NBER WORKING PAPER SERIES

TAX POLICY AND ABNORMAL INVESTMENT BEHAVIOR

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Working Paper 27363
http://www.nber.org/papers/w27363

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2020

The views expressed here are ours and do not necessarily reflect those of the U.S. Treasury Office of Tax Analysis, nor the IRS Office of Research, Analysis and Statistics. We thank Andy Abel, Heitor Almeida, Jediphi Cabal, Mike Devereux, Martin Feldstein, John Guyton, Jim Hines, Martin Jacob, Justin Murfin, Tom Neubig, Mitchell Petersen, Annette Portz, Jim Poterba, Josh Rauh, Lisa Rupert, Joel Slemrod, Michael Smolyansky, Amir Sufi, Toni Whited, and seminar and conference participants for comments, ideas, and help with data. We thank Thomas Winberry and Irina Telyukova for sharing code. We thank Tianfang (Tom) Cui, Laurence O'Brien, Iris Song, Caleb Wroblewski, and especially thank Francesco Ruggieri for excellent research assistance. Xu thanks the Mendoza College of Business at the University of Notre Dame and Gies College of Business at University of Illinois Urbana Champaign for financial support. Zwick gratefully acknowledges financial support from the Neubauer Family Foundation, the Initiative on Global Markets, and the Booth School of Business at the University of Chicago. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 27363
June 2020
JEL No. D21,D22,D92,G31,H25,H32

ABSTRACT

This paper documents tax-minimizing investment, in which firms tilt capital purchases toward fiscal year-end to reduce taxes. Between 1984 and 2013, average investment in fiscal Q4 exceeds the average of fiscal Q1 through Q3 by 37%. Q4 spikes occur in the U.S. and internationally. Research designs using variation in firm tax positions and the 1986 Tax Reform Act show that tax minimization causes spikes. Spikes increase when firms face financial constraints or higher option values of waiting until fiscal year-end. We develop an investment model with tax asymmetries to rationalize these patterns. Models without purchase-year, tax-minimization motives are unlikely to fit the data.

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How do taxes affect business investment? The importance of this question is widely recognized, as policymakers often invoke the contribution of investment to economic growth when proposing tax reforms. Such proposals presume a model of corporate behavior, usually based on the user cost framework of Hall and Jorgenson (1967). Yet recent studies have raised questions that the benchmark user cost model of a representative firm struggles to answer. Why do some tax instruments have large effects on investment, while others do not? What drives the heterogeneity across firms in responsiveness to tax changes? Reconciling these findings and revealing the underlying mechanisms remain goals of ongoing research.

This paper documents tax-minimizing investment, in which firms tilt capital purchases toward fiscal year-end to reduce taxes. We develop a new measure of investment behavior, which is simple, transparent, and orthogonal to low- and medium-frequency policy and firm-by-time shocks. This approach removes time-varying omitted factors coinciding with the identifying variation we exploit, thus addressing a key concern with existing empirical work. We demonstrate the importance of taxes for corporate investment behavior and further illustrate that tax asymmetry—in particular, the immediacy of the tax incentive—matters critically for understanding how firms respond. We conclude that models most likely to fit the data feature a purchase-year, tax-minimization motive.

The paper begins with a robust stylized fact about investment behavior among American public companies. Firms frequently tilt their investment toward fiscal year-end, leading to quantitatively significant spikes in capital expenditures (CAPEX) in the fourth fiscal quarter (Q4). This pattern is pronounced among firms across the size distribution and present in nearly every year between 1984 and 2013. Over the full sample period, fiscal Q4 CAPEX is on average 37% higher than the average of the first three fiscal quarters. The pattern is robust to non-December fiscal year-end, to changes in fiscal year-end, and to within-year seasonality of sales and cash flows. Moreover, fiscal Q4 investment spikes exist internationally. In data from 33 countries, fiscal Q4 spikes appear nearly universal during the period between 2004 and 2014. Although the magnitude of spikes varies across countries, the general pattern of Q4 spikes is robust.

We interpret Q4 investment spikes as the result of tax-minimizing behavior consisting of two connected motives. First, depreciation allowances are deducted from firms' pre-tax income and hence reduce their tax bill. Deduction conventions usually allow firms to deduct depreciation for year-end purchases as if the capital had been deployed halfway through the year. This feature creates a “depreciation motive” for firms to increase investment toward the end of the fiscal year and especially in the last quarter. Because purchases made later in the year face a lower effective after-tax price, firms making a fixed amount of investment are better off tilting that investment toward fiscal year-end than uniformly investing throughout the year.

Second, because tax positions can be better estimated close to fiscal year-end when most revenues and expenses for the year have been recorded, investing near the fiscal year-end allows firms to maximize the tax benefit of depreciation. We refer to this feature as the “option value motive” because firms have an incentive to wait and see how their tax position evolves during the fiscal year. If the year goes well, then they can increase investment at year-end to minimize their remaining tax burden. If the year goes poorly and the firm’s taxable income is already close to zero, then they will have less reason to invest in the current fiscal year to reduce taxes. The sharp nature of Q4 spikes allows us to show that these tax motives are driving an important part of this investment behavior. Both motives are necessary to rationalize our findings.

We use two research strategies to identify the link between tax minimization and Q4 investment spikes. The first strategy exploits the budget kink created by the asymmetry in corporate tax positions: when a firm moves from positive to negative tax position, the firm must defer the tax benefits of investment from the current year until some future year. To pursue this strategy, we combine Q4 CAPEX spike data from Compustat with tax position data from corporate tax returns for the years 1993 through 2010. Fiscal Q4 investment spikes are substantially higher when firms have an immediate incentive to offset taxable income with new investment rather than having to carry forward tax benefits to future years. Regression estimates show that within firm, a positive-taxable-income fiscal year has a spike between 6% and 11% higher than a negative-taxable-income fiscal year, which is large compared to the sample average of 37%. Additionally, taxable firms with large stocks of net operating loss carryforwards, which serve as an alternative tax shield, show significantly smaller Q4 spikes.

In the second research strategy, we study the effect of tax policy changes on investment spikes using the Tax Reform Act of 1986 (TRA86) in the U.S. Three components of TRA86 reduced firms’ tax-minimization incentive and as a result the potential size of fiscal Q4 investment spikes. First, the Investment Tax Credit (ITC), through which firms could receive reductions in tax liabilities as a percentage of the price of purchased assets, was repealed. Second, the top corporate income tax rate decreased significantly. Third, the Modified Accelerated Cost

Recovery System (MACRS) was introduced as the new depreciation system, under which new investment gets a lower depreciation amount per year.[1] Each change leads to lower tax benefits from new corporate investment and hence reduces the incentive for firms to tilt investment toward year-end. Consistent with a tax-minimization motive, regression estimates confirm that after 1987, fiscal Q4 investment spikes are 5 to 10 percentage points lower than before.

What type of firm is more inclined to employ a tax-minimizing investment strategy? Because firms relying heavily on internal funds to finance investment face higher effective discount rates, such firms should retime spending more strategically to save taxes and retain cash. We test this prediction by studying the effects of tax changes on investment spikes, while sorting firms based on different proxies for financial constraints. Regression estimates show that financially constrained firms conduct more tax-minimizing investment. Using a decomposition of the widely studied correlation between investment and cash flows, we show that tax-minimizing investment likely confounds the interpretation of the investment-cash flow sensitivity as a measure of financial constraints.

Firms facing higher option values for waiting until fiscal year-end to make investment decisions—those with longer average investment durations, those with positive earnings on average and less downside earnings volatility, and those that beat their analyst earnings forecasts—also show higher investment spikes. The analyst-forecast finding suggests that earnings management and tax planning are interconnected decisions. We also find supportive evidence that spikes are related to "Use it or lose it" budgeting incentives thought to characterize internal capital markets, though such incentives cannot explain differential behavior based on tax incentives.

To address whether Q4 spikes have longer-lasting effects, we study the cumulative impact of investment spikes on the level of investment. In other words, do Q4 investment spikes immediately reverse in the next quarter or two, such that the higher investment would not be detectable if aggregated over a slightly longer time frame? We follow average quarterly investment levels up to eight quarters after spikes in different fiscal quarters and confirm that investment spikes in Q3 and Q4 do not fully reverse in the immediate subsequent quarters. Firm-years with Q3 or Q4 spikes in year t show investment rates (relative to $t-1$ capital) that are 6% higher in year t and 12 to 17% higher in the next three years. Thus, we do not find

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[1] MACRS also directly targets spikes by applying a lower depreciation allowance for property placed in service when Q4 investment exceeds 40% of investment for the whole tax year.

evidence of immediate reversal of investment after spikes.

