Firm Investment and the User Cost of Capital: New U.S. Corporate Tax Reform Evidence

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Abstract

The Tax Cuts and Jobs Act of 2017 (TCJA) marked the first time in three decades that material changes were made to the corporate tax code of the United States. We use TCJA as a natural experiment to estimate the impact of changes in user cost of capital on investment. Following the method of Auerbach and Hassett (1991), using cross-sectional data we find that the user cost is associated with higher rates of investment consistent with previous studies. BEA asset types with greater reductions in user cost of capital and marginal effective tax rate (METR) after the 2017 TCJA had greater (and statistically significant) increases in their investment rates several years after the tax reform. Specifically, we find the magnitude of a 1 percentage point decrease in user cost is associated with a 1.68 to 3.05 percentage point increase in the rate of investment, larger than prior estimates of the responsiveness of investment with respect to user cost of capital.

Keywords: Corporate Taxes, Investment, Capital, User Cost of Capital, Business Taxes, Firms
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1 Introduction

The Tax Cuts and Jobs Act of 2017 (TCJA), which was signed into law on December 22, 2017, marked the first time in three decades (since the Tax Reform Act of 1986) that material changes were made to the corporate tax code of the United States. Most prominently, the top marginal corporate tax was changed from 35 percent to 21 percent effective in 2018 (Figure 1). In addition to the change in the marginal corporate tax rate schedule, TCJA also included major reforms to the corporate tax base. Certain capital expenditures received automatic expensing through 2023 with staged phaseout through 2027. Furthermore, pass-through business benefited from a reduced individual income rate and the introduction of the Section 199A deduction on qualified business income (QBI). Together these changes reduced the user cost of capital for investments in the US.[1]

At the time of passage of the TCJA, the Congressional Budget Office (CBO) estimated overall that TCJA would reduce revenues by $2.314 trillion on a static basis, and by $1.854 trillion on a dynamic basis from 2018 to 2027.[2] Some of this expected decline in tax revenues was due to reductions in projected corporate tax revenues. However, corporate tax revenues have surged in recent years from closer to 1% of GDP in the 2018-2020 period to closer to 1.5% of GDP since 2021 (Figure 2). The costs of TCJA therefore could ultimately prove to have been much smaller if there has been a bigger investment response than the scoring agencies expected.[3]

This may in principle be a result of dynamic economic growth effects, reflecting corporations' response to investment incentives.[4] Indeed, increasing business investment was one of the main goals of TCJA. The driving idea is that if the TCJA can successfully lower the cost of capital for businesses, then the lower cost of capital would induce higher fixed investment and economic growth. In this paper, we investigate the elasticity of firm fixed investment with respect to changes in the user cost of capital using recent tax reforms as sources of identifying variation.

In this paper we use an asset-level approach to disentangle the policy effects of the TCJA from other contemporaneous events. But to start, it is worth observing that the macro trends over time are consistent with positive effects of the TJCA. Productivity fell substantially in the United States over the decades from the 1950s through early 2000s (Gordon (2017)), which has contributed to economic growth falling below its postwar long-run average. Capital investment has been demonstrated to be a key determinant of productivity per Auerbach and Hassett (1992) and the broader growth accounting literature, and increasing capital per worker is one of the primary ways of increasing labor productivity. Capital deepening, or the rate of increase

[1] A host of international provisions also aimed to incentivize the repatriation of accumulated foreign cash holdings and of ongoing earnings, while moving the US more towards a territorial system of taxation, although these have not yet driven major changes in the international investment patterns and geographic allocation of capital of multinationals (Garcia-Bernardo et al., 2022)

[2] See "How the 2017 Tax Act Affects CBO's Projections", Congressional Budget Office, November 29, 2024 (https://www.cbo.gov/publication/53787) and Congressional Budget Office "The Budget and Economic Outlook: 2018 to 2028" Appendix B"The Effects of the 2017 Tax Act on CBO's Economic and Budget Projections" (https://www.cbo.gov/sites/default/files/115th-congress-2017-2018/reports/53651-outlook-appendixb.pdf. The original score from the CBO for the Tax Cuts and Jobs Act of 2017, was released on December 21, 2017, estimated that the legislation would reduce revenues by about $1,649 billion and decrease outlays by about $194 billion over the period from 2018 to 2027: "Distributional Effects of Changes in Taxes and Spending Under the Conference Agreement for H.R. 1" https://www.cbo.gov/publication/53429)

[3] Logically, budgetary costs might also be seen as more justifiable if they generate greater prosperity in the form of more economic output.

[4] Others have argued this is simply the result of a booming economy, which they argue is booming for reasons orthogonal to corporate tax reform such as pandemic-era fiscal stimulus. See Gale et al. (2022). However, this trend continues to persist now many years since the fiscal stimulus has subsided.

of capital per unit of labor input had reached historic lows in the years after the Great Recession (Figure 3). Recent years have generally seen stronger increases in capital per worker, although this may have been in part due to labor market disruptions around the Covid pandemic and the policy response to it. Overall, capital deepening tends to spike in years of tax reforms.

According to data from the National Income and Product Accounts (NIPA) on non-residential investment (Figure 4), fixed investment rates of firms vary across capital asset type. Intellectual property products show investment rates that have risen considerably over time, while equipment and structures investment rates have remained more stable over time. Investment rates have increased in the aggregate after certain tax reforms, yet the macro evidence by itself does not allow consideration of which firms are affected the most from various tax reforms and how their investment behavior changes accordingly. This motivates our more granular analysis of panel data of BEA asset classes that allows for a clearer identification of the relationship of investment to the user cost of capital than simply analyzing macro trends in the aggregate, which are suggestive but affected by various contemporaneous shocks.

Several recent studies also consider various sources of cross-sectional variation in TCJA. Kennedy et al. (2024b) study the differential behavior of C-corporations which are subject to the corporate tax code and S-corporations which are pass-through entities (and taxed differently) as an identification strategy to infer the effects of TCJA. Chodorow-Reich et al. (2024) estimate capital effects in the context of a global investment model, relying on the implications in the model of estimated elasticities of domestic and international investment with respect to user costs of capital.

We are principally concerned with estimating to what degree the TCJA lowered U.S. firms' cost of capital and how those changes affected their investment rates, using basic variation in the cost of capital across time and different assets as driven by the tax law. In earlier research, Auerbach and Hassett (1991); Cummins et al. (1994, 1995, 1996) developed a method (building on the previous work of Summers (1981) and Hayashi (1982)), using tax reform years as natural experiments. With firm microdata from Compustat, they estimate the response of firm investment decisions to such "tax surprises" which lower their cost of capital. Auerbach and Hassett (1991) analyze the impact of the Tax Reform Act of 1986 and initially developed the empirical method of using tax reforms as natural experiments to measure the elasticity of investment with respect to user cost. Cummins et al. (1994, 1995) analyze the impact of all U.S. corporate tax reforms in the post-war era up to and including the Tax Reform Act of 1986, estimating an investment rate to user cost coefficient of about -0.65. This paper extends this same method to analyzing the investment impact of corporate tax changes in the Tax Cuts and Jobs Act of 2017.

Our results derive from looking at investment rate changes as a function of user cost changes *relative to 2016* (one year prior to the passage of TCJA) on each annual horizon since the tax reform was passed. We believe this approach captures the dynamic effects of the tax reform. These effects may vary over time as firms adjust their investment decisions in response to policy uncertainty and other factors that create adjustment costs.

We find that BEA asset types with greater reductions in user cost of capital and marginal effective tax rate (METR) after the 2017 Tax Cuts and Jobs Act had greater (and statistically significant) increases in their investment rates. We find that this is the case for several years after the tax reform. Our measured investment response to user cost ranges from a 1.68 to 3.05 percentage point increase in the rate of investment in response to a 1 percentage point decrease in user cost. These estimates also imply a larger elasticity of investment to the user cost than the paramater used by the Congressional Budget Office of around -0.7 (CBO, 2018). Hassett and Hubbard (2002) review the literature and find investment-user cost elasticities ranging from -0.5 to -1.0, citing estimates from Caballero (1994); Cummins et al. (1994, 1995); Caballero et al. (1995).[5] To be clear, we do not directly estimate an investment-user cost elasticity, but rather the relationship between the investment rate and the user cost of capital informed by the theoretical results of Summers (1981) and Hayashi (1982). However, it is straightforward to convert our estimates into investment elasticities by dividing the coefficient by the mean investment rate and multiplying by the mean UCC following Cummins et al. (1994). Doing so, we find investment rate-user cost elasticities ranging from -1.91 to -3.45, and investment level to user cost elasticities ranging from -1.80 to -3.26, markedly higher than prior estimates. Our findings are robust across several specifications.

Chodorow-Reich et al. (2024) also calculate asset-class-based user costs, and they apply them in firm-level microdata. Their setup is distinct in that a firm can invest in two markets (domestic or foreign) and has separate user costs of capital for each. That paper models complementarity effects between foreign and domestic capital. For the purposes of the present analysis, we are only concerned with measuring user cost effects on U.S. investment and not foreign investment, in contrast to Chodorow-Reich et al. (2024) who consider both. BEA data of course does reflect foreign firm investment into the U.S. The implicit assumption in our simplified setup is that changes in user cost for foreign firm investment in the U.S. are similar to the domestic changes, and that the user cost for investment outside of the U.S. for foreign or multinational firms on the margin are not changing substantially or alternatively are not highly material due to high adjustment costs or other factors.[6] There were also no major concomitant corporate tax reforms in major advanced economies at the same time as the Tax Cuts and Jobs Act of 2017 that would meaningfully impact corporate investment in the U.S.. There are some exceptions such as the temporary 2017 French corporate tax increase from 33.3% to 38.3%. We think this would have relatively minor effects on foreign multinational investment in the U.S..

The paper proceeds as follows. Section 2 discusses the previous theoretical and empirical research on corporate taxation and investment as well as the data used in this paper, Section 3 describes our empirical approach, Section 4 presents our results, and Section 5 concludes.

