi}\left(\frac{\lambda_{0^+}}{1-\tau^*} - \frac{\lambda_0}{1-\tau_0} - (TT^* - TT_0)\right). \tag{A.85}$$

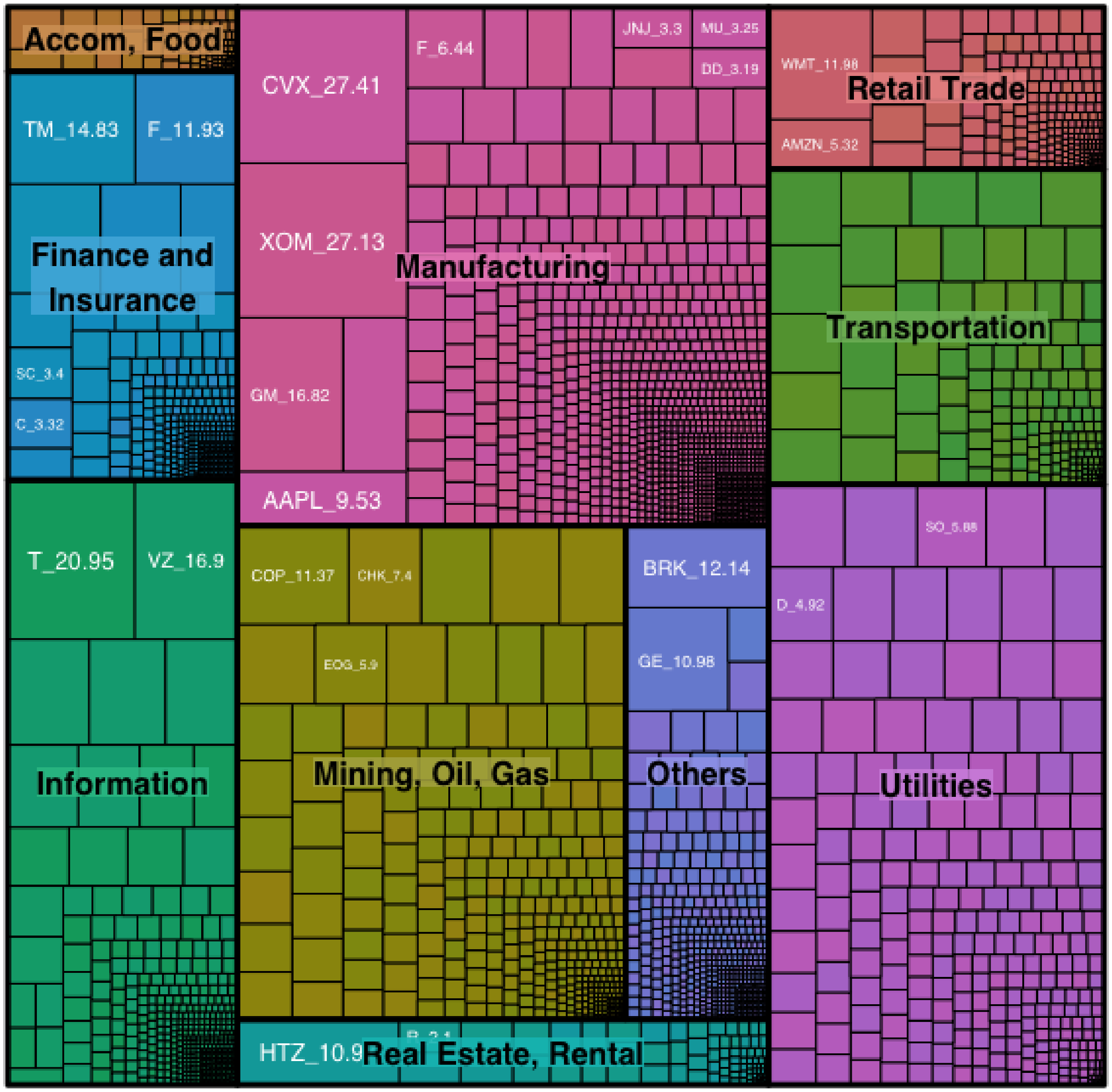
Combining equations (A.80), (A.84) and (A.85), we find:

$$\begin{aligned}
c_1 &= \frac{Cov\left(\frac{I_{0^+}}{K_0} - \frac{I_0}{K_0}, TT^* - TT_0\right)}{Var\left(TT^* - TT_0\right)} \\
&= \frac{Cov\left(\frac{1}{\phi}\left((TT^* - TT_0) + \left(\frac{d_1\phi}{1-\alpha}\right)\ln\left(TT^*/TT_0\right) - (TT^* - TT_0)\right), TT^* - TT_0\right)}{Var\left(TT^* - TT_0\right)} \\
&= \left(\frac{d_1}{1-\alpha}\right)\frac{Cov\left(\ln\left(TT^*/TT_0\right), TT^* - TT_0\right)}{Var\left(TT^* - TT_0\right)} \\
&\approx \left(\frac{d_1}{1-\alpha}\right) \times \frac{1}{TT_0}.
\end{aligned} \tag{A.86}$$

The final expression in equation (A.86) contains a much more complicated mapping of parameters and policy variables into the regression coefficient than our preferred specification (see e.g. Auerbach and Hassett, 1992, for an example of this approach). Moreover, because around a tax reform firm-level heterogeneity in $TT_0$ likely is correlated with $TT^* - TT_0$, a cross-sectional regression need not even produce an appropriate weighted-average of $\left(\frac{d_1}{1-\alpha}\right) \times \frac{1}{TT_0}$. Including Tobin's Q as a separate regressor as in Desai and Goolsbee (2004) does not resolve the problem if the change in $\lambda$ is measured with any error (e.g., because marginal $Q$ is not observed).