To isolate the impact of tax motives from underlying productivity shocks, we compare early-year (Q1–Q2) spikers to late-year (Q3–Q4) spikers under the assumption that the latter show higher investment for more tax-motivated reasons. Such late-year spikers show substantially more persistence of cumulative investment than early-year spikers, which implies that late-year spike persistence cannot be explained by productivity persistence alone. In addition, Q4 spikes are negatively autocorrelated over longer horizons, which further suggests a process with medium-term mean reversion rather than mechanical repetition of spikes each year with only short-term implications.

Taken together with the results on firms' characteristics—that we see higher spikes for firms in taxable position, for firms with higher profitability and lower downside volatility, and for firms more likely to face financial constraints—the cumulative persistence of investment following spikes likely reflects time-varying opportunities for firms to offset tax bills associated with positive earnings shocks. We examine this idea through the lens of a quantitative investment model that embeds a tax-minimization motive. The model helps clarify the intuition for the persistence of investment following spikes. Part of the persistence reflects the underlying persistence of productivity shocks. However, productivity cannot account for the stronger persistence in versions with tax asymmetries and the possibility of tax losses. A version of the model with a depreciation motive but no tax losses shows lower persistence than the full model, which reflects the increased option value of retiming investment when firms face a non-trivial risk of tax losses in future years.

In the last part of the paper, we trace through the implications of investment spikes for capital goods suppliers and lenders. In Census survey data from domestic manufacturers, spikes in aggregate capital goods shipments coincide with the months during which firms commonly have fiscal year-ends. These spikes propagate through production chains by inducing suppliers to accumulate inventories in advance of purchase spikes, a fact we confirm in both aggregate data and for suppliers linked to customers in the Compustat Segments Customer database. In commercial lending data from 2005 through 2014, the month of December sees significantly higher new business volume than other months, which validates firms' reported fiscal year-end investment spikes from the lending side of the market. In corporate financial statements, fiscal Q4 investment spikes are also associated with new debt issuance spikes. In contrast to these strong quantity effects, we find no effects on equipment prices or interest rates.

Research going back to Hall and Jorgenson (1967) has made much progress in characterizing the model of corporate investment behavior and estimating the effect of taxes on investment. Relative to this literature, which often focuses on measuring policy parameters, our goal is to help understand the underlying mechanism. In addition, because most research relies on quasi-experiments based on non-random tax changes, the extent to which estimated tax effects reflect unobservable firm or macroeconomic factors remains unclear. Our approach complements this work by focusing on a new measure of investment behavior that is orthogonal to low- and medium-frequency firm-by-time shocks.[2]

Prior research has also uncovered several anomalies with respect to the benchmark user cost framework. Studies of different tax instruments yield ostensibly conflicting results: Yagan (2015) finds dividend taxes do not affect corporate investment; Suárez Serrato and Zidar (2016), Ohrn (2018), and Giroud and Rauh (2019) find meaningful effects of tax rate changes on firm location, investment, and employment; and House and Shapiro (2008) and Zwick and Mahon (2017) find "bonus" and Section 179 depreciation incentives have a significant effect on investment. The response in Zwick and Mahon (2017) is more pronounced for small firms than for large firms, with investment decisions showing more sensitivity to immediate tax benefits than the standard model predicts. Edgerton (2010) uses financial accounting data to study the role of corporate tax asymmetries and finds less evidence that immediacy matters for public firms, while acknowledging measurement limitations may drive these results because financial accounts do not directly reveal public firms' tax positions.

Our findings contribute to this literature by confirming the importance of immediacy for tax effects and by highlighting how policy instruments that directly target investment behavior—such as depreciation incentives or investment tax credits—influence corporate decision-making. We use the permanent incentive caused by the half-year convention and the change in incentives following TRA86 to document these effects among large public companies. We propose a simple modification of the workhorse dynamic problem of the firm and show how this model can qualitatively and quantitatively account for the patterns in the data.[3] Promoting intertem-

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[2] The literature relying on policy-induced variation includes Cummins, Hassett and Hubbard (1996), Goolsbee (1998), Chirinko, Fazzari and Meyer (1999), Desai and Goolsbee (2004), House and Shapiro (2008), Edgerton (2010), Becker, Jacob and Jacob (2013), Yagan (2015), Ljungqvist and Smolyansky (2014), Zwick and Mahon (2017), Ohrn (2018), and Giroud and Rauh (2019). Hassett and Hubbard (2002) survey the early research and offer a consensus view, which is mostly consistent with subsequent findings.

[3] Key studies that propose models of how firms make investment decisions include Summers (1981), Hayashi (1982), Abel and Eberly (1994), Caballero and Engel (1999), Cooper and Haltiwanger (2006), and Winberry (Forthcoming). In a recent paper, Chen et al. (2019) use a lumpy investment model to study the relative efficacy

poral substitution of investment into the present from the future several years is a central motivation for many fiscal stimulus policies. Our results help explain why some firms are more responsive to stimulus and suggest that regimes in which the option value motive is stronger are likely to display greater responsiveness to such policies.

The outline of the paper is as follows. Section 1 explains the tax policies related to corporate investment and describes our data. Section 2 describes the fiscal Q4 CAPEX spikes both in the U.S. and other countries and examines the robustness of spikes to possible confounds. Section 3 establishes the link between tax minimization and fiscal Q4 spikes by exploiting firms' tax position and policy reforms in the U.S. Section 4 studies cross-sectional and dynamic drivers of tax-minimizing investment. Section 5 presents the model. Section 6 discusses additional implications of tax-minimizing investment behavior. Section 7 concludes.

1 Policy Background and Data

1.1 Policy Background

When making an investment, a firm is permitted a sequence of tax deductions for depreciation over a period of time approximating the investment's useful life. Allowable depreciation deductions offset the firm's taxable income, reducing its tax bill. The current U.S. tax code's schedule of depreciation deductions is specified by the Modified Accelerated Cost Recovery System (MACRS). MACRS assigns a recovery period and depreciation method for each type of property. The recovery period refers to the number of years it takes to completely depreciate the investment, while the depreciation method refers to the speed of depreciation.[4]

Averaging conventions establish when the recovery period begins and ends. The convention determines the number of months for which firms can claim depreciation in the year they place property in service. The most common convention for equipment investment is the half-year convention, where firms treat all property placed in service during a tax year as placed at the midpoint of the year. This means that a half-year's worth of depreciation is allowed for the year

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of policies that target fixed costs, such as investment tax credits, versus those that target marginal costs, such as corporate tax cuts.

[4] The common recovery periods for equipment investment are 3-, 5-, 7-, 10-, 15-, and 20-year. Structures are typically depreciated over 27.5 or 39 years. The most common depreciation methods for equipment are 200-percent declining balance and 150-percent declining balance, switching to straight-line. For structures, the depreciation method is straight-line. More detail is available in IRS publication 946.

the property is placed in service. Because the half-year convention applies even to investments made at the end of the year, the code creates an incentive for firms to accelerate the timing of investment purchases at the end of the fiscal year in order to realize the deductions a year earlier. In other words, the schedule creates a nonlinearity in the marginal incentive to invest near the end of the fiscal year because of discounting applied to the tax savings from future deductions. Our research design exploits this feature and the sharp behavior it induces to separate investment responses driven by the tax code from other confounding factors.

Our focus is primarily on tax policy that affects the incentive for large firms to invest during our sample period of 1984 to 2013 in the U.S., though we also study investment behavior in a sample of developed and developing countries. The U.S. passed the Tax Reform Act of 1986 (TRA86, enacted October 22, 1986) to simplify the income tax code and broaden the corporate tax base. Three key changes affected corporate incentives regarding CAPEX spending.

First, TRA86 abolished the Investment Tax Credit (ITC).[5] The ITC generates reductions in tax liability as a percentage of the purchase price of investments and reduces tax liabilities dollar-for-dollar. The ITC is not refundable, and thus is valuable for a firm only if there is a tax liability.[6] Between 1979 and 1985, the ITC was set at 10 percent for spending on business capital equipment and special purpose structures, which was considerably more generous than first-year deductions for most investments. By targeting investment directly, the ITC creates a strong incentive for firms to retime investment as a tax planning strategy. Thus, removal of the ITC reduced the incentive to wait to fiscal year-end to make tax-minimizing investments.