2 Theoretical Background and Data

2.1 Investment

The inclusion of the user cost of capital in the neoclassical theory of investment was originally developed by Jorgenson (1963), and further extended by Hall and Jorgenson (1967) to include corporate taxes. Auerbach (1983) uses this same user cost approach to assess the estimates of changes to the corporate tax code across the prior decades. Tobin's q was conceptualized by Tobin (1969) as an alternative approach to estimating investment, with the advantage of explicitly modeling the costs of adjustment. This approach is attractive in that it has the ability to distinguish delivery/adjustment lags from expectational lags. Summers (1981), Hayashi (1982) and Abel (1979) link the Tobin's q approach to investment with the firm's problem of

[5] Other recent literature estimates, such as Bitros and Nadiri (2017) and Dwenger (2014), cited in the literature review of Gravelle and Keightley (2024), find investment-user cost elasticity estimates of around -0.5 to -0.9. These papers use more structural approaches to estimating investment user cost elasticities rather than the reduced-form approach to studying exogenous tax reforms of Cummins et al. (1994, 1995)

[6] For example, locally concentrated firms face high adjustment costs of relocation. In the 2010s, there were on average only a few tax inversions per year, and were never more than eight tax inversions in a given year. Subsidiaries of globally integrated multinational firms can often make separate investment decisions based on local user costs. While global tax competition certainly matters for aggregate firm investment, our contention is that the cross-sectional variation within the U.S. in user-cost across asset types is a dominating force and alone sufficient to measure the investment response to user cost.

determining an optimal investment path in the presence of adjustment costs, namely the presence of taxation. In addition, Hayashi (1982) lays out conditions under which marginal q and average Q are equal (if the production cost function and the total adjustment cost function are homogenous of degree one). Summers (1981), Hayashi (1982) and Salinger and Summers (1983) estimate Tobin's q and tax-adjusted Q by estimating regressions for several individual firms using a time series of each firm's relevant data from Compustat. Summers (1981) and Hayashi (1982) derive a reduced form optimal investment rule from first principles where the investment rate is a function of time and a modified q (which is composed of Tobin's q, the rate of investment tax credit, k, and the present discounted value of tax deductions on new investment, z):

$$\frac{I}{K} = \beta(\tilde{q}; t) = \beta\left(\frac{q}{1-k-z}; t\right) \tag{1}$$

Blanchard et al. (1993) and others have pointed out that the empirical performance of the Q model (its ability to explain variation in investment) has not been as impressive.

Cummins et al. (1994, 1995), following the work of Auerbach and Hassett (1991) which studies the 1986 U.S. Tax Reform Act, introduced a new identification strategy that uses many corporate tax reforms as natural experiments inducing exogenous changes to the user cost of capital and tax-adjusted Q to understand their effect on investment. Cummins et al. (1996) applies the same method to international tax reforms and find similar improvements. Cohen et al. (2002) and Cohen and Cummins (2006) look at the investment impacts of temporary partial expensing from the 2002 Bush tax reforms.

This paper seeks to apply the same methods to see to what degree changes in tax-adjusted user cost of capital can explain variation in investment following the Tax Cuts and Jobs Act of 2017. Other papers have also recently explored the effects of the Tax Cuts and Jobs Act of 2017.[7] Gale and Haldeman (2021) survey the literature and acknowledge that investment rose after TCJA albeit while arguing it was driven by trends in aggregate demand, oil prices, and intellectual capital (despite providing no evidence other than time series correlations). In the cross section, Wagner et al. (2020) examine which industries and firms benefited and lost from TCJA corporate tax changes in terms of differences in effective tax rates.

To measure the changes in investment following more recent tax reforms extending the original work of Auerbach and Hassett (1991) and Cummins et al. (1994) using corporate tax surprises as natural experiments, we obtain data on the relevant investment and user cost of capital variables using BEA asset data. The BEA fixed asset accounts classify capital into three broad asset categories. Private equipment consists of machinery, vehicles, and other tangible tools used in production. Private structures include residential and nonresidential buildings as well as infrastructure such as pipelines, mines, and power plants. Intellectual property products (IPP) encompass intangible assets like software, research and development, and artistic originals. Each category is further broken down into individual asset types. For each type, the BEA reports measures of gross and net stocks, investment flows, and depreciation.

Due to the optimal investment rule derivations of Summers (1981) and Hayashi (1982), investment is often calculated as a percentage of prior period capital stock ($I_{i,t}/K_{i,t-1}$). $I_{i,t}$ is investment at time t for BEA asset type i. We gather data on investment for each of the 96 BEA fixed asset types from the BEA Fixed Asset Tables.[8] We aggregate across industries to get a measure of fixed investment by asset. Three asset categories (Tape Drives, DASDs, and Local Transit Structures) receive no investment in the data during

[7] Other recent papers have also explored state-level variation in corporate taxation. Kumar (2020) uses exogenous state-level variation in tax changes and find that an income tax cut equaling 1 percent of GDP led to a 1 percentage point higher nominal GDP growth and about 0.3 percentage point faster job growth in 2018.

[8] Investment is obtained from Table 2.7, "Investment in Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type".

our period of study from 1987 to 2023. We drop these assets, bringing our sample to 93 fixed asset classes.

$K_{i,t}$ is the capital stock at time t for BEA asset type i. Capital Stock data is obtained from Table 2.1, "Current-Cost Net Stock of Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type". We aggregate across industries to get a measure of capital stock by asset.

2.1.1 User Cost of Capital

The user cost of capital can be written several equivalent ways including the formulation of Hall and Jorgenson (1967) and DeBacker and Kasher (2018).[9] We calculate cost of capital separately for C-corporations and pass-through entities as:

$$\rho_{i,t,j} = \frac{r_{t,j} + \delta_i - \pi_t}{1 - \tau_{t,j}}(1 - k_{i,t} - \tau_{t,j} z_{i,t}) - \delta_i \tag{2}$$

where $r_{t,j}$ is the discount rate in period t and tax treatment $j \in (C, PTE)$, δ_i is the depreciation rate for asset class i, π_t is the inflation rate, $\tau_{t,j}$ is the statutory income tax rate at the first level of taxation (the corporate tax rate for C-corporations and the individual tax rate for PTEs), investment tax credit $k_{i,t}$, $z_{i,t}$ is the net present value of depreciation deductions from a dollar of new investment. Without an investment tax credit $k_{i,t}$ (that has been absent in the U.S. since the Tax Reform Act of 1986) becomes:

$$\rho_{i,t,j} = \frac{r_{t,j} + \delta_i - \pi_t}{1 - \tau_{t,j}}(1 - \tau_{t,j} z_{i,t}) - \delta_i \tag{3}$$

We calculate $z_{i,t}$ using IRS information on depreciation rules under the Modified Accelerated Cost Recovery System (MACRS) in effect since 1987. CPI inflation rates ($\pi_{i,s}$) are obtained from the BLS. Depreciation rates ($\delta_{i,t}$) by BEA asset type are obtained from BEA. Note that unlike other countries (such as Canada), the BEA has not updated depreciation rates since the 1970s which likely causes BEA capital stocks to be overstated. Additionally, intellectual property was not considered a distinct asset type by BEA until the mid-2010s. Previously software had its own treatment and was considered expense.

To account for QBI deductions for PTEs introduced in the 2017 tax bill, we make two separate calculations of the cost of capital for PTEs, then weight the two to get our final measure of $\rho_{i,t,PTE}$. The first is based on the top marginal individual tax rate after 2017, $\tau_{t,I} = 37\%$. The second is based on a QBI-reduced tax rate, $\tau_{t,QBI} = 0.8 * \tau_{t,I} = 29.6\%$, following the findings of Kennedy et al. (2024a). They find that if there were a 100% QBI deduction for all pass-through income, PTEs would face a 29.6% top marginal tax rate. With these two measures, we calculate a weighted cost of capital for PTEs as follows:

$$\rho_{i,t,PTE} = 0.76 * \rho_{i,t,PTE}(\tau_{t,I}) + 0.24 * \rho_{i,t,PTE}(\tau_{t,QBI}) \tag{4}$$

According to the Congressional Research Service (Guenther, 2024), taxpayers with AGI above $200,000 filed 28% of claims for the deduction, accounting for 76% of the total dollar amount. Thus, if we assume that all of the remaining 24% from earners under $200,000 is eligible, we can apply these weights as above to create a weighted cost of capital for PTEs that incorporates the QBI deduction.

Finally, we construct a weighted cost of capital which combines the cost of capital faced by C-corporations and PTEs. For each fixed asset class, we construct weights based on the proportion of the total asset stock held by C-corporations and PTEs. Data on total assets by fixed asset class are taken from the 2011 SOI, and weights are calculated in the Cost of Capital Calculator (see Appendix Table 1 for weights by asset). If we

[9] We use open source code from the DeBacker and Kasher (2018) User Cost of Capital Calculator[10] and extend it back further in time with additional data.

define the proportion of the total asset stock for asset class i held in C-corporations as α_i, we calculate a weighted cost of capital as follows:

$$\rho_{i,t} = \alpha_i * \rho_{i,t,C} + (1 - \alpha_i) * \rho_{i,t,PTE} \tag{5}$$

User cost of capital or $c_{i,t,j}$, which adds in depreciation rates to $\rho_{i,t,j}$, can be written as:

$$c_{i,t,j} = \rho_{i,t,j} + \delta_i = \frac{r_{t,j} + \delta_i - \pi_t}{1 - \tau_{t,j}}(1 - \tau_{t,j} z_{i,t}) \tag{6}$$

For historical discount rates, some papers use discount rates from Gormsen and Huber (2023) which updates the Poterba and Summers (1995) discount rates from 2002 through the present. Since we seek to use a longer historical time series, we use the user cost of capital calculator from DeBacker and Kasher (2018) to calculate discount rates based on Moody's AA-rated corporate bonds.

To give a sense of magnitude of what a 1 percentage point decline in the user cost of capital amounts to in marginal corporate tax rate reduction terms: assuming a 2% constant inflation rate, a 2% constant interest rate rate, a 10% depreciation rate (depreciation rates for structures are typically higher while lower for equipment), an investment tax credit of 0%, and a z = 0.7, a 1% decline in the user cost of capital would be equivalent to decreasing the marginal corporate tax rate from 35% to 17%.

Figure 5 plots weighted user cost of capital ($c_{i,t}$) by BEA asset type from 1987 to 2023. Note that many of the declines in user cost are on the magnitude of only a few percentage points. Given the scale of the y axis, it is difficult to discern the drop in user costs following the TCJA. To make these changes more clear, figure 6 plots the year-to-year change in user costs. There is a substantial drop in user costs post-TCJA and a varied response between assets. Figure 7 plots weighted cost of capital which adds back in depreciation rates. Looking in the cross section, due to the new bonus depreciation schedules and additional depreciation allowances, TCJA has a greater impact on their user cost compared to structures.

