The Trump Tax Cuts and Corporate Investment
Very Preliminary and Incomplete

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February 2022

Abstract

Effective tax rates differ substantially across firms, suggestive of distortions and capital misallocation. I show that the Tax Cuts and Jobs Act led to a significant reduction in this dispersion of tax rates. Moreover, firms that enjoyed larger reductions in tax rates increased investment more. I use this evidence to calibrate a general equilibrium model with firm heterogeneity in productivity and tax rates, and show that TCJA had material effects through both cost-of-capital and reallocation effects.

1 Introduction

The Tax Cuts and Jobs Act (TCJA), signed into law by President Trump on December 22, 2017, introduced a number of changes in both corporate and individual income taxation. It was the most significant tax reform since 1986, and it was highly controversial: while some economists argued that it was ill-conceived, others lauded many of its features (Slemrod [2018]). One of TCJA's main goals was to increase capital investment in the United States. The lack of evident response of business investment following its passage led some commentators to conclude that it had little effect.[1] Various explanations

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[1] For a summary in the popular press, see New York Times, Nov. 12, 2018, "Trump's Tax Cut Was Supposed to Change Corporate Behavior. Here's What Happened."

have been advanced for this apparent lack of reaction, either related to the macroeconomic environment, or to the details of the tax reform.[2]

The first contribution of this study is to bring new evidence on the effect of TCJA by exploiting the heterogeneous exposures of firms to the tax reform. This heterogeneous exposure is not merely useful for identification, it also has interesting macroeconomic implications. Where doe heterogeneous exposure come from? While the tax reform had many complex features, a first-order effect was to *compress* the distribution of effective tax rates (ETR). This is, in part, a necessary implication of reducing the statutory tax rate: since some firms face the statutory tax rate and others are able to enjoy a lower rate through the use of deductions or tax avoidance, reducing the statutory tax rate mechanically reduces the dispersion. On top of the mechanical effect, this compression was indeed a desired effect of the reform, which aimed to reduce the importance of deductions to broaden the tax base: the unequal treatment of firms pre-TCJA, depending on their ability to shield for instance intangible assets or foreign income, was perceived to be a source of distortions.

Using Compustat data on U.S. public firms, I first demonstrate that the tax reform indeed reduced the dispersion of ETR. I then show that firms that enjoyed larger reductions in their ETR also increased investment more. This result is robust to various controls for firm characteristics. One concern is that the measured ETR could be endogenous to firm outcomes, but I show that the effect of ETR on investment is substantially different during the reform than in normal times, which is suggestive of a causal effect.

This result is of interest for at least two reasons. First, one can use these estimates to infer the overall effect of TCJA on investment by extrapolating from this cross-sectional experiment. This comes with the usual caveats about heterogeneity in treatment effects and general equilibrium effects. Second, the reduction in dispersion in tax rates is, in itself, an important effect of the tax reform, reducing distortions in capital allocation. The estimates provide evidence for this positive effect of the tax reform.

To provide an overall macroeconomic evaluation, I build a simple general equilibrium macroeconomic model with a rich cross-section of firms (as in Gomes [2001] or Gourio and Miao [2010]). Firms are ex-ante identical but become heterogeneous in productivity because they face idiosyncratic productivity risk. We introduce productivity risk because heterogeneity in productivity is a key feature of the data, making allocative efficiency im-

[2]On the macroeconomic front, one possibility is simply that there are confounders in aggregate time series data (e.g. other macroeconomic shocks such as the "trade wars" of 2018-2019), or that the effect of tax cuts was small either due to an already low cost of capital (given low interest rates and a tax system that may have been close to neutral), or to high market power of firms (which might reduce the elasticity of firms to the user cost). On the tax reform front, some point to the uncertainty over the future of tax rates given that many provisions in TCJA were scheduled to "sunset" as a factor that may have reduced the effectiveness of the tax reform. Finally, some note that the response to tax reforms is often sluggish.

portant, and because the productivity stochastic process affects firm decision rules. Firms decide on investment and face smooth adjustment costs to the capital stock. To capture the observed heterogeneity in tax rates, I assume that each firm's tax rate also follows an exogenous process (as in the large literature started by Restuccia and Rogerson [2008]). This assumption may seem surprising given that the tax code applies uniformly across companies. And to be sure, some of the observed heterogeneity in measured ETR reflects the complex way that the actual tax system works, plus our imperfect measurement, particularly of taxable income. However, it does also seem that some firms, depending on their business model, organization, industry, foreign exposure, and other factors, are able to reduce their ETR well below others. Our assumptions offer a simple way to capture this reality and its macroeconomic consequences. I then calibrate this model to reproduce the empirical evidence, and use it to assess the macroeconomic effects and implications of the tax reform. (Future work will extend this model to incorporate a richer tax code structure as well as financial structure (e.g. borrowing and payout decisions).)

The rest of the introduction discusses the related literature. Section 2 provides some background on TCJA. Section 3 then presents time series evidence about the effect of TCJA. Section 4 uses Compustat panel data to provide cross-sectional evidence. Finally, section 5 sets up and analyzes the model.

Literature Review The paper contributes to the large literature on the effect of taxes on investment and financial structure (see Hassett and Hubbard [2002] and Auerbach [2002] for surveys and Clarke and Kopczuk [2017] for facts). Jorgenson [1963] and Hall and Jorgenson [1967] developed the user-cost model to study tax policy, in an essentially static analysis, which was made explicitly dynamic by research including Abel [1982] that incorporated adjustment costs.[3] However, relatively little research has studied the effect of changes in the corporate tax itself, likely in part because of few such tax changes have occurred.[4] Instead, much of this literature has focused on the effect of temporary investment incentives, which are often used for stabilization policy. For instance, Goolsbee [1998] and House and Shapiro [2008] study the effect of bonus depreciation, exploiting the heterogeneity in exposure to the policy across different types of capital goods. Zwick and Mahon [2017] and Ohrn [2019] also find a significant response using richer data. There is a related but separate literature on the effect of dividend taxes, which theoretically can have very different effects (e.g., zero effects under the so-called "new view"). Empiri-

[3] See also Chen et al. [2019], Mertens and Ravn [2013], Winberry [2021] and Kaymak and Schott [2019], and Serrato [2018].

[4] Some important exceptions include Ohrn [2018] and Suárez Serrato and Zidar [2016] and XXX, who focus on state-level tax cuts or use international data.

cal estimates of the 2003 dividend tax reform such as Yagan [2015] indeed suggest small effects.