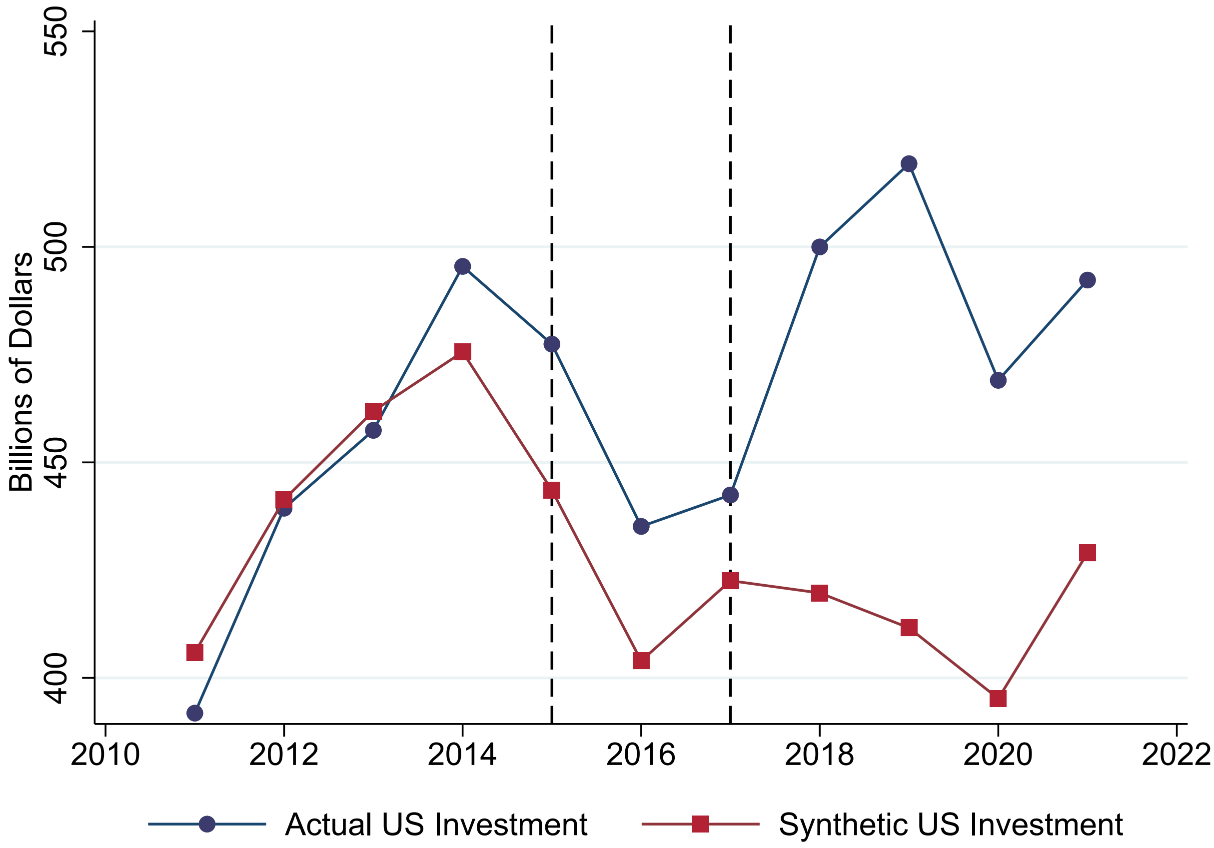
# B Appendix Figures

Figure B.1: Decomposing U.S. Investment of Public Firms by Sector and Firm



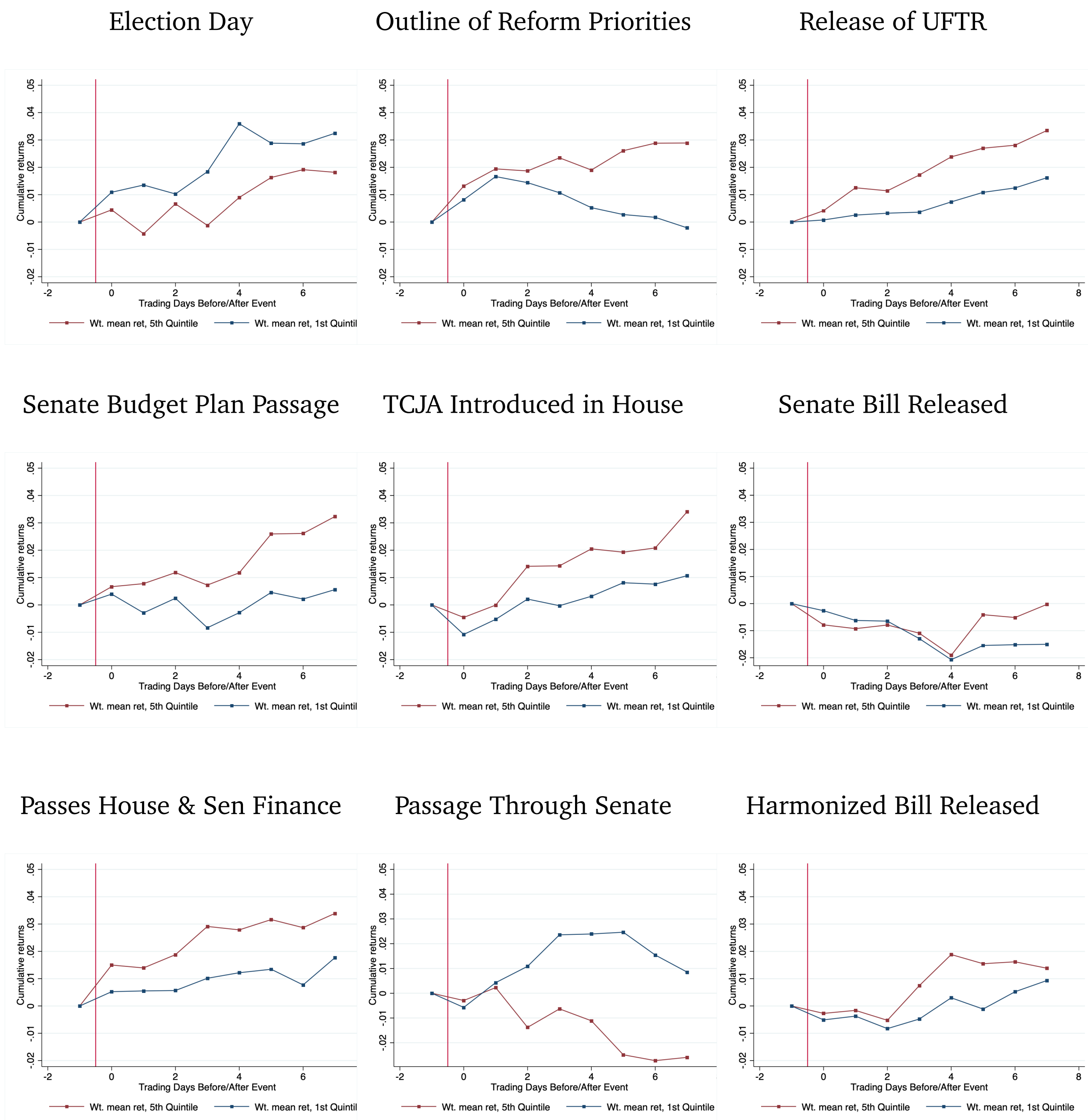

*Notes:* This treemap plots the distribution of mean capital expenditures for the preperiod (2011-2017) within each sector using Compustat data. The squares are labelled using a company's stock ticker and its mean capital expenditure in the pre-period (2011-2017) in billions of USD. Firms with the largest average investment include Chevron (CVX $27.41B), Exxon (XOM $27.13B), AT&T (T $20.95B), Verizon (VZ $16.9), General Motors (GM $16.82), Toyota Motor Credit Corp (TM $14.83), Berkshire Hathaway (BRK $12.14B), Walmart (WMT $11.98B), Ford Motor Credit Co (F $11.93B), and ConocoPhillips (COP $11.37B). This figure does not contain data from tax returns.

Figure B.2: Investment of Public Firms in U.S. and Similar Foreign Firms: Backdated Approach




*Notes:* The figure plots aggregate investment (capital expenditures) of US public firms and compares it to the investment of synthetically matched global firms. Synthetic firms were matched based on the values of firm characteristics between 2011 and 2015, which allows the 2016 and 2017 pre-reform values to serve as a validation test of the match. This figure does not contain data from tax returns.

Figure B.3: Returns for Individual Events by Tax Shock Quintile