2.2 Marginal Effective Tax Rate

The marginal effective tax rate (METR) for a given asset type is calculated as the expected pre-tax rate of return on a marginal investment subtracting the real after-tax rate of return to the business entity divided by the pre-tax rate of return on the marginal investment:

$$METR_{i,t,j} = \frac{\rho_{i,t,j} - (r_{i,t,j} - \pi_t)}{\rho_{i,t,j}} \tag{7}$$

As before with cost of capital, we account for QBI deductions when calculating the METR faced by PTEs, then calculate a weighted METR based on the proportion of assets in C-corporations and PTEs for each fixed asset class. Figure 8 plots weighted METR by BEA asset type from 1987 to 2023. The variable $\rho_{i,t,j}$ can be thought of as the pre-tax rate of return on the marginal investment, $r_{i,t,j}$ is the discount rate and π is the rate of inflation ($r_{i,t,j} - \pi_t$ is the real after-tax rate of return). Giroud and Rauh (2019) calculate METRs at the state level, however, this paper ignores such tax rules. Note the decline in METR in the aggregate is typically not the full 14% decline in the top marginal corporate tax rate from 35% to 21% due to a number of other considerations in tax code changes. METR for structures falls by nearly 10 percentage points after TCJA while METR for equipment falls by closer to 15 percentage points.[11] Note that METR

[11] Chodorow-Reich et al. (2024) finds that TJCA had only a 4 percentage point impact on the marginal effective tax rate (see Table E.4 of Chodorow-Reich et al. (2024); Eg. For Firm 1, the difference between (100-17.2)/(100-14.4)=0.967 pre and (100-10.2)/(100-9.5)=0.992 post).

also fell in 2011 due to one full year of temporary expensing provisions.

3 Empirical Strategy

To lend support for what is being observed in the BEA data, we first present some descriptive evidence of firm level investment trends before and after the passage of TCJA. Figure 9 plots the investment rates in 2016, 2017, and 2018 (the first year the TCJA became effective) for the thousands of firms with complete data from the CRSP/Compustat Merged database. This sample has only 962 firms, this is largely due to the fact that there are fewer U.S. publicly traded firms today versus 1987. The number of U.S. publicly traded firms has fallen from approximately 8,000 in 1996 to less than 4000 as of 2016 (Doidge et al., 2018). Interestingly, the fraction of firms with an investment rate between 35 and 40 percent as well as the fraction of firms with an investment rate above 40 percent increased.

To better isolate the effects of "tax surprises" and use tax reforms like the TCJA as a natural experiment, we repeat the approach of Auerbach and Hassett (1991). This approach observes differences in investment (I/K) and user cost (c) following an exogenous shock to the user cost of capital before and after corporate tax changes. We apply this method to the TCJA's reduction of the corporate income tax rate from 35 percent to 21 percent and introduction of full expensing. Our specification is as follows:

$$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}} = \alpha + \beta(c_{i,t} - c_{i,2016}) + \varepsilon_{i,t}, \tag{8}$$

Where $\frac{I_{i,t}}{K_{i,t-1}}$ is the firm investment rate in time t ($I_{i,t}$ is investment at time t and $K_{i,t-1}$ is capital at time t-1), $c_{i,t}$ is the weighted user cost for asset i in time t, and α is a constant. Following Auerbach and Hassett (1991) and Cummins et al. (1994), we primarily wish to compare investment rates beginning in the first period the tax reform law changes were in place (eg. 2018 in the case of TCJA) to the year before the tax reform legislation was passed (eg. 2016 in the case of TCJA). This is because tax reform expectations may influence investment decisions before tax reforms are passed. We estimate equation 8 for each year from 2018 through 2023.

We then can calculate the elasticity of the investment rate with respect to user cost. An elasticity gives us an important, comparable metric which tells us the expected percentage change in the investment rate in response to a 1% increase in the user cost of capital. Ultimately, such an elasticity can inform policymakers in terms of what sort of investment response one would expect from a tax policy change.

We calculate this elasticity by multiplying the coefficient from our regressions by the initial user cost of capital from 2016 and dividing by the initial investment rate from 2016 as follows[12]:

$$e(c) = \frac{\Delta(\frac{I}{K})}{\Delta c}\frac{c}{(\frac{I}{K})} = \beta\frac{c}{(\frac{I}{K})} \tag{9}$$

One threat to identification may be whether the tax reform itself was already anticipated. Figure 10 shows prediction market prices for whether or not the U.S. corporate tax rate would be cut by 12/31/2017 and 3/31/2018. As recent as late October 2017, prediction market participants expected a corporate tax rate cut by March 31, 2018 with an approximate 60% probability. If tax changes were already affecting investment

[12] Cummins et al. (1994) calculate their elasticity by taking a sample average for both I/K and UCC. We think this approach to calculating elasticity can be considered a "midpoint elasticity", which yields very similar results since the levels of I/K and UCC are fairly stable. The midpoint method for elasticity calculates percentage changes using the average of the initial and final values.

behavior in early 2017 given the anticipated tax reform, this is all the more reason to use 2016 as the base year for analysis.

Our results come from studying investment rate changes across asset classes as a function of user cost changes across asset classes *relative to 2016* (one year prior to the passage of TCJA) on each annual horizon since the tax reform was passed (eg. 2016 to 2018, 2016 to 2019, and so forth through 2023). We believe this approach captures the dynamic effects of the tax reform which may vary over time as firms may be slow to adjust their investment decisions in response to policy uncertainty and other factors that create adjustment costs.

Similarly we run regressions of changes in investment rates on changes in METR:

$$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}} = \alpha + \beta(METR_{i,t} - METR_{i,2016}) + \varepsilon_{i,t}, \tag{10}$$

The following section will discuss the empirical results from such regressions.

4 Results

When regressing on the 93 BEA asset types in our sample, coefficients are heavily affected by outliers in computer BEA types within intellectual property products. Some computer-related asset types saw large declines from 2016 to 2018 after certain BEA asset types such as "Other computer and electronic manufacturing, n.e.c." (RD25) experienced a massive uptick in investment rate (I/K) from 0.45 to 2.44 from 2015 to 2016 and back down to 0.29 in 2017 and 0.23 in 2018. The inclusion of this outlier asset type as an individual observation leads to coefficient estimates on the magnitude of -10 since user cost did not fall significantly in these areas following TCJA. This is also a result of it being a small BEA asset type of around only 985 million USD in capital stock as of 2019.

As one way to deal with significant outlier volatility in certain BEA asset types, we winsorize the top 5% and bottom 5% of observations when sorting BEA assets by cumulative investment.[13] Specifically, for each year (for example from 2016 to 2018) we calculate the change in investment rate for each asset and winsorize in each year. When doing so, we find investment-user cost coefficients on the magnitude of -1.689 and -3.053, which is directionally consistent with evidence from past US tax reforms (Auerbach and Hassett (1991) and Cummins et al. (1994) analyze tax reforms through the Tax Reform Act of 1986). However, our estimates are larger in magnitude than other literature estimates ranging from 0.5 to 0.9 from Cummins et al. (1994), Cummins et al. (1995), Bitros and Nadiri (2017) and Dwenger (2014). Figure 11 Panel A shows that the relationship between investment and user cost is negative and statistically significant, consistent with Auerbach and Hassett (1991) and Cummins et al. (1994).

Changes in the investment rate over longer periods of time vary significantly with the cost of capital (c) over time (Table 1). For the cumulative period from 2016 to 2018, a 1 percentage point decline in c is associated with a 1.689 percentage point increase in the investment rate, albeit at the 10% level of significance. Over a longer horizon, the change in the investment rate from 2016 to 2021 and 2022 also vary significantly with declines in the cost of capital (c) over those periods. We estimate a 1 percentage point decline in c is associated with a 2.873 percentage point and 3.053 percentage point increase in the investment rate for

[13]Note that Tables 3 and 4 in the Appendix show results (for uncombined and combined computer asset types) with different amounts of winsorization (no winsorization, 2.5%, 5.0% and 10.0%. Note that winsorizing at the 2.5%, 5.0% and 10.0% levels qualitatively produce similar results (the estimates from winsorizing at the 2.5% level are the largest, followed by 5.0% and 10.0%). Note that with less than 100 asset types, winsorizing 1% is equivalent to no winsorization, which leaves the most volatile asset type in the sample.

the 2016 to 2021 and 2016 to 2022 periods respectively. These estimates are meaningfully above the CBO's CapTax model which uses literature estimates (Cummins et al. (1994), Cummins et al. (1995), Bitros and Nadiri (2017) and Dwenger (2014)) finding that a 1% decrease in the user cost of capital is associated with a 0.7% increase in investment.[14]

Figure 11 Panel B shows that the relationship between investment and METR is negative and statistically significant. The change in investment rates between 2018 and 2016 varies significantly with the change in the marginal effective tax rate (METR) (a 1 percentage point decline in $METR$ is associated with a 0.086 percentage point increase in the investment rate). Looking at the longer horizon, a 1 percentage point decline in $METR$ is associated with a 0.134 percentage point and 0.145 percentage point increase in the investment rate for the 2016 to 2021 and 2016 to 2022 periods, significant at the 5% level.

Investment rates (I/K) for BEA asset type "Computers and peripheral equipment manufacturing" (RD21) experienced a massive uptick in investment rate from 45% to 244% from 2015 to 2016 and back down to 29% in 2017 and 23% in 2018. Accordingly, the BEA recommends combining with other computer asset types (which range from 41.0 billion USD to 69.5 billion USD) and weighting by capital stock. This involves combining the 4 following asset types (and weighting by capital stock (K)): Computers and peripheral equipment manufacturing (RD21), Communications equipment manufacturing (RD22), Navigational and other instruments manufacturing (RD24) and Other computer and electronic manufacturing, n.e.c. (RD25).

Figure 12 Panel A shows that the relationship between investment and user cost continues to be negative and statistically significant when combining computer-related asset types. When combining computer-related asset types and looking across different time periods (Table 2), a 1 percentage point decline in c from 2016 to 2018 is associated with a 1.554 percentage point increase in the investment rate. Over a longer horizon, a 1 percentage point decline in c is associated with a 2.188 percentage point and 2.660 percentage point increase in the investment rate for the 2016 to 2021 and 2016 to 2022 periods respectively.

Figure 12 Panel B shows that the relationship between investment and METR continues to be negative and statistically significant when combining computer-related asset types. When combining computer-related asset types, a 1 percentage point decline in $METR$ from 2016 to 2018 is associated with a 0.078 percentage point increase in the investment rate. Looking at the longer horizon, a 1 percentage point decline in $METR$ is associated with a 0.107 percentage point and 0.135 percentage point increase in the investment rate for the 2016 to 2021 and 2016 to 2022 periods significant at the 5% level.