Second, the corporate income tax rate for the top bracket decreased significantly after 1987: the top rate dropped from 46% in 1984-1986 to 40% in 1987, to 34% in 1988-1992, and then remained at 35% in 1993-2013.[7] The decrease in the corporate income tax rate further reduced the tax-minimization incentive of CAPEX spending, as for a given amount of CAPEX, the reduction in tax liability is lower when the tax rate is lower.

Third, the depreciation system switched from the Accelerated Cost Recovery System (ACRS) to the Modified Accelerated Cost Recovery System (MACRS) after 1987. In general, MACRS lengthens the recovery periods for property. For example, automobiles and trucks had a depreciation schedule of 3 years under ACRS, but 5 years under MACRS; non-technical office

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[5] Starting with the Revenue Act of 1962, the ITC went through many rounds of major changes, including being suspended, reinstated, and eventually repealed in 1986.

[6] The safe-harbor leasing provision in the Economic Recovery Tax Act of 1981 allowed the sale of unused tax credits to firms with current tax liabilities, but it was eliminated at the end of 1983.

[7] Appendix Table A.1 provides detail of corporate income tax changes during 1984–2013.

equipment had a depreciation schedule of 5 years under ACRS, but 7 years under MACRS.[8] In addition, MACRS requires firms to use the mid-quarter convention if the total depreciable bases of MACRS property placed in service during the last 3 months of the tax year are more than 40% of the total MACRS property during the entire year.[9] For property placed in service during Q4, only 1.5 months of depreciation is allowed under the mid-quarter convention instead of 6 months of depreciation under the half-year convention.[10] The lengthening of depreciation periods and the mid-quarter convention requirement further reduced the incentive for tax-minimizing investment, as the same amount of investment leads to a smaller first-year depreciation deduction and lower initial tax savings after TRA86.

Table 1 illustrates the tax incentives for a \$100 investment in computers, comparing a scenario in which the firm places the investment on the first day of fiscal Q1 versus the last day of the previous fiscal Q4. All calculations assume a 7% discount rate and depreciate investment using the 200% declining balance method and half-year convention. In the post-TRA86 regime, accelerating the purchase accelerates the depreciation schedule by one year, yielding \$2.04 in net present value tax savings; in other words, the firm saves 2% by making the investment one day earlier. If firms use higher effective discount rates, the incentive to accelerate investment to fiscal Q4 will be even larger. The higher tax rate and shortened recovery periods in the pre-TRA86 period raises this benefit by 38% to \$2.82. The investment tax credit has a larger effect, raising the benefit by an additional \$0.66 to \$3.48. Thus, the overall benefit to accelerating the investment increases by 70% with pre-TRA86 parameters.

Other tax policy parameters can also interact with investment to affect firms' tax liabilities. For example, if investments are financed through equity, then dividend taxes will have a similar though more indirect effect through changing the cost of capital.[11] In addition, during the past

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[8] IRS publication 534. ACRS set up a series of useful lives based on 3 years for technical equipment, 5 years for non-technical office equipment, 10 years for industrial equipment, and 15 years for real property. MACRS lengthens the lives of property further for taxpayers covered by the alternative minimum tax (AMT).

[9] Excluding nonresidential real property, residential rental property, any railroad grading or tunnel bore, property placed in service and disposed of in the same year, and property that is being depreciated under a method other than MACRS. In our data, 16% of firm-years have Q4 CAPEX in excess of 40% of total annual CAPEX.

[10] A few factors make this 40% threshold less salient in the data. First, the threshold does not apply to structures or other property that is depreciated under a non-MACRS method, all of which are included in the CAPEX numbers in the financial statement. Second, the threshold does not apply to investments made by incorporated foreign subsidiaries, if the depreciation is instead taken overseas. The consolidated CAPEX in financial accounts includes both categories and may therefore overstate the investment spike relevant for domestic tax purposes. Third, the 40% threshold does not restrict "bonus" depreciation allowed under IRC Section 168(k), which will offset the lost depreciation from switching to mid-quarter for the residual, non-bonus investment basis.

[11] King (1977), Auerbach (1979), and Bradford (1981) theoretically analyze the difference in incentives for equity-financed and internally financed investments on the margin. In an empirical analysis of payout taxes,

two recessions, U.S. policymakers have introduced additional first-year (or "bonus") depreciation to stimulate investment and have expanded the Section 179 provision, which allows small and medium-sized businesses to fully deduct the cost of eligible purchases during the year of purchase. The 2% effective subsidy across quarters in Table 1 is similar in magnitude to the subsidy from 50% bonus depreciation.[12]

1.2 Data

Our primary sample includes Compustat U.S. firms spanning the years from 1984 through 2013. The sample excludes financial firms and utilities, as well as firm-years without quarterly capital expenditure (CAPEX) information. Firms with asset amounts less than $10 million are also excluded from the sample. The full U.S. sample includes 119,386 firm-year observations for 15,437 unique firms. On average, our sample represents 87% of the aggregate annual CAPEX of all Compustat firms.

Firms report year-to-date CAPEX in their quarterly 10-Q filings. To produce our primary measure of investment behavior, we first use this year-to-date data to back out CAPEX in each quarter. For example, in fiscal year 2012, U.S. Airways reports quarterly year-to-date CAPEX as: Q1 $87 million, Q2 $191 million, Q3 $428 million, and Q4 $775 million. Thus CAPEX for each quarter is: Q1 $87 million, Q2 $104 million, Q3 $237 million, and Q4 $348 million. The year-to-date format makes within-year changes in CAPEX less salient, though this example indicates strong bunching of investment in the last quarter of the year. We use the *Q4 spike* as our key measure of tax-driven investment behavior, defined as the ratio of Q4 CAPEX to the average of Q1 through Q3, which equals 243% in this case.[13]

Table 2 presents summary statistics for the sample of U.S. and international firms. For the U.S. sample, the average firm-year has $2.7 billion in assets and $172 million in CAPEX. The average Q4 spike is 137% (with median 119%), which indicates that Q4 CAPEX is 37% higher

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Yagan (2015) finds that investment did not respond to the 2003 dividend tax cut in the U.S.; Alstadsæter, Jacob and Michaely (2015) find that investment responds for cash-constrained firms following a dividend tax cut in Sweden.

[12] See, e.g., Zwick and Mahon (2017), Table 1. House and Shapiro (2008) and Zwick and Mahon (2017) study these programs in detail. Relative to the pre-TRA86 versus post-TRA86 comparison in Table 1, bonus depreciation only modestly raises the incentive to accelerate investment into fiscal Q4.

[13] This example suggests U.S. Airways may have crossed the 40% threshold at which point depreciation conventions switch from half-year to mid-quarter. This would be the case if all CAPEX included here were subject to the threshold, as a spike of 243% corresponds to a fourth quarter share of 45%. See discussion in Section 1.1.

than the average of CAPEX for the first three fiscal quarters.[14] In firm-quarter-level regressions of CAPEX with firm and calendar-quarter fixed effects, Q4 CAPEX exceeds Q1 CAPEX by 23%. In a simple investment model, the elasticity of investment with respect to the net of tax rate, $1-\tau z$, equals the price elasticity. Interpreting spikes as a response to the tax incentives in the system suggests elasticities in the range of 8 to 15.[15] As these estimates reflect a large degree of intertemporal substitution, it is not surprising the implied elasticities exceed conventional estimates from other settings.

Sales also display some Q4 periodicity due perhaps to the holiday season with a Q4 sales spike yielding a mean value of 112%. In Section 2, we demonstrate the robustness of the Q4 CAPEX spike to this seasonality in addition to a host of other potential confounds. Similar summary statistics are documented for international firms. Appendix Table A.2 provides detailed definitions for other firm characteristics.

For some analyses, we supplement the Compustat U.S. data with corporate tax returns from the Statistics of Income (SOI) division of the IRS Research, Analysis, and Statistics unit. Each year the SOI produces a stratified sample of approximately 100,000 unaudited corporate tax returns that includes all the largest U.S. firms.[16] We use these data to design sharp tests of whether the Q4 CAPEX spike depends on a firm's tax position as measured using tax accounting data.