There is some recent work studying specifically the effect of TCJA. Most of this work takes an "ex-ante" perspective to estimate of the effects of TCJA without looking at data post-TCJA. For instance, Barro and Furman [2018] offer an ex-ante estimate based on a user cost framework.[5] There are also a number of macroeconomic studies who differ in their methods (reduced-form or model-based) and their focus. An incomplete list include Mertens [2018], Kopp et al. [2019]), Gale et al. [2018], Bhattarai et al. [2020], Occhino [2019], Sedlacek and Sterk [2019], and Furno [2021]. One important change of TCJA was to affect the relative attractiveness of S-corps vs. C-corps. I do not study this margin and focus on public firms (which are all C-corps).

Finally, the paper is also related to the vast literature on misallocation, e.g. Restuccia and Rogerson [2008] (Add others here).

2 The TCJA and its impact on corporations

This section describes briefly some background information on TCJA and a list of key changes in corporate taxation it introduced.

Background and Motivation for Tax Reform Prior to TCJA, C-corporations were subject to a marginal tax rate of 35% on their taxable income, which included all worldwide income, but was subject to a number of deductions. While this top statutory rate had remained constant since 1986, other countries' top tax rates had declined, as shown in figure 1, reflecting international tax competition. While the US used to have a tax rate that was typical of other countries, it was now one of the largest, creating concern about competitiveness: the high tax rate created disincentives to locate in the U.S. if you were a foreign company, and incentives to keep profits abroad (either through cash or through FDI investment) if you were a U.S. national company with subsidiaries abroad, as profits were taxed only on "repatriation". There was also an incentive to "invert" the corporate structure so as to avoid worldwide U.S. taxation.

Another important development motivating the reform was the rise of S-corporations and partnerships.[6] These reduced the taxable income of C-corps, and overall taxable income, while reducing the share of public firms, perhaps at an organizational cost.[7] More

[5] See also CBO, Tax Foundation, etc.: Add cites.

[6] See Cooper et al. [2016] and Smith et al. on the rise of S-corps.

[7] Add refs on this.

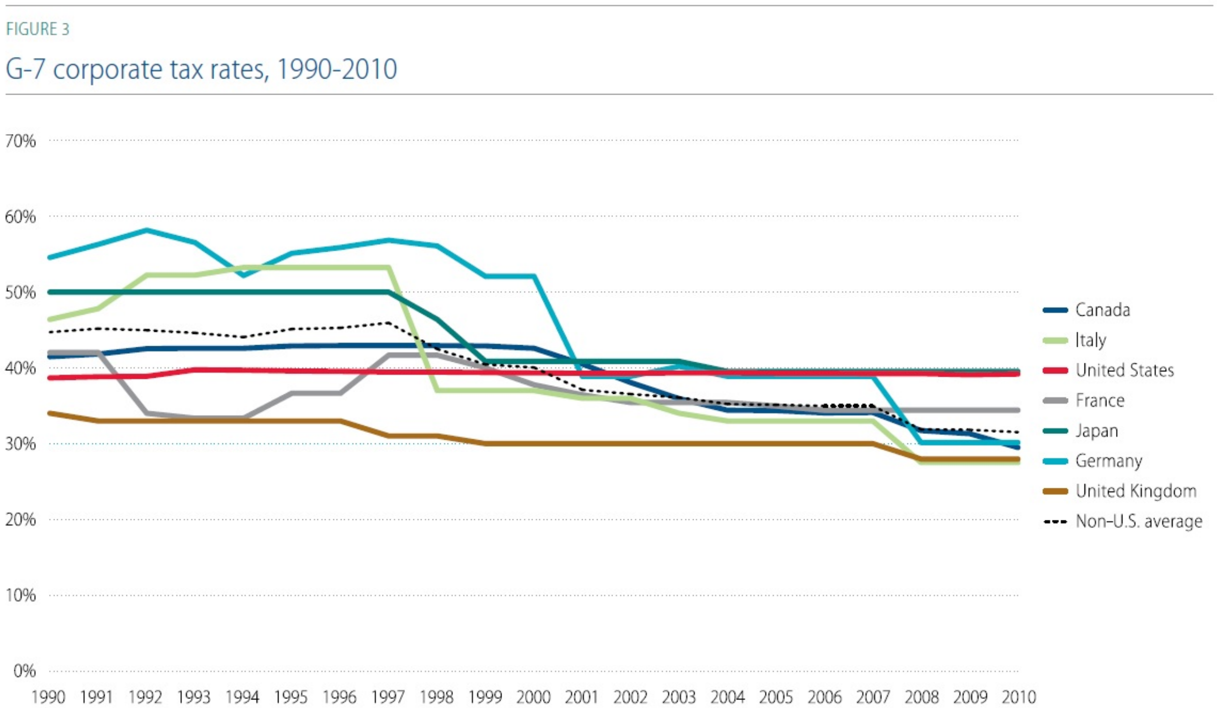

Figure 1: G7 statutory corporate tax rates. Source: Auerbach, 2010

generally, the heterogeneity among U.S. firms in effective taxation (with some firms notoriously able to avoid taxation) created a concern about distortions (and unfairness). For instance, the U.S. tax system seemed to disfavor physical investment relative to intangible investment.

Finally, a last important motivation for the reform was the relative weakness of business investment. Given the importance of investment in short-term job creation and in long-term growth, there was political interest in subsidizing it.

Key provisions (To revise)

We review briefly some key provisions of TCJA for corporations that affected investment.[8] The marginal tax rate was reduced from 35% to 21%.[9] Investment in short-lived capital was allowed to be fully expensed.[10] The deductibility of interest expenses was

[8]We do not discuss changes in individual income taxation. Some of these changes could affect firm investment in principle, by changing discount rates, but the effects are likely relatively minor since the tax rates change on the individual side were much smaller.

[9]Moreover, this became a flat tax. (Prior to the reform, there was a small progressivity in tax rates, with income subject to lower tax rates below a small amount (XXX$).) The corporate AMT was also suppressed.

[10]This provision expires in 2023.

restricted to 30% of EBITDA. There were also new restrictions on deductibility of losses (e.g. carrybacks were disallowed and carryforward were limited to XXX years). The deductibility of R&D and the R&D tax credit were limited (starting 2022). Some provisions were retroactive to Sept. 27th, 2017 (the date the bill was introduced).

On the international side, the US moved towards a territorial system for taxation. Previously U.S. corporations were taxed in the U.S. on their worldwide income, leading many to keep the profits from foreign operations in these foreign subsidiaries (through FDI or holdings of securities, often cash-like) rather than repatriating them, so as to delay taxation. This also created incentives for inversion of U.S. companies, i.e. to become foreign companies. Post TCJA, companies are only taxed on their US income, however this is limited by the introduction of minimum taxes (GILTI and BEAT) that aim to avoid tax avoidance into low-tax jurisdictions (e.g. by moving intellectual property). TCJA also created a one-time tax on foreign assets (tax rate? 12%?, that could be paid over 6 years) in lieu of the corporate tax due (so-called"Deemed repatriation").

Finally, as noted above, there were also changes in the taxation of pass-through entities, including a new deduction.