We find that BEA asset types most impacted by the 2017 tax reform, with greater reductions in user cost of capital and marginal effective tax rate (METR) after the 2017 TCJA was implemented, had greater (and statistically significant) increases in their investment rates, several years after the tax reform. Specifically, we find the magnitude of a 1 percentage point decrease in user cost being associated with a 1.68 to 3.05 percentage point increase in the rate of investment, larger than prior estimates found in Cummins et al. (1994), Cummins et al. (1995), Bitros and Nadiri (2017) and Dwenger (2014).

The CBO uses an investment elasticity of -0.7 (CBO, 2018), where this parameter refers to the percent change in the *level* of investment with respect to a one percent increase in the user cost of capital. Based on our estimates of the theoretically-grounded I/K specification, we can calculate the elasticity of the investment *rate* with respect to the user cost of capital. Taking the estimated coefficients from Table 1, we can divide by the mean 2016 investment rate (0.1818) and multiply by the mean 2016 UCC (0.2058) to get a range of elasticities of -1.91 to -3.45 (see Table 5 for more details). These I/K elasticities are more than double the investment elasticity of -0.7 estimated by the CBO (CBO, 2018), although again these are different elasticities

[14]See CBO (2018): "In CBO's estimation, a 1 percent decrease in the user cost of capital translates into a 0.7 percent increase in investment"

as the latter is an elasticity of the level of investment as opposed to the investment rate. An alternative back-of-the envelope calculation would use mean in-sample investment rates to convert our estimates to an elasticity of the level of investment with respect to a one percent increase in the user cost of capital, more directly analogous to the elasticity concept used by the CBO in its modeling. Considering the mean investment rate across all years in our sample is 18.2%, we would multiply our coefficients by a factor of 5.49 to convert from the investment rate to investment. Additionally, a 1 percentage point change taken at the mean UCC across all years in our sample (from 0.195 to 0.205) equates to a 5.13% change. Multiplying our coefficients by 5.49/5.13 yields elasticities ranging from -1.80 to -3.26, more than double the CBO's estimate. There are some further challenges with interpretation. CBO wishes to use such short-run elasticities from Cummins et al. (1994) (estimated from cross-sectional data by using investment data from only one year after historical corporate tax reforms) for the purposes of long-run general equilibrium modeling. Our estimates in contrast look at the longer run, many years after the TCJA was implemented, and arguably would be even more applicable for such modeling purposes.

One other question of interest is the extent to which changes to bonus expensing versus changes in the corporate tax rate (changes in τ) are influencing the results. To attempt to decompose these effects, we run a separate series of specifications where we regress the cumulative change in investment rate on two covariates: one where τ changes and bonus depreciation changes are kept constant in UCC (cumulatively) and another where τ is kept constant and bonus depreciation changes in UCC (cumulatively) post-tax reform. In one specification, we regress on just the one covariate (where τ is kept constant). In a second specification, we regress on the second covariate (where bonus depreciation is kept constant). In a third specification, we regress on both specifications. The results of these regressions are in Table 3.What one sees from these results is that the responses in investment in 2020 and 2021 are largely driven by changes in z (changes in capital expensing tax rules) while estimates from other years are positive and similar in magnitude but not statistically significant. This suggests that changes to capital expensing tax rules may be even more potent than changes in the corporate tax rate when it comes to promoting business investment.

5 Conclusion

Using U.S. corporate tax reforms introduced in the Tax Cuts and Jobs Act of 2017 as natural experiments, this paper demonstrates that U.S. firms on average increased their fixed investment in response to exogenous decreases in user cost of capital and marginal effective tax rates (METR). In particular, we find that BEA asset types with greater reductions in their user cost of capital and marginal effective tax rate (METR) after the 2017 Tax Cuts and Jobs Act had greater (and statistically significant) increases in their investment rates. We find that this is the case for several years after the tax reform. Our measured investment response to the user cost is that a 1 percentage point decrease in the user cost is associated with a 1.68 to 3.05 percentage point increase in the rate of investment. Back-of-the-envelope conversions of these estimates to elasticities also point to elasticities that are considerably higher than found previously. Our findings should be of interest to those scoring the costs of future changes to tax policy, especially the extension of TCJA provisions.

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6 Tables

Table 1: Cumulative Investment Response to Tax Changes

$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}}$	2018	2019	2020	2021	2022	2023
	(1)	(2)	(3)	(4)	(5)	(6)
$c_{i,t} - c_{i,2016}$	-1.689*	-1.057	-1.115	-2.873**	-3.053**	-1.282
	(0.890)	(0.847)	(1.113)	(1.166)	(1.180)	(1.154)
Constant	-0.010	-0.004	-0.019	-0.059	-0.066	-0.012
	(0.008)	(0.007)	(0.011)	(0.024)	(0.027)	(0.011)
R^2	0.050	0.022	0.016	0.087	0.096	0.021
$METR_{i,t} - METR_{i,2016}$	-0.086*	-0.054	-0.041	-0.134**	-0.145**	-0.070
	(-0.003)	(-0.001)	(-0.013)	(-0.012)	(-0.010)	(-0.005)
Constant	-0.003	-0.001	-0.013	-0.012	-0.010	-0.005
	(0.005)	(0.005)	(0.007)	(0.006)	(0.006)	(0.005)
R^2	0.044	0.020	0.007	0.066	0.089	0.019
N	93	93	93	93	93	93

Notes: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Data for fixed investment from BEA Fixed Asset Tables. User cost of capital and METR data from OSPC Cost of Capital Calculator. We calculate change in asset investment rates by year then winsorize the top 5% and bottom 5% of observations in each year.

Table 2: Cumulative Investment Response to Tax Changes (Computer-related asset types combined)

$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}}$	2018	2019	2020	2021	2022	2023
	(1)	(2)	(3)	(4)	(5)	(6)
$c_{i,t} - c_{i,2016}$	-1.554*	-0.864	-0.484	-2.188**	-2.660**	-0.638
	(0.881)	(0.800)	(0.900)	(0.935)	(1.076)	(0.947)
Constant	-0.009	-0.002	-0.011	-0.041	-0.054	-0.006
	(0.008)	(0.007)	(0.008)	(0.018)	(0.025)	(0.008)
R^2	0.081	0.016	0.004	0.082	0.093	0.006
$METR_{i,t} - METR_{i,2016}$	-0.078	-0.043	-0.005	-0.107**	-0.135***	-0.029
	(0.047)	(0.044)	(0.052)	(0.048)	(0.049)	(0.058)
Constant	-0.002	0.000	-0.007	-0.006	-0.006	-0.002
	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)	(0.004)
R^2	0.037	0.014	0.000	0.070	0.102	0.004
N	90	90	90	90	90	90

Notes: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Data for fixed investment from BEA Fixed Asset Tables. User cost of capital and METR data from OSPC Cost of Capital Calculator. User cost of capital and METR data from OSPC Cost of Capital Calculator. Computer-related asset types (RD21, RD22, RD24, RD25) are combined and weighted by capital stock to reduce volatility. We calculate change in asset investment rates by year then winsorize the top 5% and bottom 5% of observations in each year.

Table 3: Cumulative Investment Response to Tax Changes: User Cost of Capital and Effective Tax Rate Analysis

$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}}$	2018			2019			2020			2021			2022			2023		
	τ	*bonus*	Both	τ	*bonus*	Both	τ	*bonus*	Both	τ	*bonus*	Both	τ	*bonus*	Both	τ	*bonus*	Both
$c_{i,t} - c_{i,2016}$	-1.667		-2.083*	-0.745		-1.154	-1.292		-2.060*	0.431		-1.336	-0.022		-0.195	-0.569		-0.429
(τ changes; *bonus* fixed)	(1.204)		(1.213)	(1.061)		(1.114)	(0.984)		(1.201)	(0.850)		(1.061)	(0.512)		(0.490)	(0.527)		(0.542)
$c_{i,t} - c_{i,2016}$		-1.002	-1.233*		-0.599	-0.821		-0.129	-1.144		-2.298**	-3.283**		-3.066***	-3.108***		-1.234	-1.055
(bonus changes; τ fixed)		(0.688)	(0.694)		(0.659)	(0.692)		(0.851)	(1.029)		(0.967)	(1.241)		(0.955)	(0.965)		(0.932)	(0.961)
Constant	-0.003	-0.005	-0.016	0.001	-0.001	-0.006	-0.013	-0.011	-0.024	0.003	-0.048	-0.084	0.005	-0.068	-0.071	-0.002	-0.011	-0.010
	(0.006)	(0.007)	(0.009)	(0.004)	(0.006)	(0.008)	(0.004)	(0.008)	(0.011)	(0.011)	(0.019)	(0.034)	(0.007)	(0.023)	(0.025)	(0.003)	(0.008)	(0.008)
R^2	0.020	0.022	0.053	0.005	0.009	0.020	0.018	0.000	0.031	0.002	0.058	0.074	0.000	0.101	0.103	0.012	0.018	0.025
N	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93	93

Notes: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Data for fixed investment from BEA Fixed Asset Tables. User cost of capital and METR data from OSPC Cost of Capital Calculator. We calculate change in asset investment rates by year then winsorize the top 5% and bottom 5% of observations in each year. Estimates for 2017 are excluded because both measures of UCC and METR are identical, thus collinear. Here we run a separate series of specification where we regress the cumulative change in investment rate on two covariates: one where τ changes and bonus depreciation changes are kept constant in UCC (cumulatively) and another where τ is kept constant and bonus depreciation changes in UCC (cumulatively) post-tax reform. In one specification, we regress on just the one covariate (where τ is kept constant). In a second specification, we regress on the second covariate (where bonus depreciation is kept constant). In a third specification, we regress on both specifications. The results of this regression are in Table 6. What one sees from these results is that the responses in investment in 2020 and 2021 are largely driven by changes in z (changes in capital expensing tax rules). This suggests that changes to capital expensing tax rules may be even more potent than changes in the corporate tax rate when it comes to promoting business investment.