We draw international evidence of Q4 CAPEX spikes from the Compustat Global database. Starting from 2004, Compustat Global collects quarterly CAPEX information systematically. We focus on countries with sufficiently available quarterly CAPEX information during the period of 2004–2014. Table 2(b) presents summary statistics for the sample of international firms. In total, 15,764 firms and 88,067 firm-year observations from 33 countries (excluding the U.S.) are included in our international sample.

We also draw from Compustat Segment data, which provide detailed information on segment structures and financial characteristics of each segment. We use these data to measure

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[14] Throughout the paper, Q4 CAPEX spikes are censored at 500 to ensure outliers are not driving our results. In addition, our graphical analysis focuses on medians to demonstrate representativeness and robustness of spike patterns.

[15] The 2.0% subsidy for five-year investments in Table 1 implies a net of tax rate subsidy (i.e., the change in the net of tax rate, or change in the tax term) of 2.9%. The subsidy is lower for longer-lived items because of the delay in their baseline depreciation schedules. Because we do not observe the asset mix of investment for Compustat firms, we cannot provide a more precise estimate and instead provide a range based on a 23% response and implied subsidies between 1.5% and 2.9%.

[16] Please refer to Zwick and Mahon (2017) for a detailed description of the data. We link these data using the EIN reported in publicly available corporate financial statements.

the corporate or budgetary complexity of firms.[17] In addition, we use Compustat Customer Segments data to identify corporate supplier and customer links for our sample of U.S. firms.

Finally, we draw data on equipment lending from the Equipment Leasing and Finance Association's (ELFA) Monthly Leasing and Finance Index (MLFI-25), aggregate investment from the Manufacturers' Shipments, Inventories, and Orders (M3) survey data from the Census Bureau, the Producer Price Index (PPI) from the Bureau of Labor Statistics, and interest rate data from RateWatch (part of S&P Global Market Intelligence). The MLFI-25 measures monthly commercial equipment lease and loan activity reported by participating ELFA member companies, which represents a cross-section of the equipment finance sector. The M3 survey provides monthly statistical data on economic conditions in the domestic manufacturing sector. The PPI program measures the average change over time in the selling prices received by domestic producers for their output. The RateWatch database provides detailed interest rate information for commercial equipment loans, commercial real estate loans, and personal loans.

2 Investment Spikes in Fiscal Q4

In this section, we document the size and persistence of Q4 CAPEX spikes and assess their robustness to potential measurement and reporting issues. Figure 1(a) presents the time series of fiscal Q4 investment spikes for U.S. firms in Compustat between 1984 and 2013. We plot the median ratio of quarterly CAPEX to the average CAPEX within a firm's fiscal year. The fourth quarters, indicated by red dots, consistently display higher CAPEX compared to the first three quarters. The fiscal Q4 spikes are relatively lower during the 2001 and the 2008 recession periods but remain above 100%.[18]

We conduct several robustness checks to confirm this behavior is both present and real. First, we show that steady growth cannot mechanically explain the magnitude of Q4 spikes. To account for the average fiscal Q4 spike of 137%, investment would have to grow 17.5% per quarter on average, implying a counterfactual amount of annual growth in investment. Figure 1(b) plots the quarterly median CAPEX level instead of the ratio, revealing a clear spike pattern

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[17] Following convention in the literature, we only keep segment information for firms whose segment data add up to more than 80% of the sales and CAPEX at the consolidated level.

[18] Figure 1(a) and other time series figures use the average within a firm's fiscal year as the denominator to demonstrate the robustness of this pattern at the aggregate level. In subsequent analysis, we use the average of the first three quarters as the denominator to permit an easier interpretation of investment effects, such as the effect of taxes on Q4 CAPEX.

inconsistent with a steady growth explanation.[19]

Second, fiscal year-end investment spikes are not driven by calendar-year seasonality and are still present for firms that do not display seasonality in cash flows or sales. In the U.S. sample, 57.1% of firms have fiscal year-ends in December, 10.4% in June, 8.2% in September, 7.4% in March, with the remaining 16.9% distributed across the other eight months. Figure 1(c) plots the time series of Q4 CAPEX spikes for firm-years with non-December fiscal year-ends. Fiscal Q4 CAPEX spikes still hold for the non-December subsample, alleviating the concern that calendar-time patterns drive year-end spikes. Figure 1(d) plots Q4 CAPEX spikes for firm-years with smooth cash flows, defined as having fiscal Q4 cash flows lower than the average of the first three fiscal quarters. Though partly attenuated, fiscal Q4 investment spikes remain robust after controlling for seasonality in cash flows.[20]

Third, Figure 1(e) isolates firms that move their fiscal year-end to six months later. The y-axis measures the ratio of quarterly CAPEX to average CAPEX in a firm-year. White bars indicate the fiscal year-end quarter according to the old regime, and orange bars indicate the fiscal year-end quarter after switching. CAPEX spikes transition to the new fiscal Q4 after the switch. The consistency of this pattern before and after the fiscal year-end change clearly demonstrates that CAPEX spikes are indeed related to the fiscal year-end.

Investment expenditures are not the only cost that firms can manage near fiscal year-end for tax purposes. The IRS allows firms to deduct R&D expenditures in the tax year when incurred. Firms may also claim the R&D credit against tax for certain qualified R&D expenditures and combine the credit as one component of the general business credit. Appendix Figure B.2 presents the time series of fiscal Q4 R&D spikes for U.S. firms in Compustat between 1989 and 2013.[21] The fourth quarters, indicated by red dots, consistently display higher R&D compared to the first three quarters, and the first fiscal quarter displays the lowest R&D within a year.[22]

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[19] In Appendix Figure B.1(a), we use the average of lagged-two-period to forward-two-period quarterly CAPEX as the denominator to calculate the spike ratio. This method is immune to discrete jumps in the denominator when moving across years. Fiscal Q4 spikes remain clear and large. Appendix Figure B.1(b) plots spikes with the average of Q4 and the next fiscal Q1 in the numerator of the spike measure. The graph reveals that, on average, the drop in fiscal Q1 investment only partially offsets the prior Q4 spike. We further explore the relationship between spikes and the level of investment in Section 4.3. We thank Mitchell Petersen for comments on how to address this concern.

[20] Appendix Figure B.1(c) shows the same pattern holds for firms with smooth sales.

[21] R&D is net of R&D related salary and benefit expenses, which is calculated at industry average according to the Business Research and Development and Innovation Survey (BRDIS) conducted by the National Science Foundation. We assume salary and benefit expenses are flat over four quarters in the same fiscal years. Fiscal Q4 R&D spikes remain robust when we include salary and benefit expenses.

[22] R&D spikes are smaller after 2001. We have confirmed this change in R&D spikes is not due to adjustment of

Last, we move to an international sample to show that fiscal Q4 CAPEX spikes occur nearly universally. For the period from 2004 to 2014, Figure 2 plots the time series of fiscal Q4 investment spikes for countries with at least nine years of data. In each plot, fiscal Q4s are indicated by red dots. We sort countries according to their average corporate income tax rate during the period—Switzerland has the lowest average corporate income tax rate (about 8%), while Pakistan has the highest (about 35%).

Across the 24 countries listed in Figure 2, we observe fiscal Q4 CAPEX spikes throughout. Countries such as Indonesia, China, and Mexico show the highest spikes, while the United Kingdom, Australia, New Zealand, and France show much lower spikes than average. Australia, New Zealand, and France use the effective life for property depreciation. For example, for property placed in service in the last month of a fiscal year, a firm only gets to depreciate 1/12 of the first year depreciation amount for the current tax year. The effective life method significantly reduces the tax savings from fiscal year-end investment. As a whole, the evidence from international data are remarkably consistent with the pattern prevailing in U.S. data. This suggests that factors more general than the specific U.S. institutional setting are responsible for Q4 CAPEX spikes.

3 Investment Spikes and Tax Policy

In this section, we present direct evidence that Q4 CAPEX spikes are driven by a tax-minimization motive. We pursue two complementary strategies. First and most direct, we show that firms consistently spike only when they are in the position to use depreciation deductions during the current tax year. Second, we show that the Tax Reform Act of 1986, which considerably reduced the marginal incentive to tilt investment to year-end, caused Q4 spikes to fall. Overall, the results reveal a clear role for tax motives in driving investment spikes.