User Cost of Capital Framework It may be useful to recall a simple user cost of capital framework and some benchmark neutrality results. Consider a firm that generates profits $\pi(k)$ when its capital stock is k. Then, the desired capital stock is given by the first-order condition:

$$\pi'(k) = q\frac{1-\tau_x}{1-\tau_c}\left(r+\delta-\frac{\dot{q}}{q}\right), \tag{1}$$

where q is the price of capital, r the required rate of return, δ the depreciation rate, τ_c the corporate tax rate, and τ_x is present value of tax deductions per unit of investment. This is the celebrated Jorgenson [1963] result.[11] If $\tau_x = \tau_c$, the desired capital stock is unaffected by the tax rate - a so called "neutrality result". There are two special cases where this obtains: (1) if there is full, immediate expensing of all investment, in which case a unit of investment generates a subsidy τ_c upfront; (2) if both depreciation (actual physical plus economic depreciation) *and* interest costs are tax-deductible (which is for instance the case if the investment is debt-financed and interest costs are tax-deductible).[12]

[11] This condition is derived from the first-order conditions of a firm that chooses investment to maximize the present value of after-tax dividends,

$$d = (1-\tau_c)\pi(k) - (1-\tau_x)qx,$$

subject to the capital accumulation $\dot{k} = x - \delta k$.

[12] These results were established by King [1974], Stiglitz [1973], King [1975], Abel [1983]. There are additional implicit assumptions, such as symmetric tax treatment of losses, etc.

TCJA reduced τ_c, and increased τ_x (at least relative to tau_c by introducing immediate expensing.[13] The simple user cost model hence suggests that investment should increase to reach the new target capital stock. (To add: back of the envelope calculation.)

3 Time Series Evidence

This section documents the behavior of some key aggregate time series around the passage of TCJA. Figure 2 depicts the evolution of real GDP and real non-residential investment as well as S&P 500 total dividends and total share repurchases (buybacks). The only series showing a clear reaction to TCJA is share repurchases.

It is perhaps unsurprising that it is difficult to tease out a clear effect from these time series, given the influence of other macroeconomic developments, such as the business cycle, other policy measures such as the introduction of tariffs, and monetary policy tightening during that period. For instance, the flattening of investment in 2015 due to the manufacturing slowdown following the decline of oil prices and the appreciation of the dollar is much starker in this figure.

Looking closely, non-residential investment seems to accelerate slightly after TCJA. One approach to tease out a potential effect of TCJA is to do a heuristic "diff-and-diff" and compare the evolution of nonresidential investment to that of comparable series. Figure 3 shows that indeed, non-residential investment grows faster than GDP or residential investment, which is consistent with a positive effect. (However, residential investment was weak during this period for a variety of reasons, including higher interest rates and TCJA reform of the personal income tax.) Figure 4 depicts an alternative comparison within non-residential investment, showing equipment, structures and IPP (intellectual property products). This comparison is potentially useful because the tax changes benefited equipment the most.[14] The figure shows that intellectual property rose at the fastest rate of all three series, but that is consistent with the pre-trend. Equipment does not exhibit a particularly different behavior.

Overall, this evidence is consistent with the conventional wisdom that TCJA had no clear effect on economic activity, and that its main effect was redistributive, allowing increased payouts to shareholders (and hence raising stock prices). However, there is little confidence in these conclusions given the intrinsic noise in macroeconomic series.

[13] Indeed, could even have $\tau_x > \tau_c$, generating a net investment subsidy, since firms can deduct interest expense on top of the immediate expensing. (Add citation there.)

[14] Expensing applies only to physical assets of life less than 10 (Check???) years, and hence covers primarily equipment. TCJA also enacted a future reduction in the tax credit for R&D. Structures were also most affected by the limitation of interest deductibility.

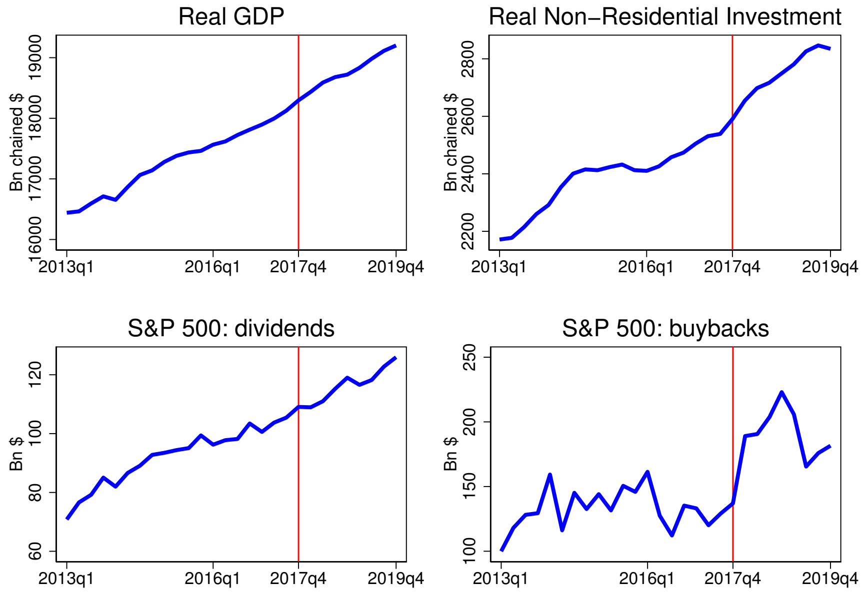

Figure 2: Macroeconomic variables: aggregate trends. The red vertical line denotes the passage of TCJA (2017q4). The top panel shows real GDP and real non-residential investment. The bottom panel shows total (nominal) S&P 500 dividends and buybacks. Source: BEA and S&P 500 (through Haver analytics).

This motivates turning to the cross-section.

4 Cross-Sectional Evidence

4.1 Data

We use Compustat to study how TCJA affected effective tax rates (ETR) paid by corporations, and how these changes in turn affected firm outcomes. We use standard data screens.[15]

There are various ways to define the effective tax rate. We focus on two measures that both use the firm's income statement. First, we calculate the total ETR for firm i in year t as

$$ETR_{it} = \frac{\text{total income taxes}_{it}}{\text{pretax income}_{it}}, \tag{2}$$

[15] We exclude financial and foreign firms, and require firms to have five years of data on sales, earnings, capital expenditures, and taxes, and five years with assets over 10m \$. This leaves us with around 2,200 firms per year.