7 Figures

Figure 1: Top U.S. Statutory Marginal Corporate Income Tax Rate Over Time (1909-2024)

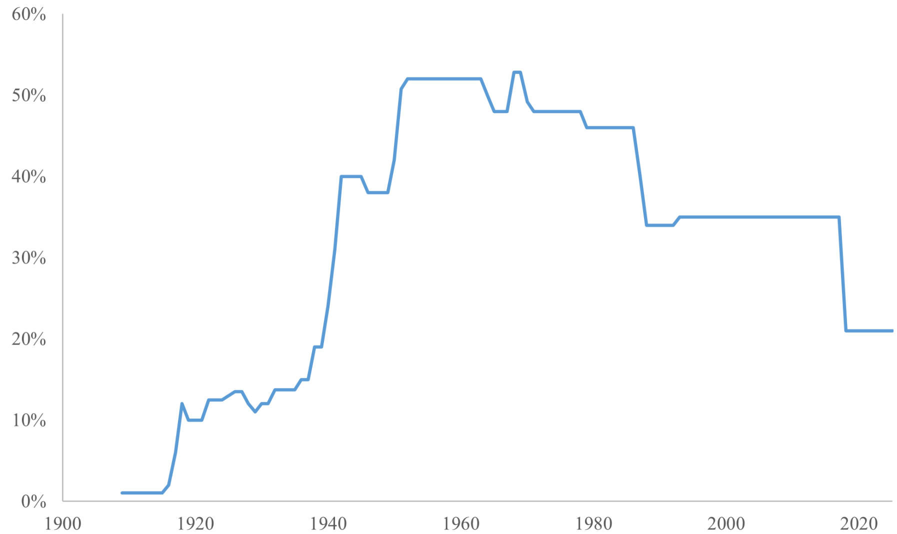
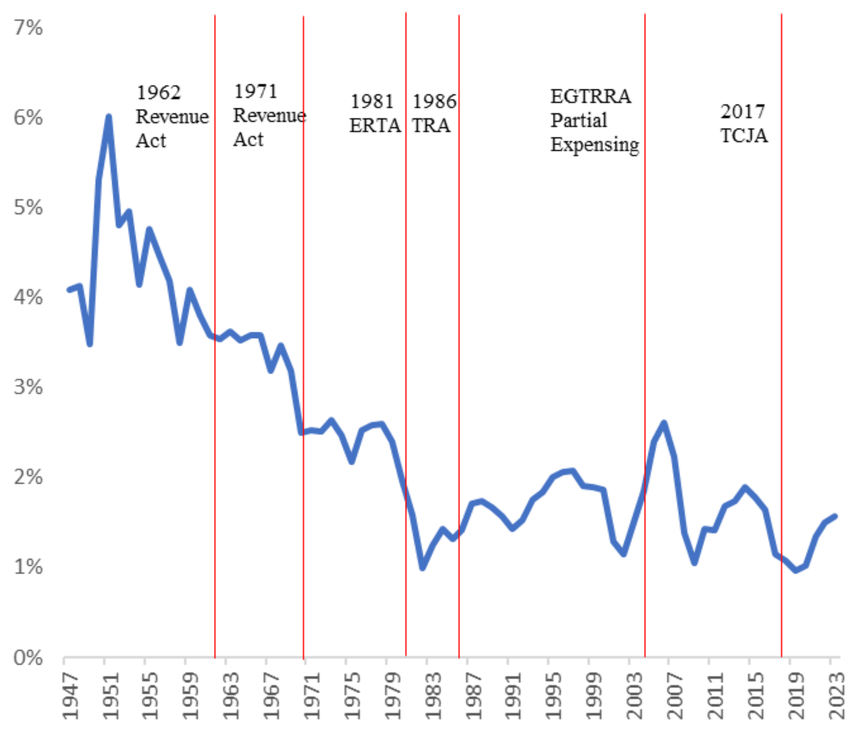
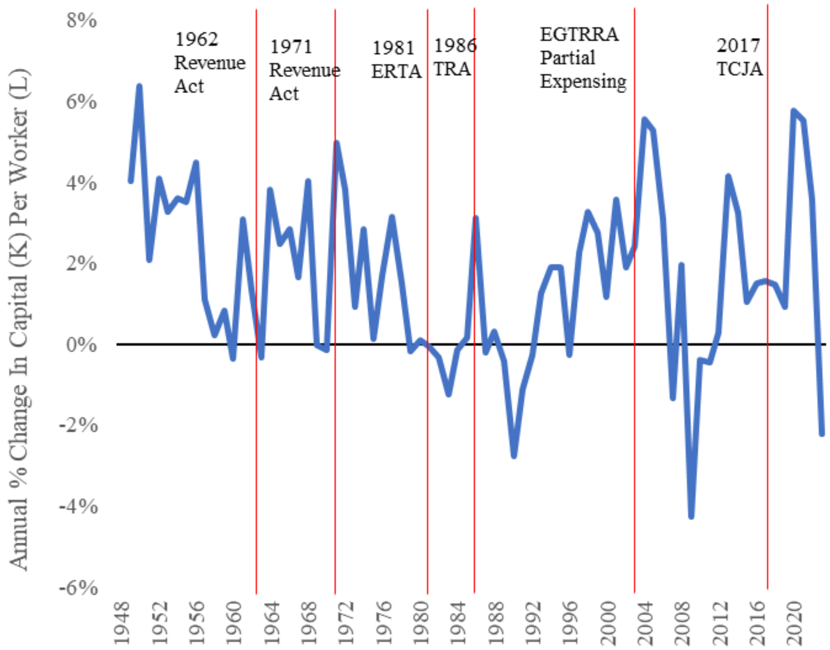


Figure 2: U.S. Federal Corporate Tax Revenue As A Fraction of GDP (1948-2023)



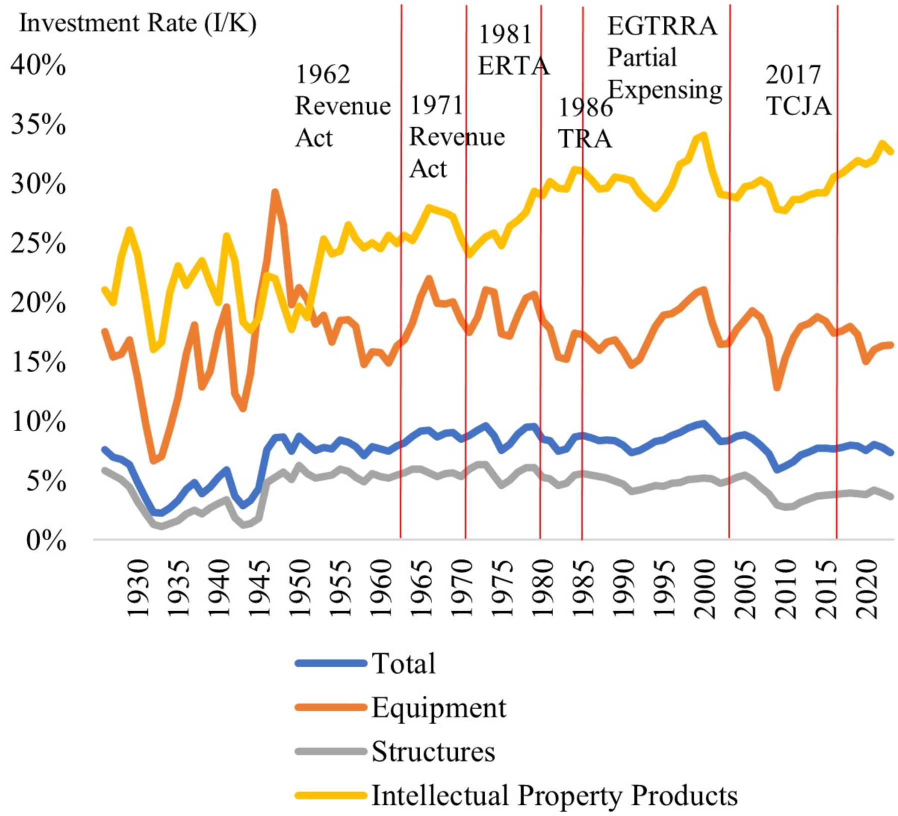
Notes: Data for corporate tax revenues are obtained from the BEA. Nominal GDP data is obtained from FRED.

Figure 3: Capital Per Worker Annual Percentage Change (1948-2023)



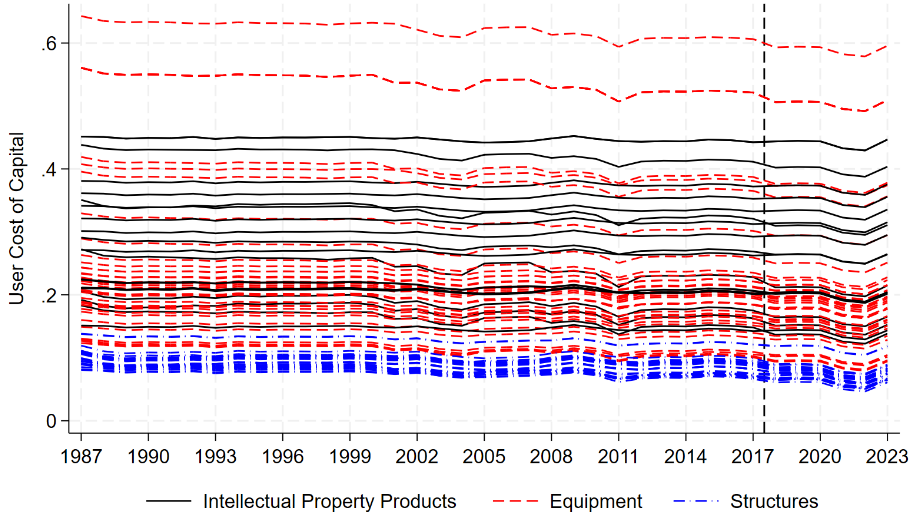
Notes: Data for fixed investment are taken from the BEA Fixed Asset Tables while total civilian labor force is obtained from the BLS.