3.1 Investment Spikes and Tax Position

We combine Q4 CAPEX spike data from Compustat with tax position data from corporate tax returns for the years 1993 through 2010. We follow Zwick and Mahon (2017) and define

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salary and benefit expenses in R&D calculation, reporting frequency, or outsourcing and firms' foreign sales. We leave further investigation of R&D spikes to future research.

D(taxable) as an indicator for whether a firm has positive income before depreciation expense and thus an immediate incentive to offset taxable income with additional investment.

Figure 3(a) plots the relationship between Q4 spikes and firm tax position. We divide firm-years into $1,000 bins based on their taxable income before depreciation expense is taken into account and plot for each bin the median Q4 CAPEX spike. The results starkly confirm the hypothesis that immediate tax position is a first-order driver of Q4 spikes. To the right of zero, the median Q4 spike is approximately 120% and considerably above 100% for all bins. To the left of zero, the median spikes are centered around 100% with no clear pattern above or below.[23]

Table 3 presents firm-level regressions designed to measure the size and robustness of the tax position result.[24] All regressions include firm and year fixed effects. Thus, the regressions measure spike responsiveness while only exploiting variation in a firm's tax position over time. Unlike regressions with the level of investment on the left-hand side, these regressions are considerably less subject to the concern that tax position and investment are jointly correlated with growth opportunities. Column (1) shows that a positive tax position leads firms to exhibit a spike that is 7.6% higher than for nontaxable firms, which equals 25% of the within-sample spike of 31% (relative to 100%, or no Q4 spike). Column (2) adds the following controls: ln(assets), Market-to-Book, Cash/Assets, CAPEX/PPE, and Sales 4/3. Even controlling for the level of investment does not materially alter the coefficient on tax position. Columns (4) through (7) show that the results are similar in the pre-2000 and post-2000 samples.

Column (3) adds a measure of cash flow (EBITDA/Assets) as an additional control, which reduces the coefficient to 2.9%. As cash flows may serve as a measure of the intensity of a firm's tax position, this regression likely "overcontrols" for confounding factors, causing a downward bias in the tax position coefficient. We include the regression because it suggests an alternative interpretation of the sensitivity between investment and cash flows, which has been used in countless studies going back to Fazzari, Hubbard and Petersen (1988) to measure financial constraints. Such a sensitivity may instead reflect a tax-minimization motive. We return to this idea in Section 4.1.

When filing tax returns, firms can deduct net operating loss carryforwards if they enter

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[23] The density of firm-year observations is relatively thin at levels below -$50M, which accounts for the wider variance in within-bin medians. In addition, the density exhibits bunching around $0, which precludes a regression discontinuity analysis at this point.

[24] Appendix Table B.2 presents regression estimates with alternative Q4 spike measures and delivers similar results.

the tax year with past losses (see IRS publication 536). Because loss carryforwards serve as an alternative tax shield, a firm with a large stock of carryforwards has a weaker incentive to accelerate investment for tax reduction. We examine this prediction in Figure 3(b) by plotting median Q4 CAPEX spikes for groups of firms sorted according to the ratio of lagged loss carryforward stock to current year net income before depreciation, while excluding firms in current tax loss position. The figure shows a strong negative relationship between the presence of this alternative tax shield and the size of Q4 spikes.[25]

3.2 Investment Spikes and the Tax Reform Act of 1986 (TRA86)

In the second research strategy, we study the effect of tax policy changes on investment spikes using TRA86. TRA86 repealed the Investment Tax Credit (ITC), decreased the top corporate income tax rate, and introduced the less generous Modified Accelerated Cost Recovery System (MACRS) for depreciation deductions. Each of these changes reduces the taxes saved given an amount of investment. The tax-minimization hypothesis thus predicts a weaker incentive to accelerate investment around the fiscal year-end and lower fiscal year-end spikes as a consequence.

We formally test this prediction in regression form and present estimates in Table 4.The coefficients of interest are on the dummy variable D(1984-1987), which indicates the corresponding years for the pre-TRA86 period in our sample and the phase-in year for the rate changes and ITC phase-out. Firm fixed effects are included in order to control for time-invariant firm characteristics. We also include firm financial characteristics such as the level of CAPEX/PPE, Sales 4/3, ln(assets), Market-to-Book, and Cash/Assets to control for the effect of contemporaneous non-tax shocks.

In general, analyses of tax regimes and investment suffer endogeneity issues, as tax reforms often respond to macroeconomic factors that could also affect investment. However, these endogeneity issues are more likely to concern the level of investment. Since we focus on the timing of investment within the same fiscal year, rather than investment levels, it is unlikely

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[25] Note that firms with loss carryforwards may still have an incentive to accelerate investment and thereby save carryforwards for the future. Our point is only that this incentive is weaker for these firms than for firms for which accelerating investment affects current taxes as well. Empirically, firms in all groups in Figure 3(b) have observed NOL deductions below their potential deductions, leaving positive taxable income to be offset by depreciation deductions. Thus, most of these firms are likely in the position to trade off the tax consequences of additional investment against taking larger NOL deductions.

that shocks affecting the level of investment would also systematically shift investment toward one part of the fiscal year. In particular, the identifying assumption is that in the absence of a change in tax motives to retime investment, we would not observe a difference before and after TRA86 in the share of investment taking place in fiscal Q4. This assumption is weaker than a common trends assumption, as it permits firm-by-time shocks that do not consistently coincide with the firm's fiscal year. Moreover, as shown in Section 2, two of the most likely alternative explanations—seasonality of cash flows and relabeling of investment purchases—cannot account for observed spike behavior.

We run regressions for different time periods for robustness. Columns (1) and (2) show regression estimates for the period of 1984 to 1992, as the corporate income tax rates after 1992 are slightly higher. Columns (3) and (4) show regression estimates for the period of 1984 to 2000. Columns (5) and (6) present regression estimates for the whole period of 1984 to 2013. In all six specifications, D(1984-1987) shows significantly higher fiscal Q4 spikes. On average, Q4 spikes drop by between 5.0 and 10.6 percentage points after TRA86, a large change relative to the mean Q4 spike of 37%. Columns (7) and (8) present regression estimates with the left-hand-side variable being a dummy variable indicating whether Q4 CAPEX is over the 40% threshold, which may trigger the mid-quarter convention requirement. The probability of firms passing the 40% threshold drops by between 1.6 and 4.3 percentage points, a modest but meaningful decrease relative to the 20.7% average before 1987.[26]

Figure 3(c) presents the dynamic response of Q4 spikes around TRA86 for the years between 1984 and 2000. We estimate regressions using the same sample and controls as Table 4, columns (3) and (4), and plot the year effects and confidence bands. The year 2000 is omitted as the benchmark year. The plot reveals a sharp decrease in average Q4 spikes beginning in 1987 and continuing to fall through the transition period in 1988 and 1989. During the transition, the corporate tax rate was higher for some firms with fiscal years ending in 1988 and the ITC was still available for some asset classes through 1989. In addition, Maydew (1997) documents income shifting immediately following TRA86 for public firms seeking to maximize net operating loss carrybacks, which may produce some post-TRA86 investment spikes. In the decade following the transition period, within-firm Q4 spikes are consistently lower than prior to TRA86.

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[26] Appendix Table B.3 shows that our TRA86 results are robust to alternative spike measures.

4 Cross-Sectional and Dynamic Drivers of Investment Spikes

This section explores how different factors influence the magnitude of fiscal year-end investment spikes across firms and within firms over time. We focus on factors likely to influence intertemporal decision-making either via the discount rate firms use to evaluate investment decisions or via the incentive to retime investment from the short- and medium-term future. We investigate whether investment spikes only reflect high frequency retiming of investment across fiscal quarters or instead combine high frequency and lower frequency adjustments in the capital stock. We also explore the interaction between tax-minimizing investment and other patterns of corporate behavior, asking what role earnings management and capital budgeting play in determining Q4 spikes.

4.1 Investment Spikes and Financial Constraints

Firms that face costly external finance should place a higher value on the tax savings associated with retiming investment, as they apply higher effective discount rates when trading off taxes paid this year versus in the future (Zwick and Mahon, 2017). We follow past literature and test this prediction by studying how tax-induced Q4 spikes vary among firms sorted according to five proxies for financial constraints: (1) ln(assets) where small firms are more constrained; (2) a non-dividend payer dummy; (3) a speculative grade bond rating dummy; and, following Faulkender and Petersen (2012), (4) a dummy variable indicating CAPEX exceeding internal cash flow, and (5) a dummy variable indicating CAPEX exceeding internal cash flow and not having an S&P rating.