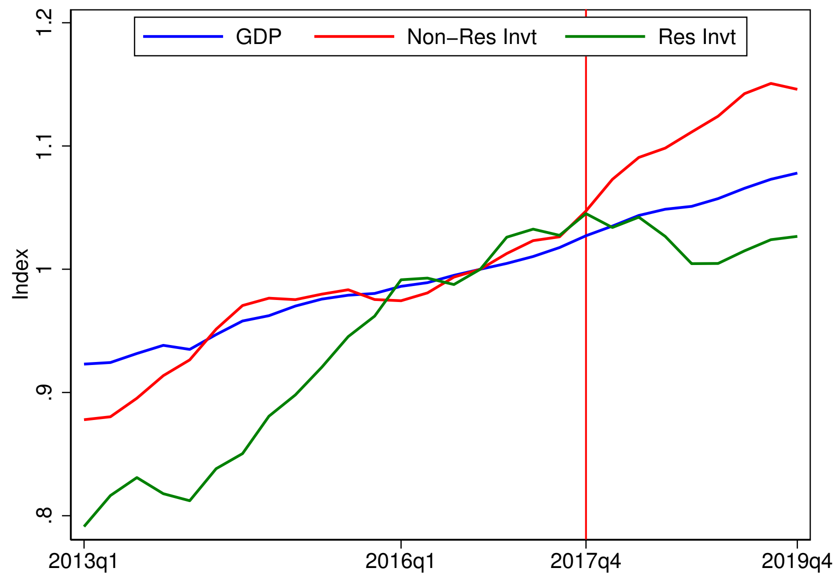

Figure 3: Macroeconomic variables: relative evolution of GDP, non-residential investment, and residential investment. The red vertical line denotes the passage of TCJA (2017q4). All series are in real terms, and are indexed to 1 in 2016q4. Source: BEA.

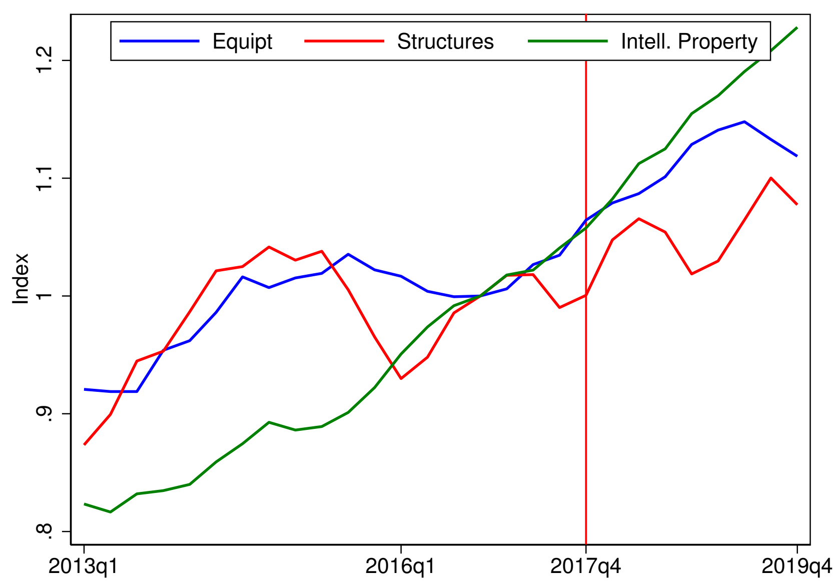

Figure 4: Macroeconomic variables: relative evolution of investment in equipment, non-residential structures, and IPP (intellectual property products). The red vertical line denotes the passage of TCJA (2017q4). All series are in real terms, and are indexed to 1 in 2016q4. Source: BEA.

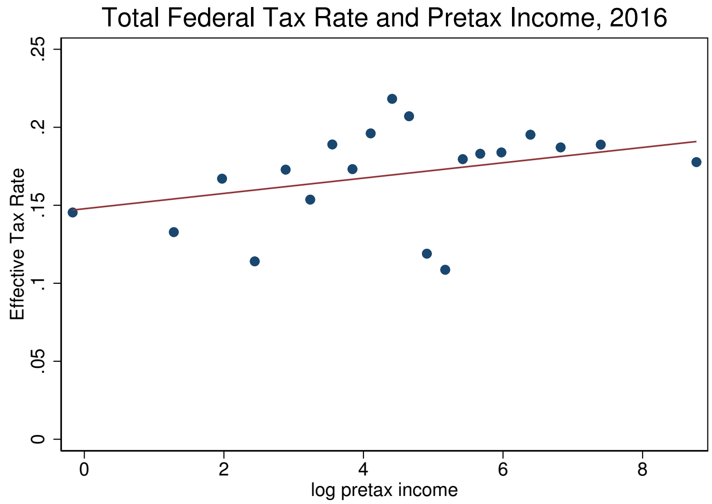

Figure 5: Relation between log pretax income and Federal ETR in 2016. Source: Compustat.

This measure covers all taxes - Federal, State and Foreign - and current as well as deferred obligations. One reason to focus on it is that it is comprehensive, Federal taxes are typically the most important, and there are interactions between the different taxes (so that separating the contribution of one can be difficult). However, we will mostly use the following measure to focus on federal taxes:

$$ETR_{it}^{Fed} = \frac{\text{total federal income taxes}_{it}}{\text{pretax income}_{it}}. \tag{3}$$

This Federal ETR includes both current and deferred taxes. It is important to note some limitations of these ETR. First, the ETR is an average, rather than marginal, tax rate. Second, this ETR is not the actual average tax rate, since the pretax income used in the denominator is not taxable income as defined by the tax code and the IRS. There are a number of differences between the two concepts of income, and between the deductions allowed by the tax code and by accounting principles (GAAP). A particularly important tax deduction consists of past and future earnings losses (e.g. carryforward and carryback of losses), which can substantially alter the ETR, especially in the short run. Figure 5 illustrates that the average federal ETR was slightly increasing with pretax income in 2016.

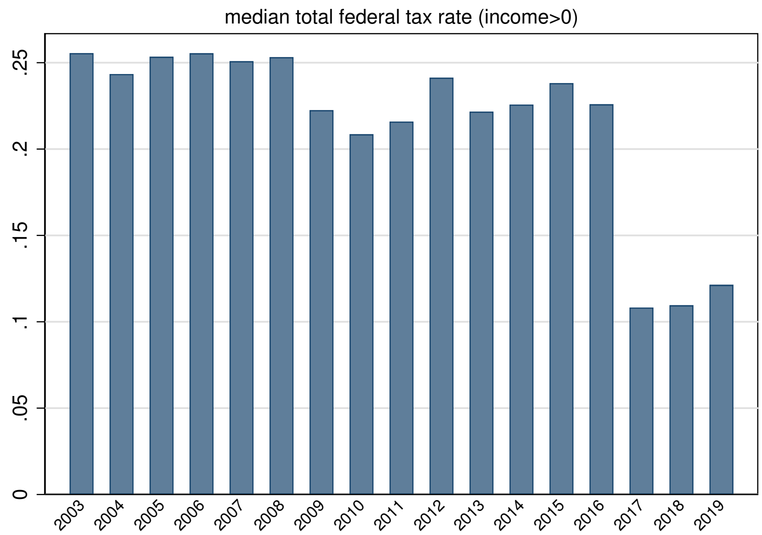

Figure 6: Median Federal ETR for companies with positive pretax income. Source: Compustat.