Figure 4: Aggregate Investment Over Capital By Asset Type From 1926 to 2023



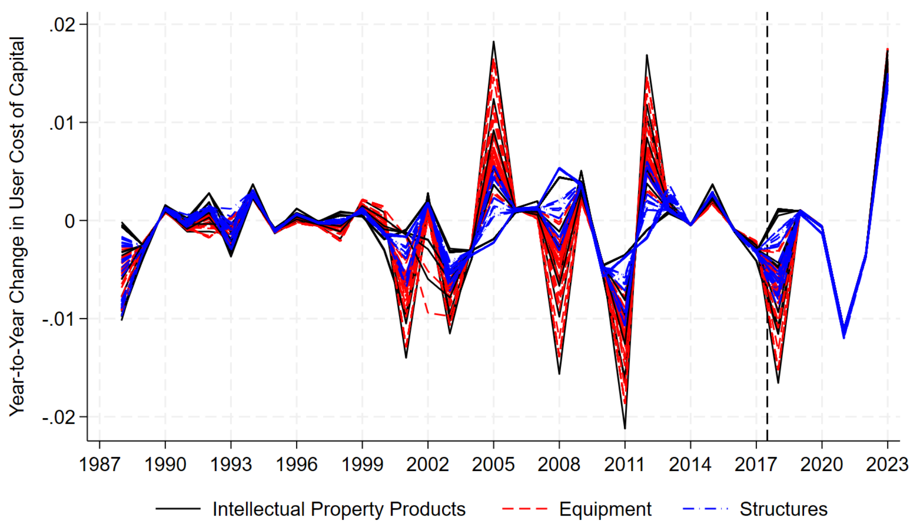
Notes: Data for fixed investment are taken from the BEA Fixed Asset Tables. Investment is obtained from Table 2.7. "Investment in Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type" while Capital Stock K is obtained from Table 2.1. "Current-Cost Net Stock of Private Fixed Assets, Equipment, Structures, and Intellectual Property Products by Type"

Figure 5: User Cost of Capital $c_{i,t}$ by BEA Asset Type (1987-2023)



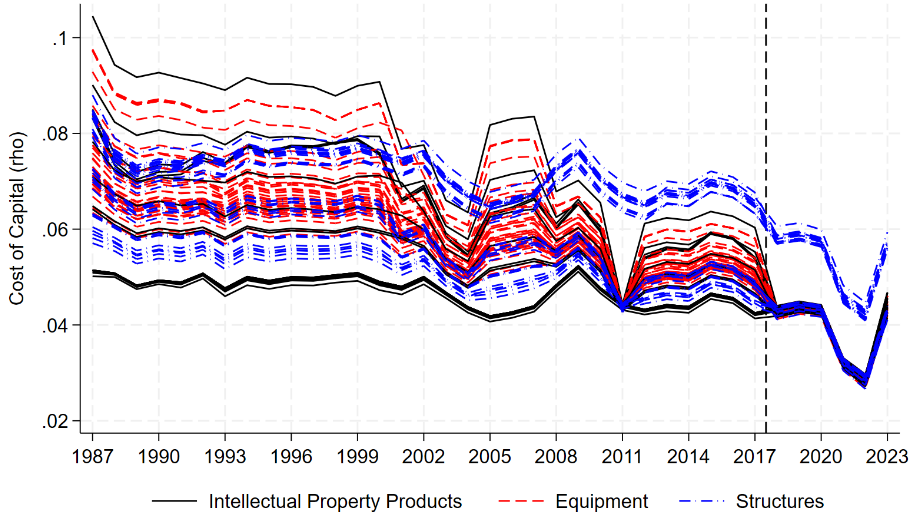
Notes: User cost of capital calculated using IRS depreciation bonus rules, top marginal corporate tax rates from the IRS, discount rates from Moody's AA rated corporate bonds, and depreciation rates from the BEA.

Figure 6: Year-to-Year Change in User Cost of Capital $c_{i,t}$ by BEA Asset Type (1988-2023)



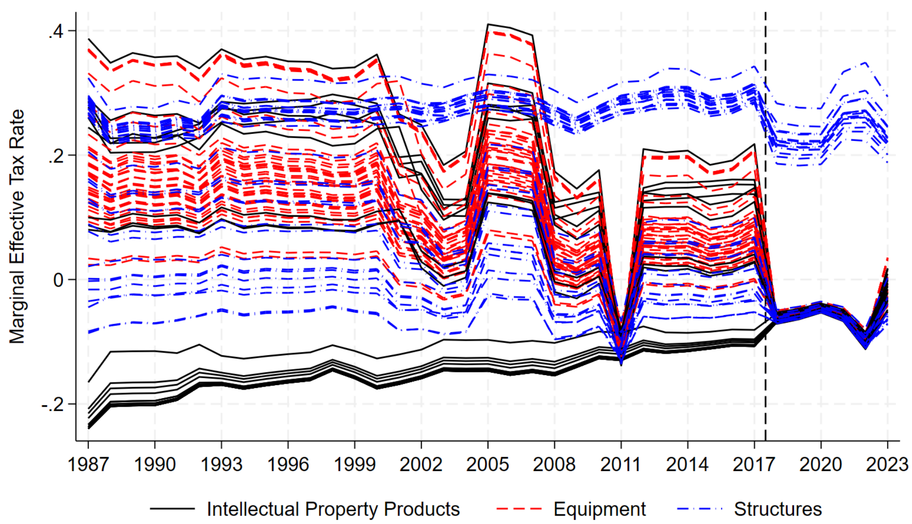
Notes: User cost of capital calculated using IRS depreciation bonus rules, top marginal corporate tax rates from the IRS, discount rates from Moody's AA rated corporate bonds, and depreciation rates from the BEA.

Figure 7: Cost of Capital by BEA Asset Type (1987-2023)



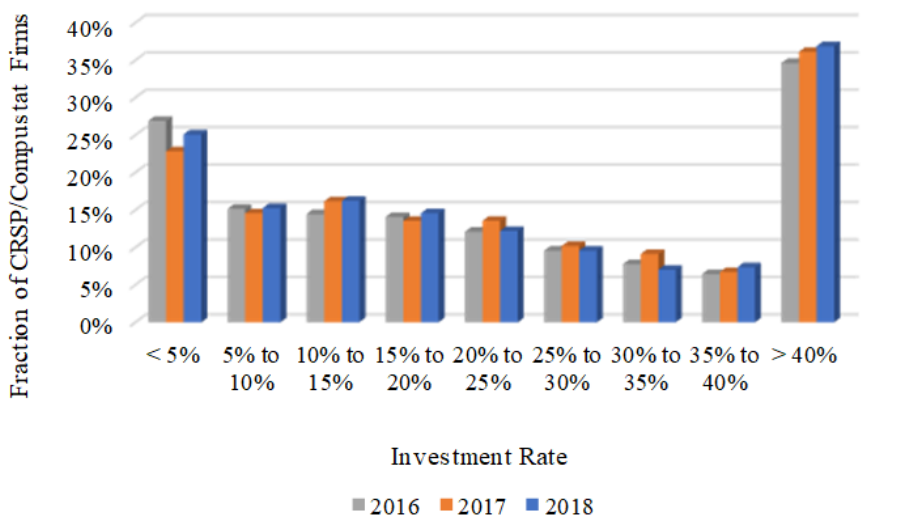
Notes: Cost of capital calculated using IRS depreciation bonus rules, top marginal corporate tax rates from the IRS, discount rates from Moody's AA rated corporate bonds, and depreciation rates from the BEA.

Figure 8: Marginal Effective Tax Rate (METR) by BEA Asset Type (1987-2023)



Notes: Marginal Effective Tax Rates (METR) calculated using IRS depreciation bonus rules, top marginal corporate tax rates from the IRS, discount rates from Moody's AA rated corporate bonds, and depreciation rates from the BEA.

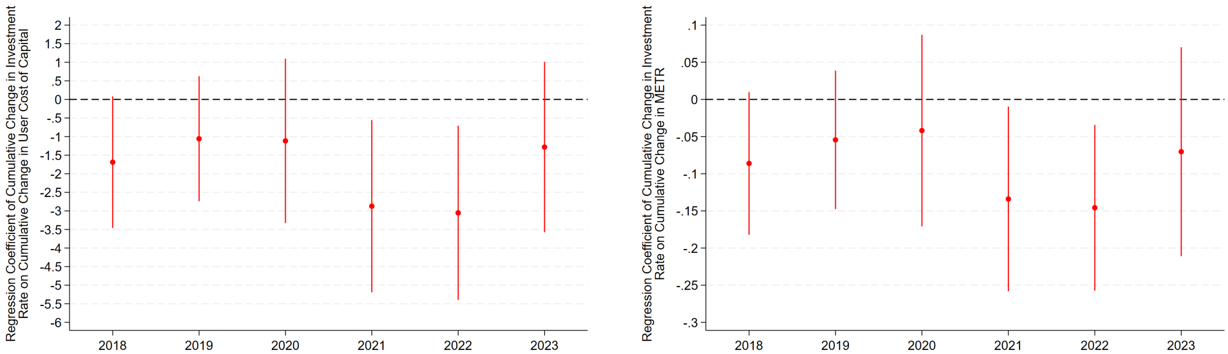
Figure 9: Distribution of Firm Investment Rates Across 2016, 2017, and 2018



Notes: Investment data are retrieved and calculated from the CRSP/Compustat Merged dataset. The investment rate is calculated as depreciation plus the change in net PPE from the prior year all divided by net PPE from the prior year.

Figure 10: PredictIt Prediction Market Prices For "Corporate tax cut by end of 2017?" and "Corporate tax cut by 3/31/18?" in the U.S.

Figure 11: Cumulative Investment Response to Tax Changes

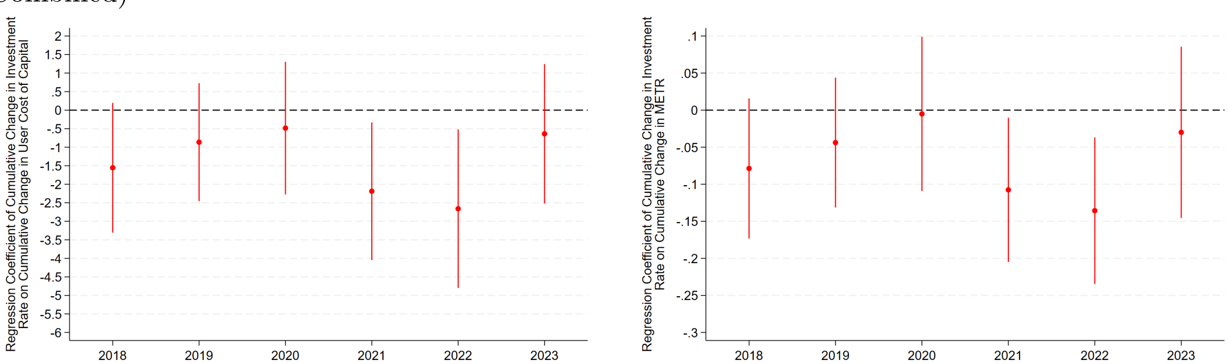


(a) User Cost of Capital

(b) METR

Notes: Point estimates shown along with 95% confidence intervals. Data for fixed investment and capital stock by asset type from BEA Fixed Asset Tables. User cost of capital and METR calculated using IRS depreciation bonus rules, top marginal corporate tax rates from the IRS, discount rates from Moody's AA rated corporate bonds, and depreciation rates from the BEA Fixed Asset Tables. We calculate change in asset investment rates by year then winsorize the top 5% and bottom 5% of observations in each year.