Rather than studying the direct correlation between financial constraint measures and fiscal Q4 CAPEX spikes, which might be confounded by omitted factors, we interact the financial constraint measures with the time-series variation in Q4 spike incentives induced by TRA86. The high discount rate prediction suggests that the decrease in Q4 spikes following the tax change should be larger for financially constrained firms. Table 5, columns (1) through (5) confirm this prediction: firms that are more constrained experience a larger drop in their Q4 spikes after 1987. The estimate in column (1) implies that firms in the top quartile of ln(assets) reduced Q4 spikes by 1.4 percentage points, whereas firms in the bottom quartile reduced Q4 spikes by 8.9 percentage points.[27] In columns (2) through (5), the effects are consistently at

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[27] The top and bottom quartiles have mean ln(assets) equal to 8.25 and 3.42, respectively. Implied effects equal

least fifty percent larger for firms more likely to face financial constraints based on alternative proxies.

One implication of the tax-minimization incentive of firms' CAPEX spending for the study of financial constraints concerns the investment-cash flow sensitivity. A large literature in macroeconomics and finance studies how firm investment responds to changes in cash flow. The idea is that if firms rely more on internal funding for investment and hence are more financially constrained, their investment should display larger sensitivities to cash flow. Our paper provides an alternative explanation for investment-cash flow sensitivities—firms experiencing higher cash flows, which tend to correspond to higher taxable incomes, might invest more due to tax minimization. This argument resonates especially in the case of one-time or low-persistence shocks to cash flows and would hold even if cash flow shocks were uncorrelated with other drivers of investment, as long as those shocks come in pre-tax dollars.

To explore this idea, we decompose the conventional investment-cash flow sensitivity into different fiscal quarters and present the results in Table 6. To enable comparison to past work, in column (1) we replicate the annual investment-cash flow sensitivity analysis by showing a firm's CAPEX is positively related to its cash flow after controlling for Tobin's Q. As is standard, both firm fixed effects and year fixed effects are included to show the within-firm sensitivity. In columns (2) and (3), we decompose annual CAPEX into four quarters and run the same regressions but with cash flow interacted with dummy variables indicating different fiscal quarters. Column (2) interacts a fiscal Q4 dummy with Cash Flow/Assets. Column (3) interacts dummies for each fiscal quarter with Cash Flow/Assets. While the investment-cash flow sensitivity remains positive with a smaller magnitude, the fourth fiscal quarter displays sensitivities about twice as large as that of the first three quarters. A financial constraint hypothesis alone cannot account for the sudden spike in sensitivity—is the fourth quarter more financially constrained than the first three? The tax-minimization hypothesis offers a natural explanation.

4.2 Investment Duration, Earnings Volatility, and Earnings Management

This section considers dynamic factors that influence a firm's decision to accelerate investment. We study firm characteristics that tend to increase the option value associated with accelerating investment to minimize taxes and ask whether these factors indeed contribute to higher Q4

$14.24 - 1.56 \times 8.25 = 1.37$ and $14.24 - 1.56 \times 3.42 = 8.90$, respectively.

spikes on average.

Figure 4(a) presents a binned scatterplot of Q4 spikes for firms sorted by the average duration of equipment investment for a firm's respective industry. The measure is derived from the reciprocal of the present value of depreciation deductions (via Zwick and Mahon (2017) at the NAICS four-digit level) with higher values representing longer equipment investment duration. The intertemporal demand elasticity for longer lived items is higher when benefits of shifting investment are temporary (House and Shapiro, 2008). Consistent with this idea, median Q4 spikes are 10% to 20% higher for firms in long duration industries versus firms in short duration industries.

Figure 4(b) provides further supporting evidence of the idea that spikes represent a firm's decision to realize a tax-minimizing option in response to a temporary positive earnings shock. We estimate local projections at the firm-year level, regressing an indicator for a Q4 spike in a future year on an indicator for a Q4 spike in the current year. We include firm and year fixed effects to estimate the autocorrelation of spikes within-firm over time. The plot presents coeffients and standard errors from regressions for leads between one and ten years. In the year following a spike, the probability of spiking falls by 8 percentage points, which corresponds to a 20% reduction in the probability that a firm spikes in the next year. This decline weakens to approximately zero over time but remains low for several additional years. This fact suggests that spikes do not reflect a fully planned, repetitive budgeting process, instead they reflect a process with mean reversion and time variation in the value of spiking.

The option value motive suggests that investment spikes cluster in fiscal Q4 because tax positions can be better estimated close to fiscal year-end when most revenues and expenses for the year have been recorded. Figures 4(c) and 4(d) present binned scatterplots for firms sorted by the mean and volatility of earnings, measured by the within-firm mean and standard deviation of EBITDA/Assets. Firms with higher average profitability display higher Q4 spikes, with the relationship strongest nearer the loss region of the distribution. Interestingly, firms with higher volatility show lower Q4 spikes. This pattern can be reconciled by the fact that earnings variance tends to come from large negative shocks to earnings. Tax code asymmetries imply that only positive surprises should be correlated with investment spikes.

Given that expensing and depreciation affect book earnings, the effect of Q4 spikes on book earnings would provide incentives or disincentives for corporate investment depending on a firm's book earnings position. Figure 5 presents a binned scatterplot of firm Q4 CAPEX spikes against Q4 earnings surprises. The vertical line with earnings surprise equal to zero indicates that firms exactly meet the median analyst forecast.[28] Firms clearly tend to beat the analyst earnings forecasts, and firms that meet or beat their analyst forecasts conduct more tax-minimizing investment. More generally, we see a positive relationship between earnings and Q4 spikes, consistent with the within-firm analysis above. When we regress the magnitude of spikes on an indicator for whether the firm beats or meets its earnings forecast, the effect size is approximately 5 percentage points. The result suggests that earnings management and tax planning are connected decisions, with an active trade-off margin operating between them.

4.3 The Cumulative Effect of Investment Spikes

To what extent do these spikes reflect only high-frequency retiming of investment versus a longer-lasting cumulative change in the level of investment? Answering this question serves two purposes. The first is to address whether year-end spikes have medium- or long-term implications beyond the quarter after a spike occurs. The second is to provide more evidence that spikes reflect time-varying opportunities for firms to offset tax bills associated with positive earnings shocks. As we move from looking at the timing of investment to looking at its level, it is important to keep in mind the possibility that certain omitted variables affecting the firm's investment opportunity set might still be at play. We take several approaches below to address this potential concern.

Figure 6 plots in event time the ratio of average quarterly CAPEX from the beginning of the spike year to the current quarter relative to a baseline, which we define as the average quarterly CAPEX in the year before the spike year. We plot this cumulative investment series separately for firms with large spikes in fiscal Q1, Q2, Q3, and Q4, respectively. Large spikes are defined as CAPEX Q/Ave(Q1–Q4) exceeding 113.65%, the sample median Q4 spike level.[29] The dotted lines indicate 95% confidence intervals. We follow average quarterly CAPEX relative to baseline up to two years after the spike year. For fiscal Q1 and Q2 spikers, the ratio reverses within 1 or 2 quarters and becomes statistically indistinguishable from 100%. In contrast, fiscal Q3 and Q4 spikers show a persistent and statistically significant increase in investment after the spike quarter, with the average investment level remaining at approximately 200% relative to the

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[28] Using the mean or median analyst forecasts generates very similar results.

[29] Though early-year spikes are less common than late-year spikes, the early-year spike sample is not prohibitively small. Fiscal Q1, Q2, Q3, and Q4 spikers account for 22%, 26%, 28%, and 50% of observations within their respective quarters.

baseline by the end of the post period.[30]

Figure 6 suggests that high-frequency intertemporal shifting cannot fully account for the higher level of investment in end-of-year CAPEX spikes. Table 7 presents firm-level regression estimates to measure the differential increase in investment level between Q1–2 and Q3–4 spikers. We examine the CAPEX level from one year before to three years after large spikes, normalized by total capital (PPENT) in the year before spikes. All regressions include event fixed effects and year fixed effects. Thus, the regressions compare within-event investment levels around large spikes, with the year before large spikes serving as the omitted benchmark. We examine the level for each year for fiscal Q1–2 spikers in columns (1) and (2) and Q3–4 spikers in columns (3) and (4), and then estimate the difference in a pooled regression in columns (5) and (6). Columns (2), (4), and (6) add Market-to-Book, Cash/Assets, and EBITDA/Assets as additional controls to absorb the impact of time-varying firm characteristics and investment opportunity shocks on investment levels.