4.2 Effective Tax Rates after TCJA

In this section, we document three facts about the behavior of ETR after the passage of TCJA: (1) unsurprisingly, average tax rates fell, (2) the dispersion in tax rates fell, (3) the reforms led to significant "reshuffling" of tax rates, i.e. post-TCJA effective tax rates are not highly correlated with pre-TCJA tax rates. This shows that the reform had heterogeneous effects on firms' tax rates.

Fact 1: TCJA reduced average ETR Figure 6 depicts the evolution of the median Federal ETR among firms that have positive income. (We focus on firms with positive income since they are the ones that may have to pay tax. For this figure and the following ones, we restrict ourselves to firms with a December fiscal-year to align with the timing of the reform. To be relaxed.) After being relatively stable since 2003, the median ETR fell substantially with the reform, from about 22% to about 11%. (A similar result also hold with total ETR, with means instead of medians, etc.)

Fact 2: TCJA reduced the dispersion of ETR Figure 7 depicts the evolution of two measures of dispersion in ETRs: the difference between the 90th percentile and the 10th percentile, and that between the 75th percentile and the 25th percentile, for firms that have positive income. (We exclude 2017 from this graph since the reform generated large one-

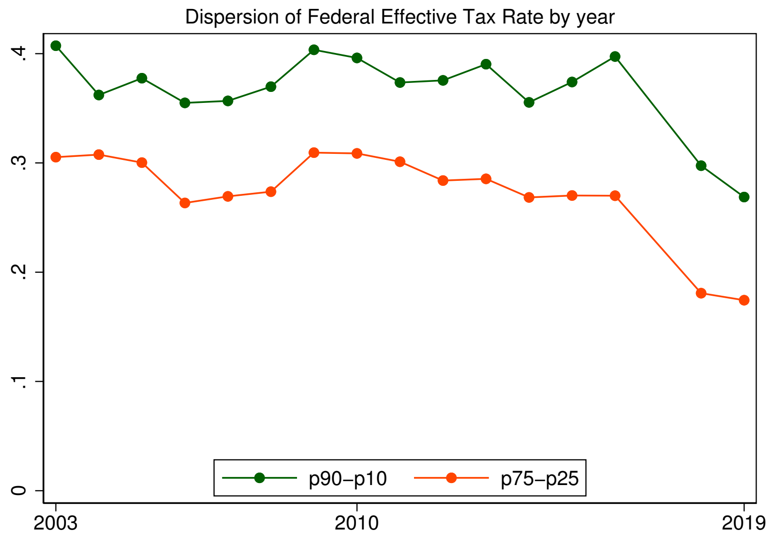

Figure 7: Dispersion of Federal ETR for companies with positive pretax income. Source: Compustat.

off tax changes due, notably, to repatriation.) Both dispersion measures fall by around 1/3, a decline much larger than anything seen before. Figure 8 depicts the entire histogram of federal ETR in 2016 and 2018. Clearly, the number of firms with an ETR above approximately 24% declined post-reform, leading to lower dispersion.

Fact 3: TCJA lead to a one-time change in ETR by firm We next illustrate the tax reform lead to large and unusual changes in rates - and not a simple shift down in the schedule. While in normal times, tax rates tend to be persistent, there was a significant break after the reform. To illustrate this, we estimate the simple equation

$$ETR_{it}^{Fed} = \alpha + \sum_{k=2003}^{2009} \beta_k \left(ETR_{it-1}^{Fed} \times D_{t=k} \right) + \varepsilon_{it}, \tag{4}$$

and depict in figure 9 the estimated β_k. Pre TCJA, the coefficient β_k is stable around 0.4. In 2017, the coefficient becomes negative, showing that the new ETR was largely unrelated to the previous ETR, i.e. there was a fundamental change. This is not too surprising: the reform changed the "rules of the game", and hence altered to some extent the identity of the firms able to enjoy a lower ETR. (The coefficient remains low in 2018 likely in part because of some one-off changes in 2017, before starting to increase again in 2019.) One may worry that 2017 is a highly unusual year, so in figure 10 I omit 2017 and show that

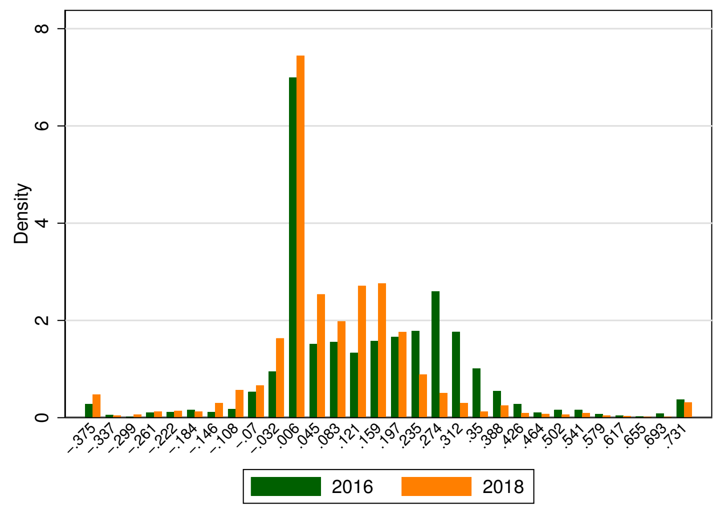

Figure 8: Distribution of Federal ETR in 2016 and in 2018. Source: Compustat.

the results are very similar if we use the twice-lagged Federal ETR in the regression rather than the single year.[16] An alternative graphical illustration of this pattern is in figure 11, which shows a scatter plot of the Federal ETR against its two-year lag, in 2018 and in 2014. The slope is much flatter in 2018. Taken together, these results show that TCJA created a one-time large change in the ETR, in a way quite distinct from the normal persistence of ETR.

4.3 Relation of ETR to real outcomes

We now consider the association between the change in ETR post TCJA and real outcomes, particularly investment. A simple regression of investment on ETR is problematic because, in any given year, ETR are somewhat endogenous to firm outcomes. For instance, a firm that is losing money will likely have a very low ETR, and a very low investment, generating a spurious positive correlation. To mitigate this problem, we propose to relate the change in ETR post TCJA (say in 2018) to firm outcomes, *relative to usual changes in ETR*, i.e. use the following regression:

$$\Delta Y_{it} = \alpha + \beta \Delta ETR_{it} + \gamma \Delta ETR_{it} D_{t=2018} + \varepsilon_{it}, \tag{5}$$

where Y is the outcome variable, and $D_{t=2018}$ is a dummy for 2018. The coefficient β here captures the usual effect of ETR on Y, which is likely endogenous, but the coefficient γ

[16] I also omit 2019 since it would compare to 2017.