*Notes:* This figure displays cumulative raw returns (CRSP variable ret) for the top (Q5) and bottom (Q1) quintiles of tax shock separately for each event in our event sample. Events are described in Appendix C, Narrative History of Key TCJA Events. This figure does not contain data from tax returns.

# C Appendix Tables

Table C.1: Industry-level Trends in Globalizing Investment

| | NAICS 2-Digit Industry | Trend (p.p.) | | NAICS 2-Digit Industry | Trend (p.p.) |
|---|---|---|---|---|---|
| 1 | Information (51) | -1.68 | 11 | Utilities (22) | -0.24 |
| 2 | Educational Services (61) | -1.44 | 12 | Admin Services (56) | -0.12 |
| 3 | Manufacturing, Food (31) | -0.96 | 13 | Mining and Extraction (21) | 0.00 |
| 4 | Wholesale Trade (42) | -0.84 | 14 | Health Care (62) | 0.00 |
| 5 | Manufacturing, Materials (32) | -0.60 | 15 | Transportation (48) | 0.00 |
| 6 | Accommodation and Food (72) | -0.60 | 16 | Retail Trade (44) | 0.00 |
| 7 | Real Estate and Rental/Leasing (53) | -0.48 | 17 | Arts, Entertainment, Rec (71) | 0.48 |
| 8 | Manufacturing, Heavy (33) | -0.48 | 18 | Retail Trade (45) | 0.60 |
| 9 | Professional, Scientific Svcs (54) | -0.36 | 19 | Agriculture (11) | 0.84 |
| 10 | Other Services (81) | -0.24 | 20 | Construction (23) | 1.80 |

*Notes:* The estimates in this table come from regressing $\omega_I \equiv \frac{I_{SOI}}{I_{CSTAT}}$ on time trend from 1993 to 2019. Manufacturing and information sectors drive the trend.