Firm-years with large CAPEX spikes indeed experience higher investment levels compared to pre-spike years, and the increases in investment level are persistent and do not reverse even after three years. Interestingly, Q3–4 spikers display a much stronger increase in investment level compared to Q1–2 spikers. We formally investigate the statistical difference across these two subgroups in columns (5) and (6) of Table 7. The coefficient estimates of the interaction terms *Q34 Spiker* remain statistically positive and quantitatively significant from the spiking year until three years after, confirming the higher investment levels by Q3–4 spikers after large spikes. Adding additional firm controls does not alter this conclusion. Figure 6(e) plots the coefficient estimates with 95% confidence intervals for these two subgroups to demonstrate this difference graphically.

The differential responses in investment level are consistent with the tax-minimization hypothesis in the following sense. While potential confounding shocks such as large investment opportunities are likely evenly distributed across fiscal quarters, Q3–4 spikers face a stronger tax-minimization motive relative to Q1–2 spikers, resulting in higher investment levels that do not immediately reverse in the subsequent few fiscal years. This effect operates in addition to the likely effect of persistent productivity shocks, which can account for the weaker but positive persistence of investment for Q1–2 spikers but not for the differential persistence when

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[30] Appendix Figure B.3 plots each quarter's CAPEX relative to the average quarterly CAPEX in the year before spikes, confirming that averaging CAPEX does not drive the observed investment persistence following large spikes.

comparing Q1–2 spikers to Q3–4 spikers.

We interpret this fact as reflecting both the depreciation and option value motives. Firms that face a temporary opportunity to invest and reduce their tax burden will increase investment this year. Because investment is a long-lived asset, they may substitute investment from several years in the future, which results in persistent investment levels when cumulated over subsequent years. House and Shapiro (2008) apply this logic to understand the response of long-lived investment to temporary investment incentives. In our setting, it helps us understand why corporate investment appears to respond to time-varying tax incentives arising from the interaction of the low after-tax price and time-varying firm profitability. We explore this logic further in the context of the model in Section 5.

4.4 Investment Spikes and Internal Capital Markets

An alternative explanation for the Q4 CAPEX spikes is related to firm budget cycles. Many firms have budgets expiring at the end of fiscal years, where accounts will be set lower subsequently if budgets are not spent. Those firms face a "Use it or lose it" dilemma. Moreover, in some firms, evaluation of employee or manager performance might also be linked to budget spending, where more spending can be interpreted as better performance. These factors create an incentive for firms to rush to spend budgets near the fiscal year-end. Oyer (1998) connects seasonal sales patterns to year-end incentive contracts among salespeople and executives. Shin and Kim (2002) show that large, cash-rich and diversified firms spend more CAPEX in Q4, suggesting agency costs in investment decisions. Similar year-end "rush to spend" behavior has been observed in other organizations. Liebman and Mahoney (2017) study spikes in year-end procurement spending for the U.S. federal government and show that expiring budgets lead to wasteful year-end spending, while an agency that has the ability to roll over the unfinished budget does not exhibit year-end spending spikes.

Due to the lack of firms' budget data, a direct test of the budget hypothesis is not viable. As an alternative, we study different measures of budgetary complexity. If the rush in fiscal year-end CAPEX spending is true, then we would expect it to be more pronounced in firms with more complex budgetary structures where budgets across different divisions cannot be uniformly managed. We test this idea and present the results in Table 8.

We use two different measures to capture the complexity of a firm's budgetary structure:

the number of segments and the number of two-digit SIC codes in the corporate segment. The variation explored in Table 8 is mainly cross-sectional and all measures are standardized for easy interpretation. Because complexity is increasing in firm size, we condition on size to measure the impact of complexity within firm-size groups. Table 8 shows that firms with more complex budgetary structures indeed display higher Q4 spikes—a one standard deviation increase in the complexity measures leads to a 1.6% to 2.6% increase in fiscal Q4 CAPEX spikes. The economic magnitudes of the effects shown in Table 8 are somewhat smaller than our estimated tax effects, but this finding may reflect our inability to measure budget incentives directly. We therefore interpret this result as suggesting that "Use it or lose it" incentives are likely contributing to Q4 spikes, though such incentives cannot explain the responsiveness of spikes to tax changes.[31]

5 A Dynamic Model of Tax-Minimizing Investment

This section develops a dynamic model of investment in the presence of a tax motivation to accelerate investment. We examine how different factors influence the magnitude of fiscal year-end investment spikes and use the model to understand the persistence of cumulative investment following spikes.

Beginning with a discrete time, neoclassical investment model with adjustment costs (Abel, 1982; Hayashi, 1982; Winberry, Forthcoming), we introduce predictable time variation in the value of the investment tax shield. We calibrate the model to match partial equilibrium investment moments quantitatively. We then apply the model to answer two questions. First, can a standard calibration deliver investment spikes that are quantitatively comparable to those observed in the data? Second, what is the relative importance of the depreciation motive and option value motive in accounting for the evidence, especially the persistence of cumulative investment following spikes?

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[31] We investigated whether the tax status results are either mitigated or amplified by "use it or lose it" motives. To do this, we estimated regressions like in Table 3 but interacting tax status with proxies for firm complexity. We do not find the tax position effects are meaningfully different for more complex firms. While consistent with the idea that strong tax incentives appear more important than firm complexity effects for spike behavior, exploring these forces with better measurement of "use it or lose it" incentives would be an interesting avenue for future research.

5.1 Model

The model follows Winberry (Forthcoming), modified to include a tax asymmetry, the half-year convention for depreciating current year investment, and four sub-periods within the fiscal year. Firms choose labor n and capital k to maximize profits. The labor choice is static, given by:

$$n(k,\varepsilon) = \underset{n}{\operatorname{argmax}}\left\{e^{\varepsilon}k^{\theta}n^{\nu} - wn\right\} = \left(\frac{\nu e^{\varepsilon}k^{\theta}}{w}\right)^{\frac{1}{1-\nu}}, \quad \theta + \nu < 1$$

where ε is a productivity shock and $\theta,\ \nu$, and w are parameters. Productivity evolves according to the AR(1) process:

$$\varepsilon = \rho\varepsilon_{-1} + \xi,$$

where $\xi \sim \mathcal{N}(0,\sigma_{\varepsilon}^{2})$, $|\rho| < 1$.

Investment, i, yields capital for next period according to the law of motion, $k' = (1-\delta)k + i$. Adjustment costs follow the standard convex form, $-\frac{\phi}{2}\left(\frac{i}{k}\right)^{2}k$. The model abstracts from fixed costs to focus on the dynamics from a richer tax environment, which is sufficient to match most of the empirical results.

Profitability depends on productivity and an additional random term, ω, that provides a simple way to generate both a left-skewed distribution of profitability to fit the Compustat data and a significant mass of firms in tax loss position to fit the tax data. ω can be thought of as either a random overhead fixed cost or accounting adjustment, which creates the possibility the firm experiences operating losses. Define the firm's gross operating surplus (GOS) prior to depreciation deductions as:

$$GOS(k,\varepsilon,\omega) = e^{\varepsilon}k^{\theta}n(k,\varepsilon)^{\nu} - wn(k,\varepsilon) + \omega.$$

The firm's tax bill equals a linear tax τ on taxable income, defined as GOS less depreciation deductions, if taxable income is positive and zero otherwise: $TB = \tau \max\left\{TI, 0\right\}$. Tax asymmetries interact with the left-skewed profitability process, jointly determined by ε and ω, to generate rich investment dynamics across firms and within firms over time.

Each fiscal year has four quarters: Q1, Q2, Q3, and Q4. For tax purposes, the firm accumulates quarterly realizations of gross operating surplus and investment expenditures, which jointly determine the firm's end-of-year tax position and reset after Q4. The current stock of gross operating surplus, g, evolves as $g' = g + GOS(k,\varepsilon,\omega)$ in Q1 through Q3 and $g' = 0$ in

Q4.