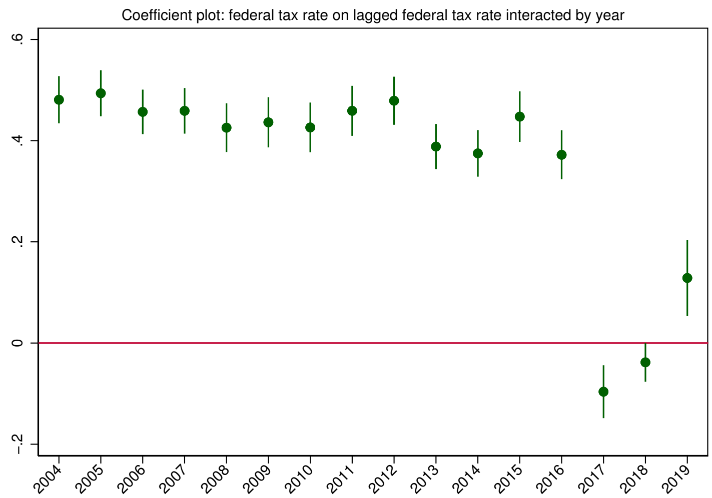

Figure 9: Regression coefficient of Federal ETR on lagged Federal ETR interacted with year dummies. Source: Compustat.

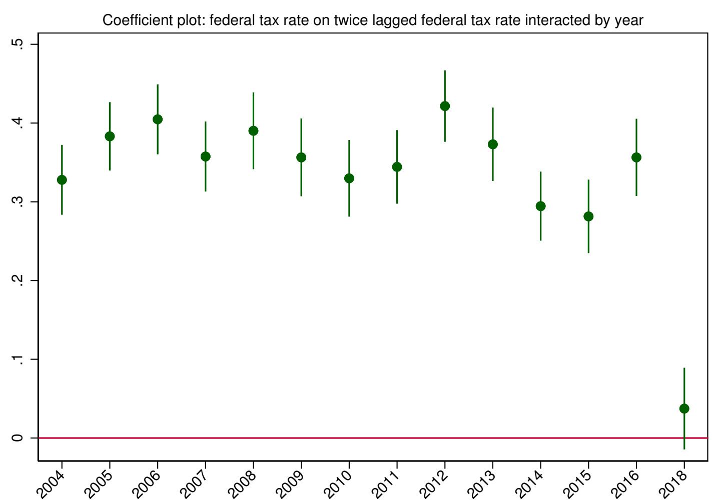

Figure 10: Regression coefficient of Federal ETR on twice-lagged Federal ETR interacted with year dummies. Years 2019 and 2017 are excluded. Source: Compustat.

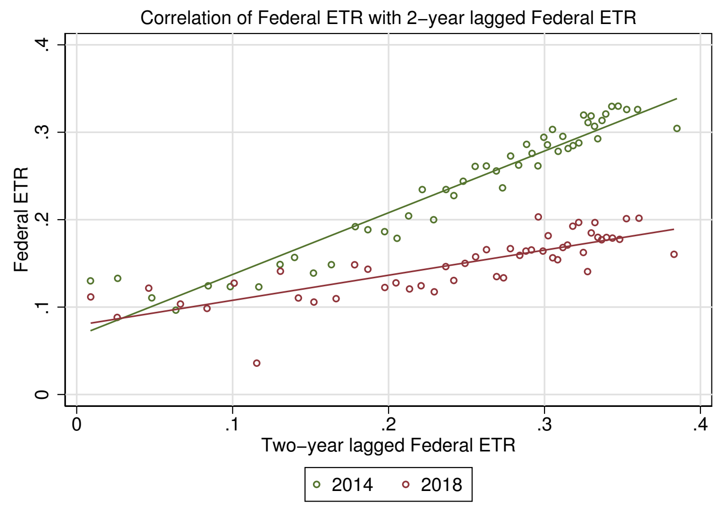

Figure 11: Scatter plot of Federal ETR vs. twice-lagged Federal ETR, for two years: 2018 and 2014. Source: Compustat.

captures the additional effect of the change in ETR in 2018, which likely comes primarily from the tax reform.

One issue in implementing this equation is the timing. We have two years of post TCJA data (2018 and 2019), and one year (2017) with complex status because the tax reform, while applied partly retroactively, was only announced at the end of the year, and hence could not affect many decisions.[17] Hence, rather than a simple first-difference Δ, we apply the following lag polynomial:

$$N(L) = \frac{1+L}{2} - \frac{L^3+L^4}{2},$$

and estimate

$$N(L)Y_{it} = \alpha + \beta N(L)ETR_{it} + \gamma N(L)ETR_{it}D_{t=2019} + \delta_{j,t} + \varepsilon_{it}. \tag{6}$$

The logic is simply that we pool the two years of data post TCJA (2018 and 2019) and compare the outcomes to that of the two years before the tax reform (2015 and 2016), and simply exclude 2017. (We will show results with alternative transformations, which give qualitatively similar results, below.) We also may include fixed effects $\delta_{j,t}$, e.g. industry fixed effects, time fixed effects, and industry-time effects, to reduce the effect of

[17]While there was some anticipation of a tax reform, both its passage and its specific features were still quite uncertain until late in the Fall. (Add refs.)

unobserved firm heterogeneity that might be correlated with changes in ETR during the reform. We run this regression on the entire panel to estimate the coefficient of interest γ. Table 1 provides the results when the outcome variable is the investment rate I/K (the ratio of capital expenditures to the lagged stock of property, plant and equipment). The table shows that, in normal times, a higher ETR is associated with a higher investment rate (i.e. $\beta > 0$), but this pattern is markedly different in 2019 (i.e., $\gamma < 0$). During that year, a one percentage point increase in the ETR was associated with a decline of about 0.12 percentage point in the investment rate. This effect is robust to including year, industry, and industry-year fixed effects and is highly statistically significant. The magnitude is economically significant: a 10 percentage point reduction in the ETR (consistent with figure 6, or approximately with the reduction in the statutory rate) would lead the investment rate to increase by about 1.2%. The median investment rate is about 18%, so the effect amounts to an increase of about 6-7%.

	(1) I/K	(2) I/K	(3) I/K
NetrSUMFED	0.099***	0.098***	0.091***
	(5.69)	(6.02)	(5.21)
NetrSUMFED2019	-0.122***	-0.122***	-0.126***
	(-7.23)	(-7.49)	(-7.37)
Year FE	Y	Y	N
Ind FE	N	Y	N
Year x Ind FE	N	N	Y
Start year	1995	1995	1995
Observations	35481	35480	34581

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 1: Estimates of regression (6) for the investment rate. Standard errors are two-way clustered by industry and year.