Figure 12: Cumulative Investment Response to Tax Changes (Computer-Related Asset Types Combined)



(a) User Cost of Capital

(b) METR

Notes: Point estimates shown along with 95% confidence intervals. Data for fixed investment and capital stock by asset type from BEA Fixed Asset Tables. User cost of capital and METR calculated using IRS depreciation bonus rules, top marginal corporate tax rates from the IRS, discount rates from Moody's AA rated corporate bonds, and depreciation rates from the BEA Fixed Asset Tables. Computer-related asset types (RD21, RD22, RD24, RD25) are combined and weighted by capital stock to reduce volatility. We calculate change in asset investment rates by year then winsorize the top 5% and bottom 5% of observations in each year.

8 Appendix

Appendix Table 1: C-Corp vs. PTE Asset Shares by Asset Type

Code	Asset Name	C-Corp Share	PTE Share
	Mean	0.715	0.285
AE10	Theatrical movies	0.896	0.104
AE20	Long-lived television programs	0.907	0.093
AE30	Books	0.826	0.174
AE40	Music	0.656	0.344
AE50	Other entertainment originals	0.569	0.431
EI11	Nuclear fuel	0.947	0.053
EI12	Other fabricated metals	0.764	0.236
EI21	Steam engines	0.930	0.070
EI22	Internal combustion engines	0.888	0.112
EI30	Metalworking machinery	0.844	0.156
EI40	Special industrial machinery	0.832	0.168
EI50	General industrial equipment	0.806	0.194
EI60	Electric transmission and distribution	0.911	0.089
ENS1	Prepackaged software	0.765	0.235
ENS2	Custom software	0.764	0.236
ENS3	Own account software	0.758	0.242
EO11	Household furniture	0.509	0.491
EO12	Other furniture	0.674	0.326
EO21	Farm tractors	0.445	0.555
EO22	Construction tractors	0.727	0.273
EO30	Other agricultural machinery	0.367	0.633
EO40	Other construction machinery	0.556	0.444
EO50	Mining and oilfield machinery	0.824	0.176
EO60	Service industry machinery	0.604	0.396
EO71	Household appliances	0.557	0.443
EO72	Other electrical	0.826	0.174
EO80	Other	0.674	0.326
EP12	Office and accounting equipment	0.741	0.259
EP1A	Mainframes	0.738	0.262
EP1B	PCs	0.722	0.278
EP1D	Printers	0.705	0.295
EP1E	Terminals	0.707	0.293
EP1G	Storage devices	0.715	0.285
EP1H	System integrators	0.706	0.294
EP20	Communications	0.829	0.171

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Code	Asset Name	C-Corp Share	PTE Share
EP31	Photocopy and related equipment	0.713	0.287
EP34	Nonelectro medical instruments	0.543	0.457
EP35	Electro medical instruments	0.533	0.467
EP36	Nonmedical instruments	0.645	0.355
ET11	Light trucks (including utility vehicles)	0.683	0.317
ET12	Other trucks, buses and truck trailers	0.693	0.307
ET20	Autos	0.741	0.259
ET30	Aircraft	0.755	0.245
ET40	Ships and boats	0.793	0.207
ET50	Railroad equipment	0.784	0.216
RD11	Pharmaceutical and medicine manufacturing	0.852	0.148
RD12	Chemical manufacturing, ex. pharma and med	0.852	0.148
RD21	Computers and peripheral equipment manufacturing	0.884	0.116
RD22	Communications equipment manufacturing	0.884	0.116
RD23	Semiconductor and other component manufacturing	0.884	0.116
RD24	Navigational and other instruments manufacturing	0.884	0.116
RD25	Other computer and electronic manufacturing, n.e.c.	0.884	0.116
RD31	Motor vehicles and parts manufacturing	0.871	0.129
RD32	Aerospace products and parts manufacturing	0.871	0.129
RD40	Software publishers	0.956	0.044
RD50	Financial and real estate services	0.798	0.202
RD60	Computer systems design and related services	0.553	0.447
RD70	Scientific research and development services	0.499	0.501
RD80	All other nonmanufacturing, n.e.c.	0.721	0.279
RD91	Private universities and colleges	0.590	0.410
RD92	Other nonprofit institutions	0.450	0.550
RDOM	Other manufacturing	0.869	0.131
SB10	Religious	0.337	0.663
SB20	Educational and vocational	0.571	0.429
SB31	Hospitals	0.489	0.511
SB32	Special care	0.481	0.519
SB41	Lodging	0.340	0.660
SB42	Amusement and recreation	0.498	0.502
SB43	Air transportation	0.804	0.196
SB45	Other transportation	0.739	0.261
SB46	Other land transportation	0.587	0.413
SC01	Warehouses	0.685	0.315
SC02	Other commercial	0.671	0.329
SC03	Multimerchandise shopping	0.637	0.363
SC04	Food and beverage establishments	0.555	0.445
SI00	Manufacturing	0.778	0.222

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Code	Asset Name	C-Corp Share	PTE Share
SM01	Petroleum and natural gas	0.829	0.171
SM02	Mining	0.829	0.171
SN00	Farm	0.342	0.658
SO01	Water supply	0.704	0.296
SO02	Sewage and waste disposal	0.668	0.332
SO03	Public safety	0.604	0.396
SO04	Highway and conservation and development	0.610	0.390
SOMO	Mobile structures	0.542	0.458
SOO1	Office	0.654	0.346
SOO2	Medical buildings	0.521	0.479
SU11	Other railroad	0.793	0.207
SU12	Track replacement	0.800	0.200
SU20	Communication	0.913	0.087
SU30	Electric	0.937	0.063
SU40	Gas	0.921	0.079
SU50	Petroleum pipelines	0.844	0.156
SU60	Wind and solar	0.896	0.104

Appendix Table 2: Change in UCC by BEA Asset

Panel A: Change in UCC by Major Asset Group

Major Asset Group	Baseline UCC (2016)	Δ UCC 2018-2016	Δ UCC 2023-2016
Equipment	0.2631	-0.0107	-0.0097
Structures	0.0875	-0.0085	-0.0092
Intellectual Property	0.2680	-0.0062	-0.0048
Asset Average	0.2058	-0.0088	-0.0083

Panel B: Change in UCC by BEA Asset

Code	Asset Name	Major Asset Group	Baseline UCC (2016)	Δ UCC 2018-2016	Δ UCC 2023-2016
AE10	Theatrical movies	Intellectual Property	0.1509	-0.0142	-0.0125
AE20	Long-lived television programs	Intellectual Property	0.2307	-0.0189	-0.0159
AE30	Books	Intellectual Property	0.1792	-0.0148	-0.0137
AE40	Music	Intellectual Property	0.3250	-0.0154	-0.0142
AE50	Other entertainment originals	Intellectual Property	0.1669	-0.0157	-0.0144
EI11	Nuclear fuel	Equipment	0.3043	-0.0103	-0.0094
EI12	Other fabricated metals	Equipment	0.1425	-0.0077	-0.0076
EI21	Steam engines	Equipment	0.1054	-0.0099	-0.0093
EI22	Internal combustion engines	Equipment	0.2618	-0.0118	-0.0105

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Table 2 Continued from previous page

Code	Asset Name	Major Asset Group	Baseline UCC (2016)	Δ UCC 2018-2016	Δ UCC 2023-2016
EI30	Metalworking machinery	Equipment	0.1747	-0.0087	-0.0083
EI40	Special industrial machinery	Equipment	0.1545	-0.0079	-0.0078
EI50	General industrial equipment	Equipment	0.1587	-0.0082	-0.0079
EI60	Electric transmission and distribution	Equipment	0.1037	-0.0099	-0.0093
ENS1	Prepackaged software	Equipment	0.6085	-0.0154	-0.0128
ENS2	Custom software	Equipment	0.3837	-0.0106	-0.0095
ENS3	Own account software	Intellectual Property	0.3753	-0.0022	0.0004
EO11	Household furniture	Equipment	0.1876	-0.0082	-0.0081
EO12	Other furniture	Equipment	0.1695	-0.0089	-0.0085
EO21	Farm tractors	Equipment	0.1975	-0.0107	-0.0097
EO22	Construction tractors	Equipment	0.2147	-0.0084	-0.0081
EO30	Other agricultural machinery	Equipment	0.1689	-0.0098	-0.0092
EO40	Other construction machinery	Equipment	0.2058	-0.0086	-0.0083
EO50	Mining and oilfield machinery	Equipment	0.2032	-0.0098	-0.0091
EO60	Service industry machinery	Equipment	0.2057	-0.0105	-0.0096
EO71	Household appliances	Equipment	0.2161	-0.0089	-0.0085
EO72	Other electrical	Equipment	0.2379	-0.0111	-0.0100
EO80	Other	Equipment	0.2001	-0.0101	-0.0093
EP12	Office and accounting equipment	Equipment	0.3677	-0.0128	-0.0111
EP1A	Mainframes	Equipment	0.5235	-0.0172	-0.0141
EP1B	PCs	Equipment	0.5235	-0.0173	-0.0141
EP1D	Printers	Equipment	0.5235	-0.0174	-0.0141
EP1E	Terminals	Equipment	0.5235	-0.0174	-0.0141
EP1G	Storage devices	Equipment	0.5235	-0.0173	-0.0141
EP1H	System integrators	Equipment	0.5235	-0.0174	-0.0141
EP20	Communications	Equipment	0.1646	-0.0083	-0.0080
EP31	Photocopy and related equipment	Equipment	0.2318	-0.0090	-0.0085
EP34	Nonelectro medical instruments	Equipment	0.1871	-0.0100	-0.0092
EP35	Electro medical instruments	Equipment	0.1870	-0.0100	-0.0093
EP36	Nonmedical instruments	Equipment	0.1873	-0.0097	-0.0090
ET11	Light trucks (including utility vehicles)	Equipment	0.2240	-0.0088	-0.0084
ET12	Other trucks, buses and truck trailers	Equipment	0.2241	-0.0088	-0.0084
ET20	Autos	Equipment	0.3897	-0.0134	-0.0115
ET30	Aircraft	Equipment	0.1351	-0.0061	-0.0065
ET40	Ships and boats	Equipment	0.1122	-0.0079	-0.0078
ET50	Railroad equipment	Equipment	0.1084	-0.0063	-0.0067
RD11	Pharmaceutical and medicine mfg	Intellectual Property	0.1456	-0.0021	-0.0021
RD12	Chemical mfg, ex. pharma and med	Intellectual Property	0.2056	-0.0021	-0.0015
RD21	Computers and peripheral equip mfg	Intellectual Property	0.4457	-0.0020	0.0010
RD22	Communications equipment mfg	Intellectual Property	0.3157	-0.0020	-0.0003