Table C.2: Coverage of the Synthetic Sample

| | **US firms** | | **Capx (Avg 2011-17)** | | **Market Value (Avg 2011-17)** | |
|---|---|---|---|---|---|---|
| | N | % | Total (in billions USD) | % | Total (in billions USD) | % |
| Cleaned Compustat Firms w/o NAICS 52 | 8,936 | 100 | 1,127.8 | 100 | 20,673.3 | 100 |
| Dropping Panels with any missing Year-Capx | 2,359 | 26 | 833.7 | 74 | 15,723.2 | 76 |
| Dropping Panels with Less than 4 Non-Missing Year-Xs | 2,278 | 25 | 833.6 | 74 | 15,460.7 | 75 |
| Synthetic Matches | 2,275 | 25 | 830.9 | 74 | 15,449.9 | 75 |
| Close Synthetic Matches | 1,493 | 17 | 599.4 | 53 | 9,168.8 | 44 |

*Notes:* This table shows how the sample declines as we drop firms with key variables missing in order to conduct synthetic matching. The X's in row 3 include sales, assets, and property, plant, and equipment. The 3 firms that are dropped in row 4 have come from NAICS industries with no no global firms. Specifically, they come from NAICS 5313, 221, and 6222, which represent real estate, utilities, and psychiatric and substance abuse hospitals. Close synthetic matches refer to the synthetic matches that have an average pre-reform period (2011-2017) capx within 10% of the US firm's average pre-period capx. This table does not contain data from tax returns.

Table C.3: Summary Statistics of Matched Firms

| Firms: | Matched: US | | Matched: Synthetic | | Closely Matched: US | | Closely Matched: Synthetic | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | Mean | Median | Mean | Median |
| ***Pre-period Characteristics (2011-17)*** | | | | | | | | |
| Capx | 366.3 | 25.0 | 304.9 | 21.2 | 402.6 | 44.1 | 399.1 | 42.1 |
| | (1,435) | | (1,296) | | (1,519) | | (1,554) | |
| Assets | 6,918.0 | 828.6 | 4,914.4 | 669.5 | 7,426.1 | 1358.2 | 6,164.0 | 1,132.7 |
| | (26,314) | | (15,811) | | (27,800) | | (18,376) | |
| PPE | 2,554.4 | 120.5 | 2,058.7 | 122.0 | 3,014.4 | 222.6 | 2,719.6 | 231.5 |
| | (10,039) | | (7,815) | | (11,215) | | (9,301) | |
| Sales | 4,906.2 | 661.7 | 2,935.7 | 412.5 | 4,717.7 | 1,126.3 | 3,570.3 | 788.8 |
| | (19,138) | | (10,500) | | (15,951) | | (12,019) | |
| Market Value | 7,474.7 | 832.5 | NA | NA | 6,864.5 | 1,232.7 | NA | NA |
| | (29,157) | | | | (22,062) | | | |
| ***Post-period Characteristics (2018-20)*** | | | | | | | | |
| Capx | 418.9 | 28.8 | 287.0 | 24.0 | 435.8 | 51.4 | 374.7 | 50.1 |
| | (1,619) | | (1,100) | | (1,454) | | (1,298) | |
| Assets | 11,791.0 | 964.6 | 6,136.7 | 943.8 | 9,357.3 | 1,854.0 | 7,653.1 | 1,668.8 |
| | (61,206) | | (18,048) | | (31,849) | | (20,865) | |
| PPE | 3,425.3 | 210.6 | 2,487.0 | 179.8 | 3,875.8 | 367.0 | 3,257.7 | 338.2 |
| | (12,432) | | (8,540) | | (13,314) | | (10,027) | |
| Sales | 5,722.2 | 851.6 | 3,180.6 | 532.3 | 5,145.3 | 1348.5 | 3,835 | 1,026.9 |
| | (22,571) | | (10,243) | | (15,790) | | (11,532) | |
| Market Value | 11,791.0 | 964.6 | NA | NA | 9,640.6 | 1,447.9 | NA | NA |
| | (61,207) | | | | (28,956) | | | |
| Observations | 2,275 | | 2,275 | | 1,493 | | 1,493 | |