Table 2 show the results for different outcome variables. We first look at sales, employment, profits (pretax income), and R&D, all scaled by lagged assets. Interestingly, there appears to be little change for these variables: the effect of lower ETR appear small, insignificant, and negative (i.e. of the opposite sign as investment) for sales and employment, negative and significant (but relatively small) for R&D, and positive for pretax profits. Table 3 present results in log. While the results are consistent for investment (and it can be checked that the magnitude is similar as the investment rate specification), the specification now shows significant positive effects of a cut in ETR on sales, employment and profits. Further research will work on reconciling these results, and considering the effect on financial decisions.

	(1) I/K	(2) RD/K	(3) S/K	(4) N/K	(5) Pi/K
NetrSUMFED	0.091***	-0.012***	0.029	-0.000	0.086***
	(5.21)	(-4.01)	(1.07)	(-0.94)	(8.97)
NetrSUMFED2019	-0.126***	0.009**	0.024	0.001	-0.028**
	(-7.37)	(3.06)	(0.86)	(1.80)	(-2.90)
Year x Ind FE	Y	Y	Y	Y	Y
Start year	1995	1995	1995	1995	1995
Observations	34581	19382	34768	33072	34768

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2: Estimates of regression (6) for different outcomes. Standard errors are two-way clustered by industry and year.

	(1) log N	(2) logS	(3) logI	(4) logRD
NetrSUMFED	0.126***	0.244***	0.416***	0.052
	(4.87)	(8.64)	(8.91)	(1.52)
NetrSUMFED2019	-0.258***	-0.273***	-0.587***	-0.224***
	(-9.25)	(-9.01)	(-12.73)	(-6.09)
Year x Ind FE	Y	Y	Y	Y
Start year	1995	1995	1995	1995
Observations	34300	36936	37157	16853

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Estimates of regression (6) for different outcomes. Standard errors are two-way clustered by industry and year.

Finally, table 4 considers the robustness to the differencing scheme and to the sample. We vary the number of periods we use for the pre-TCJA average, and also try including 2017 in the post-TCJA average. Some of these changes lead to large movements in the estimated coefficient γ, but most of them have limited effect, suggesting that our key finding is fairly robust.

	(1) I/K	(2) I/K	(3) I/K	(4) I/K	(5) I/K	(6) I/K
NetrSUMFED	0.076***	0.059**	0.061***	0.077***	0.067***	0.069***
	(3.88)	(3.72)	(4.22)	(4.23)	(3.85)	(3.91)
NetrSUMFED2019	-0.137***	-0.071***	-0.073***	-0.139***	-0.097***	-0.089***
	(-7.33)	(-4.47)	(-5.04)	(-7.95)	(-6.03)	(-5.28)
Diff	1	1	1	1	1	1
AvgPost	2	2	2	2	2	3
AvgPre	4	2	2	4	6	3
Delay	1	1	1	1	1	0
Year x Ind FE	Y	Y	Y	Y	Y	Y
Observations	1995	1995	1975	1975	1975	1995
N	21809	27839	33008	24706	18612	24337

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Robustness to differencing scheme and sample.

Takeaway Overall, we have shown that firms that experienced larger declines in ETR also experienced larger increases in investment (and perhaps to a lower extent in sales and employment). This suggests that TCJA had some impact. To measure its macroeconomic impact requires to aggregate these estimates, taking into consideration the heterogeneous effect we document. In order to do that, we turn to a macroeconomic model.

5 Model

In this section we introduce a simple general equilibrium model with firm heterogeneity in productivity and in taxes in the spirit of Gomes [2001] and Gourio and Miao [2010]. We then calibrate this model to reproduce the empirical evidence of section 4, and use it to assess the macroeconomic effects and implications of the tax reform. (Future work will extend this model to incorporate a richer tax code structure as well as financial structure (e.g. borrowing and payout decisions).)

5.1 Model Description

Time is continuous and there is no aggregate uncertainty.

Firms There is a constant measure one of firms. We abstract from entry and exit for now. Each firm operates a production function:

$$y = zk^{\alpha}n^{v}, \tag{7}$$

where z is idiosyncratic productivity, k is capital, and n is labor. Both output and input markets are assumed to be competitive. The firm static profit maximization is

$$\pi(k,z;w) = \max_{n\geq 0} \left(zk^{\alpha}n^{v} - wn\right) \tag{8}$$

which can be solved to find the firm labor demand, output supply, and profit:

$$n(k,z;w) = \left(\frac{zvk^{\alpha}}{w}\right)^{\frac{1}{1-v}}, \tag{9}$$

$$y(k,z;w) = z^{\frac{1}{1-v}}k^{\frac{\alpha}{1-v}}\left(\frac{v}{w}\right)^{\frac{v}{1-v}}, \tag{10}$$

$$\pi(k,z;w) = y(k,z;w)(1-v). \tag{11}$$

We assumed that the firm idiosyncratic productivity and tax rate are governed by a continuous time Poisson stochastic process $s = 1...N_s$ with transition matrix Λ. Denote $z = z(s)$ the firm productivity and $\tau_c = \tau_c(s)$ the firm tax rate.[18]

The firm chooses its gross rate of investment x, hence $dk = (x - \delta k)\,dt$, but pays on top of the investement cost an adjustment cost $c(x,k)$ which is assumed smooth.

We assume that the firm maximizes the expected discounted value of its dividends. The firm sequential problem at time t if it starts with capital k and state s is:

$$\begin{aligned}
V_t(k,s) &= \sup_{\{x_t\}} E_t \int_0^{\infty} e^{-\int_0^u r_{t+v}dv} \begin{pmatrix} (1-\tau_c(s_{t+u}))\,\pi(k_{t+u}, z(s_{t+u}); w_{t+u}) \\ +\tau_c(s_{t+u})k_{t+u}d - (1-\tau_x)\left(x_{t+u} + c(x_{t+u}, k_{t+u})\right) \end{pmatrix} dt, \\
s.t. &: dk_{t+u} = (x_{t+u} - \delta k_{t+u})du, \\
k_t &= k, s_t = s.
\end{aligned}$$

Here r_t is the interest rate, and $\pi(k,z;w)$ is the static profit function derived above. The term $d\tau_c k$ reflects a depreciation allowance. Note that d may differ from δ because the tax code depreciation may not reflect theactual depreciation. (However, note that we require

[18] Since z is stationary, we effectively abstract from aggregate growth, hence macroeconomic aggregates will follow a deterministic path and converge to a steady-state.

a geometric depreciation schedule.) The term $(1-\tau_x)$ reflects an investment subsidy.