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Code	Asset Name	Major Asset Group	Baseline UCC (2016)	Δ UCC 2018-2016	Δ UCC 2023-2016
RD23	Semiconductor and component mfg	Intellectual Property	0.2957	-0.0020	-0.0005
RD24	Navigational and instruments mfg	Intellectual Property	0.3357	-0.0020	-0.0001
RD25	Other computer and electronic mfg	Intellectual Property	0.4457	-0.0020	0.0010
RD31	Motor vehicles and parts mfg	Intellectual Property	0.3556	-0.0020	0.0001
RD32	Aerospace products and parts mfg	Intellectual Property	0.2656	-0.0020	-0.0008
RD40	Software publishers	Intellectual Property	0.2716	-0.0076	-0.0074
RD50	Financial and real estate services	Intellectual Property	0.2054	-0.0022	-0.0015
RD60	Computer systems design and rltd	Intellectual Property	0.4140	-0.0119	-0.0104
RD70	Scientific r&d services	Intellectual Property	0.2046	-0.0027	-0.0018
RD80	All other non-mfg, n.e.c.	Intellectual Property	0.2052	-0.0023	-0.0016
RD91	Private universities and colleges	Intellectual Property	0.2095	-0.0072	-0.0073
RD92	Other nonprofit institutions	Intellectual Property	0.2092	-0.0075	-0.0077
RDOM	Other mfg	Intellectual Property	0.2056	-0.0020	-0.0014
SB10	Religious	Structures	0.0854	-0.0086	-0.0101
SB20	Educational and vocational	Structures	0.0855	-0.0097	-0.0110
SB31	Hospitals	Structures	0.0854	-0.0093	-0.0106
SB32	Special care	Structures	0.0854	-0.0093	-0.0106
SB41	Lodging	Structures	0.0981	-0.0094	-0.0106
SB42	Amusement and recreation	Structures	0.0776	-0.0058	-0.0066
SB43	Air transportation	Structures	0.0920	-0.0114	-0.0124
SB45	Other transportation	Structures	0.0920	-0.0111	-0.0121
SB46	Other land transportation	Structures	0.0706	-0.0046	-0.0057
SC01	Warehouses	Structures	0.0904	-0.0107	-0.0118
SC02	Other commercial	Structures	0.0954	-0.0110	-0.0121
SC03	Multimerchandise shopping	Structures	0.0954	-0.0108	-0.0119
SC04	Food and beverage establishments	Structures	0.0954	-0.0104	-0.0115
SI00	Manufacturing	Structures	0.1023	-0.0122	-0.0131
SM01	Petroleum and natural gas	Structures	0.1241	-0.0056	-0.0061
SM02	Mining	Structures	0.0941	-0.0057	-0.0062
SN00	Farm	Structures	0.0756	-0.0106	-0.0100
SO01	Water supply	Structures	0.0748	-0.0094	-0.0091
SO02	Sewage and waste disposal	Structures	0.0747	-0.0095	-0.0092
SO03	Public safety	Structures	0.0921	-0.0104	-0.0115
SO04	Highway and conservation and dev.	Structures	0.0732	-0.0083	-0.0083
SOMO	Mobile structures	Structures	0.1044	-0.0067	-0.0071
SOO1	Office	Structures	0.0934	-0.0107	-0.0118
SOO2	Medical buildings	Structures	0.0934	-0.0100	-0.0112
SU11	Other railroad	Structures	0.0696	-0.0087	-0.0085
SU12	Track replacement	Structures	0.0731	-0.0049	-0.0057
SU20	Communication	Structures	0.0752	-0.0077	-0.0077

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Code	Asset Name	Major Asset Group	Baseline UCC (2016)	Δ UCC 2018-2016	Δ UCC 2023-2016
SU30	Electric	Structures	0.0724	-0.0074	-0.0075
SU40	Gas	Structures	0.1243	-0.0054	-0.0059
SU50	Petroleum pipelines	Structures	0.0713	-0.0041	-0.0050
SU60	Wind and solar	Structures	0.0782	-0.0042	-0.0050

Appendix Table 3: Cumulative Investment Response to Tax Changes

$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}}$	2018 (1)	2019 (2)	2020 (3)	2021 (4)	2022 (5)	2023 (6)
$c_{i,t} - c_{i,2016}$:						
No Winsorization	-12.957	-11.470	-8.683	-11.754*	-13.971	-17.233
	(9.202)	(8.108)	(6.007)	(6.979)	(8.869)	(12.644)
2.5% Winsorization	-2.091*	-1.946	-1.618	-3.786**	-4.034**	-1.791
	(1.080)	(1.222)	(1.414)	(1.563)	(1.688)	(1.469)
5% Winsorization	**-1.689***	**-1.057**	**-1.115**	**-2.873****	**-3.056****	**-1.282**
	(0.890)	**(0.847)**	**(1.113)**	**(1.166)**	**(1.180)**	**(1.154)**
10% Winsorization	-1.251*	-0.745	-0.333	-1.786**	-2.289**	-0.761
	(0.697)	(0.725)	(0.719)	(0.693)	(0.868)	(0.816)
$METR_{i,t} - METR_{i,2016}$:						
No Winsorization	-0.679	-0.629	-0.463	-0.557*	-0.553	-1.020
	(0.483)	(0.438)	(0.334)	(0.332)	(0.337)	(0.747)
2.5% Winsorization	-0.107*	-0.103	-0.066	-0.176**	-0.177**	-0.101
	(0.059)	(0.068)	(0.082)	(0.081)	(0.076)	(0.091)
5% Winsorization	**-0.086***	**-0.054**	**-0.042**	**-0.134****	**-0.145****	**-0.070**
	(0.048)	**(0.046)**	**(0.064)**	**(0.062)**	**(0.056)**	**(0.070)**
10% Winsorization	-0.062	-0.037	-0.001	-0.088	-0.120	-0.041
	(0.037)	(0.039)	(0.041)	(0.036)	(0.041)	(0.049)
N	93	93	93	93	93	93

Notes: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Data for fixed investment from BEA Fixed Asset Tables. User cost of capital and METR data from OSPC Cost of Capital Calculator. We calculate change in asset investment rates by year then winsorize the observations at the top and bottom. The benchmark specification is bolded. Note that with less than 100 asset types, winsorizing 1% is equivalent to no winsorization

Appendix Table 4: Cumulative Investment Response to Tax Changes (Computer-related asset types combined)

$\frac{I_{i,t}}{K_{i,t-1}} - \frac{I_{i,2016}}{K_{i,2015}}$	2018	2019	2020	2021	2022	2023
	(1)	(2)	(3)	(4)	(5)	(6)
$c_{i,t} - c_{i,2016}$:						
No Winsorization	-1.925	-1.244	-0.902	-2.798**	-2.997*	-0.671
	(1.260)	(1.057)	(1.314)	(1.381)	(1.517)	(1.180)
2.5% Winsorization	-1.575*	-0.979	-0.675	-2.433*	-2.598**	-0.711
	(0.908)	(0.867)	(1.071)	(1.234)	(1.219)	(1.170)
5% Winsorization	**-1.554***	**-0.864**	**-0.484**	**-2.188****	**-2.660****	**-0.638**
	(0.881)	**(0.800)**	**(0.900)**	**(0.935)**	**(1.076)**	**(0.947)**
10% Winsorization	-1.297*	-0.782	-0.166	-1.761**	-2.262**	-0.320
	(0.710)	(0.747)	(0.675)	(0.724)	(0.904)	(0.778)
$METR_{i,t} - METR_{i,2016}$:						
No Winsorization	-0.097	-0.066	-0.021	-0.127*	-0.141*	-0.032
	(0.068)	(0.059)	(0.076)	(0.074)	(0.073)	(0.074)
2.5% Winsorization	-0.079	-0.049	-0.012	-0.112*	-0.129**	-0.033
	(0.049)	(0.047)	(0.062)	(0.066)	(0.057)	(0.073)
5% Winsorization	**-0.078**	**-0.043**	**-0.005**	**-0.107****	**-0.135*****	**-0.029**
	(0.047)	**(0.044)**	**(0.052)**	**(0.048)**	**(0.049)**	**(0.058)**
10% Winsorization	-0.065*	-0.039	0.007	-0.085**	-0.120***	-0.013
	(0.038)	(0.041)	(0.038)	(0.037)	(0.041)	(0.041)
N	90	90	90	90	90	90

Notes: Robust standard errors in parentheses. *** p<0.01 ** p<0.05 * p<0.10. Data for fixed investment from BEA Fixed Asset Tables. User cost of capital and METR data from OSPC Cost of Capital Calculator. Computer-related asset types (RD21, RD22, RD24, RD25) are combined and weighted by capital stock to reduce volatility. We calculate change in asset investment rates by year then winsorize the observations at the top and bottom. The benchmark specification is bolded. Note that with less than 100 asset types, winsorizing 1% is equivalent to no winsorization.

Appendix Table 5: Aggregate Investment Elasticities

Year	Coefficient	Mean I/K	Mean UCC	Elasticity
2018	-1.689*	0.1818	0.2058	-1.911
2019	-1.057	0.1818	0.2058	-1.196
2020	-1.115	0.1818	0.2058	-1.262
2021	-2.873**	0.1818	0.2058	-3.252
2022	-3.053**	0.1818	0.2058	-3.456
2023	-1.282	0.1818	0.2058	-1.451

Notes: This table presents conversions of our estimated coefficients into investment elasticities. Column 2 presents our estimated coefficients from regressions of the cumulative change in the investment rate on the cumulative change in UCC (see Table 1). Column 3 reports the mean investment rate (winsorized at 5%) in 2016 (the initial year in our sample). Column 4 reports the mean UCC in 2016. Column 5 presents the investment rate elasticities, which are calculated by taking the estimated coefficient divided by the mean initial investment rate and multiplied by the mean initial UCC.