*Notes:* The table uses data from Compustat North America and Global. All values are in millions of USD and are adjusted for inflation using CPI data from the series https://fred.stlouisfed.org/series/CPIAUCSL#0 indexed to 2021 US dollars. It shows the summary statistics for key variables in the pre-period (2011-17) as well as the post-period (2018-19). The numbers in the brackets show the standard deviation. The first two columns show the US headquartered firms that are in the synthetically matched sample, the next 2 columns show the synthetically created global firms, and the last 4 columns represent the same but for a closely matched sample where we have dropped all matches that are not in the 10% band of each other's capx in the pre-reform period (2011-17). This table does not contain tax data.

Table C.4: Investment of US and Synthetic Matched Firms in 2019, by Industry

| Industry | US Public Firms | Synthetic Firms | Difference |
|---|---|---|---|
| Agriculture, Fishing | 0.2 | 0.2 | 0 |
| Mining, Quarrying, Oil, Gas | 70.1 | 52.4 | 17.7 |
| Utilities | 237.1 | 169.4 | 67.7 |
| Construction | 1.8 | 1.5 | 0.4 |
| Manufacturing (NAICS 31-33) | 216.1 | 195.6 | 20.5 |
| Wholesale Trade | 4.4 | 3.7 | 0.8 |
| Retail Trade (NAICS 44-45) | 19.9 | 13.6 | 6.2 |
| Transportation, Warehousing | 61.2 | 55.2 | 6.0 |
| Information | 32.3 | 32.0 | 0.3 |
| Real Estate, Rental | 5.3 | 4.0 | 1.2 |
| Professional, Science, Tech | 4.1 | 3.3 | 0.8 |
| Admin, Waste Mgmt, Remediation | 2.6 | 1.7 | 0.9 |
| Education | 0 | 0 | 0 |
| Health Care | 2.6 | 2.7 | −0.1 |
| Arts, Entertainment | 1.3 | 1.8 | −0.5 |
| Accommodation and Food | 3.6 | 2.8 | 0.8 |
| Other Services | 0 | 0 | 0 |
| Nonclassifiable | 22.4 | 21.6 | 0.8 |

*Notes:* This table displays total investment in billions of U.S. dollars in 2019 by US firms in our Compustat analysis sample, their synthetic counterparts from Global Compustat, and the difference between the two separately for each two-digit NAICS industry. This table does not contain data from tax returns.

Table C.5: DID Estimates of the effect of TCJA on Investment (Backdated Matched Sample)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| post | $0.156^{***}$ | $0.156^{***}$ | $0.160^{***}$ | $0.160^{***}$ |
| | (0.047) | (0.047) | (0.047) | (0.047) |
| Observations | 23,160 | 23,160 | 23,160 | 23,160 |
| Controls | *No* | *Yes* | *No* | *Yes* |
| 4-digit NAICS Fixed effects | *No* | *No* | *Yes* | *Yes* |

*Notes:* Standard errors in parentheses are clustered at the firm level. The outcome variable is ln(capx of treated firms) - ln(capx of synthetic firms). The controls include the mean pre-period (2011-17) values of capx, assets, sales and property, plant and equipment (PPE) of treated firms. Weighted by mean pre-period capx of treated firms. For the backdated matched sample, the firms are synthetically matched based on the values of firm characteristics between 2010 and 2014. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.This table does not contain data from tax returns.