To solve the firm's problem, it is useful to write it in recursive term using the Hamilton-Jacobi-Bellman (HJB) equation:

$$rV(k,s,t) = \sup_x \left\{ \begin{array}{c} \Pi(k,s;w_t) + (x-\delta k)V_k'(k,s,t) - (1-\tau_x)\left(x + c(x,k)\right) \\ + \sum_{s'} \Lambda(s,s')\left(V(k,s',t) - V(k,s,t)\right) + V_t(k,z,t) \end{array} \right\}, \tag{12}$$

where I have defined

$$\Pi(k,s;w) = \pi(k,z(s);w)(1-\tau_c(s)) + d\tau_c(s)k. \tag{13}$$

The first-order condition of this problem is

$$(1-\tau_x)\left(1 + c_1(x,k)\right) = V'(k,s,t). \tag{14}$$

This equation implicitely defines the optimal investment policy function $x_t^*(k,s)$. Note that the dividend d_t of the firm (which can be negative, reflecting external finance) is:

$$d_t(k,z,s) = (1-\tau_c(s))\,\pi(k,z(s);w_t) + \tau_c(s)kd - (1-\tau_x)\left(x_t^*(k,s) + c(x_t^*(k,s),k)\right). \tag{15}$$

Finally, it is useful to note two implications of (12): first, substituting in the optimal x, we have

$$\begin{aligned}(r+\lambda(s))\,V(k,s,t) &= \Pi(k,s;w_t) + (x_t^*(k,s)-\delta k)V_k'(k,s,t) \\ &\quad -(1-\tau_x)\left(x_t^*(k,s) + c(x_t^*(k,s),k)\right) \\ &\quad + \sum_{s'=1}^{n} \Lambda(s,s')V(k,s',t) + V_t(k,z,t),\end{aligned}$$

where I defined

$$\lambda(s) = \sum_{s'=1}^{n} \Lambda(s,s'). \tag{16}$$

We can also obtain the envelope condition[19]

$$\begin{aligned}(r+\delta+\lambda(s))V_k'(k,s,t) &= \Pi'(k,s;w_t) + (x_t^*(k,s)-\delta k)V_k''(k,s,t) \\ &\quad -(1-\tau_x)c_2(x_t^*(k,s),k) + \sum_{s'=1}^{n} \Lambda(s,s')V_k'(k,s',t) + V_t(k,z,t).\end{aligned}$$

[19]This is obtained by differentiating 12 with respect to k and evaluating at optimal x.

Finally, the evolution of the cross-sectional distribution is governed by the Kolmogorov Forward Equation (KFE): denoting net capital accumulation by $n(k,s,t) = x(k,s,t) - \delta k$, we have

$$\frac{\partial g(k,s,t)}{\partial t} = -\frac{\partial}{\partial k}\left(n(k,s,t)\,g(k,s,t)\right) - \sum_{j=1}^{n}\Lambda(s,j)g(k,s,t) + \sum_{i=1}^{n}\Lambda(i,s)g(k,i,t), \tag{17}$$

which allows to solve for $g(k,s,t)$ given $g(k,s,0)$.

Aggregation We obtain the the aggregates implied by the firm optimization (given prices) by firms by summing over firms using the cross-sectional distribution of firms $g_t(k,s)$:

$$\begin{aligned} Y_t &= \int\int y_t(k,s)g_t(k,s)dkds, \\ X_t &= \int\int x_t(k,s)g_t(k,s)dkds, \\ N_t &= \int\int n_t(k,s)g_t(k,s)dkds, \\ D_t &= \int\int d_t(k,s)g_t(k,s)dkds, \\ K_t &= \int\int kg_t(k,s)dkds, \end{aligned}$$

where Y_t, X_t, N_t, D_t, K_t are aggregate output supply, investment demand, labor demand, dividends, and capital respectively.

Household We assume that there is a representative household who consumes and supplies labor, with utility

$$\int_0^\infty e^{-\rho t}U(C_t, N_t)dt. \tag{18}$$

This household owns the stock of firms in the economy, and can save in government bonds. Taxes are collected on his wage and interest income at rate τ_i, and on his dividend income at rate τ_d. (We abstract from capital gains tax for now.) All tax proceeds (including corporate tax revenue) are rebated lump-sum to the representative household, i.e. there is no government spending. We further assume that the government runs a balanced budget, and government bonds are in zero net supply.[20]

[20]This assumption is irrelevant for many experiments since Ricardian equivalence holds in this model.

The budget constraint reads:[21]

$$C_t + \frac{dB_t}{dt} = D_t(1-\tau_d) + H_t + r_t(1-\tau_i)B_t + w_t(1-\tau_i)N_t, \tag{19}$$

where H_t is the lump-sum rebate of taxes, so

$$H_t = w_t\tau_i N_t + r_t\tau_i B_t + D_t\tau_d + \tau_c TI_t, \tag{20}$$

where TI_t is corporate taxable income. Dividends and corporate taxable income are determined by aggregating over the distribution of firms, see below.

The household first-order conditions are:

$$\frac{U_2(C_t, N_t)}{U_1(C_t, N_t)} = w_t(1-\tau_i) \tag{21}$$

and the consumption Euler equation:

$$U_1(C_t, N_t) = e^{-\int_t^s (r_u(1-\tau_i)-\rho)du} U_1(C_s, N_s), \tag{22}$$

for all t, s, or in differential form

$$-\left(r_t(1-\tau_i)-\rho\right) = \frac{U_{11}(C_t, N_t)}{U_1(C_t, N_t)}\frac{dC_t}{dt} + \frac{U_{12}(C_t, N_t)}{U_1(C_t, N_t)}\frac{dN_t}{dt}. \tag{23}$$

Equilibrium The equilibrium is defined in the standard way: it consists of firm policy functions $\{n_t(k,s), y_t(k,s), x_t(k,s)\}$, firm value function $\{V_t(k,s)\}$, a distribution $g_t(k,s)$, and macroeconomic aggregates $(C_t, X_t, Y_t, K_t, D_t)$ as well as prices (w_t, r_t) such that: (i) the firm is maximizing its value, so policy functions solve the HJB equation; (ii) the value functions satisfies the HJB equation; (iii) the distribution $g_t(k,s)$ satisfies the KFE; (iv) the household is maximizing utilityl (v) markets clear, i.e. labor demand equals labor supply and the resource constraint of the economy holds,

$$C_t + X_t = Y_t. \tag{24}$$

[21]Here I simplify the notation by omitting the choice of how many shares of each firm to hold. In equilibrium, the representative household must own all shares at all dates, hence it has no effect on his budget constraint.

5.2 Parametrization

We use standard separable preferences:

$$U(C,N) = \frac{C^{1-\sigma}}{1-\sigma} - \frac{B}{1+\phi}N^{1+\phi}. \tag{25}$$

and the homogeneous-of-degree-one adjustment cost function:

$$c(x,k) = \frac{\psi}{1+\xi}k\left(x/k - \overline{\delta}\right)^{1+\xi}. \tag{26}$$

To be finished.

5.3 Simulated Tax Reform

To be added.

6 Conclusion

To be added.

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