Table C.6: Tax Change Portfolios

| | Share | $K_0$/ firm | $100 \times \Gamma$ | | $100 \times \bar{\Gamma}$ | | $100 \times \tau$ | | $100 \times \bar{\tau}$ | | N |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre | Post | Pre | Post | Pre | Post | Pre | Post | |
| Group: | | | | | | | | | | | |
| Domestic 1 | 18.6 | 142 | 14.2 | 9.4 | | | 17.3 | 10.2 | | | 2883 |
| Domestic 2 | 1.9 | 64 | 22.9 | 15.5 | | | 34.7 | 22.2 | | | 639 |
| Domestic 3 | 2.7 | 94 | 23.9 | 14.5 | | | 27.0 | 15.4 | | | 638 |
| Domestic 4 | 12.1 | 92 | 29.8 | 19.6 | | | 34.6 | 21.5 | | | 2884 |
| Multinat. high 1 | 4.0 | 288 | 10.3 | 8.8 | 17.7 | 17.7 | 13.2 | 11.0 | 27.4 | 28.4 | 302 |
| Multinat. high 2 | 4.2 | 424 | 14.4 | 11.2 | 17.7 | 29.4 | 17.0 | 11.7 | 23.5 | 24.5 | 220 |
| Multinat. high 3 | 0.7 | 557 | 21.6 | 14.0 | 17.7 | 29.4 | 29.4 | 18.0 | 15.0 | 18.2 | 26 |
| Multinat. high 4 | 0.2 | 300 | 24.0 | 15.5 | 17.7 | 29.4 | 26.7 | 16.3 | 23.0 | 24.5 | 13 |
| Multinat. high 5 | 0.1 | 111 | 26.4 | 18.3 | 17.7 | 17.7 | 29.3 | 19.5 | 21.1 | 22.1 | 21 |
| Multinat. high 6 | 8.0 | 474 | 27.8 | 16.3 | 17.7 | 29.4 | 33.5 | 18.3 | 18.4 | 19.3 | 371 |
| Multinat. high 7 | 1.1 | 160 | 28.1 | 18.5 | 17.7 | 17.7 | 33.6 | 21.3 | 25.3 | 26.1 | 150 |
| Multinat. low 1 | 4.6 | 276 | 16.8 | 12.3 | 17.7 | 17.7 | 19.9 | 13.6 | 24.9 | 26.4 | 365 |
| Multinat. low 2 | 2.4 | 344 | 18.2 | 13.3 | 17.7 | 29.4 | 21.1 | 13.8 | 20.6 | 22.4 | 155 |
| Multinat. low 3 | 0.3 | 303 | 21.1 | 13.5 | 17.7 | 17.7 | 34.8 | 22.2 | 22.7 | 23.4 | 22 |
| Multinat. low 4 | 0.5 | 388 | 22.6 | 14.5 | 17.7 | 29.4 | 34.0 | 21.3 | 7.7 | 14.1 | 29 |
| Multinat. low 5 | 0.4 | 294 | 25.5 | 16.8 | 17.7 | 17.7 | 27.1 | 17.2 | 26.4 | 26.5 | 27 |
| Multinat. low 6 | 0.3 | 256 | 28.7 | 20.4 | 17.7 | 29.4 | 31.8 | 21.1 | 25.0 | 25.1 | 23 |
| Multinat. low 7 | 3.3 | 342 | 29.3 | 18.8 | 17.7 | 17.7 | 34.0 | 21.1 | 24.1 | 25.1 | 213 |
| Multinat. low 8 | 5.6 | 399 | 29.5 | 18.9 | 17.7 | 29.4 | 34.0 | 20.5 | 22.3 | 23.4 | 308 |
| Non C-corp. | 29.0 | 117 | 23.0 | 23.0 | | | 28.0 | 28.0 | | | |

*Notes*: Share is the share of domestic capital at firms in the group, in percent. $K_0$/ firm is average domestic capital per firm in billions of dollars. Pre and post refer to 2015-2016 and 2018-2019 averages.

Table C.7: Summary Statistics for Firms in Compustat

| | Mean | Std. Dev. | Median | P10 | P90 | N |
|---|---|---|---|---|---|---|
| Average Tax Rate | 0.04 | 0.05 | 0.01 | 0.00 | 0.11 | 1910 |
| Pre-TCJA $\Gamma$ | 0.21 | 0.09 | 0.22 | 0.08 | 0.31 | 1913 |
| Pre-TCJA $\bar{\Gamma}$ | 0.18 | 0.00 | 0.18 | 0.18 | 0.18 | 1914 |
| Pre-TCJA $\tau$ | 0.25 | 0.10 | 0.27 | 0.09 | 0.35 | 1914 |
| Pre-TCJA $\bar{\tau}$ | 0.15 | 0.16 | 0.11 | 0.00 | 0.37 | 1914 |
| $d$ log(Investment) | -0.06 | 0.90 | 0.07 | -1.32 | 1.03 | 1914 |
| $\hat{\Gamma} - \hat{\tau}$ | 0.04 | 0.03 | 0.04 | 0.01 | 0.08 | 1913 |
| Relative Profit (EBITD) | 0.35 | 0.62 | 0.04 | 0.00 | 1.55 | 1914 |
| Form 5471: Rel. Profit | 0.45 | 0.88 | 0.02 | 0.00 | 2.01 | 1914 |
| Form 5471: Rel. Profit (EBITD) | 0.35 | 0.64 | 0.02 | 0.00 | 1.53 | 1914 |
| Lagged (2015-6 Average) Capital | 1403.0 | 6216.0 | 99.7 | 5.5 | 2412.4 | 1914 |
| Pre-TCJA $\chi_K$ | 0.28 | 0.47 | 0.04 | 0.00 | 1.06 | 1914 |
| Eq. 15: $\hat{\Gamma}$ | -0.10 | 0.06 | -0.09 | -0.16 | -0.02 | 1913 |
| Eq. 15: $\hat{\hat{\Gamma}}$ | 0.05 | 0.07 | 0.00 | 0.00 | 0.14 | 1914 |
| Eq. 15: $\hat{\tau}$ | -0.13 | 0.08 | -0.13 | -0.22 | -0.03 | 1914 |
| Eq. 15: $\hat{\hat{\tau}}$ | 0.06 | 0.06 | 0.02 | 0.00 | 0.13 | 1914 |
| Export Share | 0.17 | 0.30 | 0.00 | 0.00 | 0.66 | 1914 |

*Notes*: This table provides summary statistics for public firms. Capital is in millions of USD. We winsorize $d$ log(Investment) from above and below at the 5% level. For disclosure reasons, we do not report true medians (or other percentiles). Instead, we report the average of observations in neighboring percentile bins.

Table C.8: Global Capital Accumulation

| log(Foreign Capital), by Region: | Multinational Firms (Pooled) | | | | |
|---|---|---|---|---|---|
| | $\hat{\Gamma}$ | $\hat{\hat{\Gamma}}$ | $\hat{\tau}$ | $\hat{\hat{\tau}}$ | N |
| Total | −1.10 | 1.00** | −0.45 | 0.17 | 2102 |
| | (1.32) | (0.36) | (1.03) | (0.64) | |
| G7 | −0.22 | 1.17** | −0.57 | 0.34 | 1532 |
| | (1.60) | (0.40) | (1.23) | (0.71) | |
| OECD (Excluding G7) | 0.74 | 0.48 | −1.03 | 0.60 | 1218 |
| | (1.68) | (0.47) | (1.30) | (0.85) | |
| BRIC | 0.11 | 1.34** | −0.38 | 0.49 | 1065 |
| | (1.70) | (0.46) | (1.31) | (0.90) | |
| Developing (non-BRIC) | −0.26 | 1.54 | 0.43 | 4.25* | 539 |
| | (3.13) | (0.84) | (2.37) | (1.86) | |
| Tax Havens (Islands) | 5.74 | 0.46 | −4.36 | 0.59 | 246 |
| | (5.51) | (1.47) | (4.07) | (2.59) | |
| Tax Havens (Non-Islands) | 2.86 | 1.63* | −2.73 | 0.12 | 926 |
| | (2.80) | (0.72) | (2.14) | (1.40) | |
| Other | 1.59 | −0.07 | −2.08 | −2.30 | 670 |
| | (3.28) | (0.84) | (2.52) | (1.27) | |

*Notes*: Standard errors appear in parentheses. This table contains coefficients from running regressions in different regions which use log(Foreign Capital) as an outcome. Regions appear as row names. $\hat{\Gamma}$ and $\hat{\tau}$ were estimated separately. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$