In the first three quarters, the firm faces no tax obligations, so its choice of investment only affects deductions made at the end of the year. Taxable income in all quarters is given by:

$$\text{(Q1–Q3)}\quad TI \equiv 0 \qquad\qquad \text{(Q4)}\quad TI \equiv (g + GOS) - 4\hat{\delta}\bar{k} - 2\hat{\delta}\left(\hat{k} - \bar{k} + pi\right),$$

where $\hat{\delta}$ is the rate of tax depreciation, p is the constant market price of investment, $\hat{k}$ is the current depreciation stock, and $\bar{k}$ is the start-of-year depreciation stock carried over from last fiscal year. Both depreciation stock variables are necessary because of the half-year convention, which treats depreciation stocks accumulated in the current year differently from those carried over from past years. The depreciation stock evolves based on the rules for deductibility during the fiscal year:[32]

$$\text{(Q1–Q3)}\quad \hat{k}' = \hat{k} + pi \qquad\qquad \text{(Q4)}\ \hat{k}' = (1 - 4\hat{\delta})\bar{k} + (1 - 2\hat{\delta})(\hat{k} - \bar{k} + pi).$$

We can now write the recursive firm problem for each quarter. The firm's state variables are the capital stock k, start-of-year and current stock of depreciation deductions $\bar{k}$ and $\hat{k}$, productivity ε, profitability shifter ω, and cumulative gross operating surplus g. The value functions in the first three quarters are defined by the Bellman equation:

$$\begin{aligned} V^N(k, \hat{k}, \bar{k}, g, \varepsilon, \omega) = {} & GOS(k, \varepsilon, \omega) \\ & + \max_i \left\{ -pi - \frac{\phi}{2}\left(\frac{i}{k}\right)^2 k + \beta \mathbb{E}_{\varepsilon'|\varepsilon,\omega'} V^C(k', \hat{k}', \bar{k}', g', \varepsilon', \omega') \right\} \\ \text{s.t.}\quad & \hat{k}' = \hat{k} + pi \qquad k' = (1-\delta)k + i \qquad \bar{k}' = \bar{k} \\ & g' = g + GOS(k, \varepsilon, \omega) \qquad i \geq 0, \end{aligned} \tag{1}$$

where $V^C(\cdot) = V^N(\cdot)$ for Q1 and Q2 and $V^C(\cdot) = V^T(\cdot)$ for Q3, marking the transition to when taxes are determined and paid. The value function in the last quarter is defined by the Bellman

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[32] For tractability, we do not model tax loss carryforwards or carrybacks across fiscal years, so deductions unused in a particular year are lost. As long as loss offsets are partial or occur with a delay, the incentive to use investment to reduce taxes will be stronger if the firm is currently taxable.

equation:

$$\begin{aligned}
V^T(k',\hat{k}',\bar{k},g',\varepsilon',\omega') &= GOS(k',\varepsilon',\omega') \\
&\quad + \max_{i'}\Big\{-\tau\max\left\{g'+GOS(k',\varepsilon',\omega')-4\hat{\delta}\hat{k}'-2\hat{\delta}\left(\hat{k}'-\bar{k}+pi'\right),0\right\} \\
&\qquad -pi'-\frac{\phi}{2}\left(\frac{i'}{k'}\right)^2 k'+\beta\mathbb{E}_{\varepsilon''|\varepsilon',\omega''}V^N(k'',\hat{k}'',\bar{k}'',g'',\varepsilon'',\omega'')\Big\} \\
\text{s.t.}\quad & \hat{k}''=(1-4\hat{\delta})\hat{k}'+(1-2\hat{\delta})(\hat{k}'-\bar{k}+pi') \\
& k''=(1-\delta)k'+i' \qquad \bar{k}''=\hat{k}'' \qquad g''=0 \qquad i'\geq 0.
\end{aligned} \tag{2}$$

We note two differences between the Q1-to-Q3 value functions (1) and the Q4 value function (2). First, the investment decision affects current taxes in (2), but only affects future taxes in (1). As a result, the after-tax price of investment is effectively higher in (1). Second, the continuation values deterministically alternate between (1) in Q3 and (2) in Q4, such that firms know which problem they face in the next period and thus how uncertainty over their profitability will be resolved. These features combine to create an incentive to tilt investment toward the end of the fiscal year and especially into the last quarter.

We compare this full model to a baseline model in which depreciation deductions start whenever the investment is made, and in which even firms with losses receive tax credits for depreciation. In this case the firm's problem is identical each quarter and defined by the Bellman equation:

$$\begin{aligned}
V(k,\hat{k},\varepsilon,\omega) &= GOS(k,\varepsilon,\omega) \\
&\quad + \max_{i}\Big\{-\tau\left[GOS(k,\varepsilon,\omega)-\hat{\delta}(\hat{k}+pi)\right]-pi-\frac{\phi}{2}\left(\frac{i}{k}\right)^2 k+\beta\mathbb{E}_{\varepsilon'|\varepsilon,\omega'}V(k',\hat{k}',\varepsilon',\omega')\Big\} \\
\text{s.t.}\quad & \hat{k}'=(1-\hat{\delta})(\hat{k}+pi) \qquad k'=(1-\delta)k+i \qquad i\geq 0.
\end{aligned} \tag{3}$$

The baseline model removes all "depreciation motives" driving spike behavior, including the tax asymmetry, the half-year convention, and the disconnect between when taxes net of depreciation deductions are due and when investment expenditures occur.

The value functions for the full model show how the incentive to use investment to minimize taxes is stronger at year-end because there is no uncertainty about the firm's tax position as a function of investment. We refer to this feature as the "option value" motive because firms have an incentive to wait and see how their tax position evolves during the fiscal year. If the year goes well, then they can increase investment at year-end to minimize their remaining tax burden. If the year goes poorly and the firm's taxable income is already close to zero, then they will have less reason to increase investment in the current fiscal year to reduce taxes.

The option value motive is not relevant when firms are always taxable. In this case, they face a similar problem every year. In the model with $\omega = 0$ and under the standard calibration, firms rarely find themselves in tax loss position. We therefore use an $\omega = 0$ version to measure the relative importance of the option value motive versus the depreciation motive for spike levels and persistence.

5.2 Solution and Calibration

We solve the model by value function iteration and then simulate investment and capital paths for 10,000 firms with different productivity shock paths over $T = 500$. We use the following parameters from Winberry (Forthcoming): output elasticities $\nu = 0.64$ and $\theta = 0.21$, discount rate $\beta = 0.975$, productivity persistence $\rho = 0.9$, the standard deviation of productivity $\sigma_{\varepsilon} = 0.08$, and convex adjustment costs $\phi = 2.95$. We parametrize ω as a scaled Bernoulli variable with arrival probability of 0.17 and scale upon arrival of -0.5, jointly chosen to match (1) the share of firms with negative gross operating surplus to the distribution of profitability in our Compustat data and (2) the share of firms with negative taxable income in Q4 to the distribution of tax losses in our tax data. In the Compustat data, the coefficient of variation for this variable is 1.8, while its simulated analogue (GOS/Assets) has coefficient of variation of 1.7. The simulation generates a nontaxable share of 30%, compared to 31% for our matched analysis sample.[33] Notably, when we simulate the model with $\omega = 0$, the nontaxable share is approximately zero. Thus, our calibrated productivity process matches the underlying variance of earnings and taxable income better than the standard model in the literature.

We also follow Winberry (Forthcoming) and set economic depreciation $\delta = 0.025$ per quarter and tax depreciation $\hat{\delta} = 0.119$ to match a 10% aggregate CAPEX/Assets ratio in the data and the statutory depreciation schedule, respectively. The standard deviation of annual investment relative to assets is 0.06 in the simulation compared to 0.13 in the data, likely reflecting the fact that the model does not feature the mix of long and short duration investment present in the data. The tax rate is $\tau = 0.35$, the top statutory rate at the end of our sample.

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[33] Relative to the 36% net operating loss share in Zwick (Forthcoming), the empirical nontaxable share is lower here because (1) it is computed before depreciation deductions and (2) it only includes public companies.

5.3 Results

Figure 7 plots the ratio of average investment in each quarter to average investment in the whole year, indicating that the model is able to match the data's quantitatively large spikes at the end of the fiscal year. We plot results for three versions of the model following the parameterization above, a "Baseline" version without depreciation motives (as in (3)), a "Depreciation" version that adds depreciation motives but removes the profitability shifter from the model, and a "Full" version that reintroduces the profitability shifter and thereby the option value motive for spikes.

The Depreciation model yields larger spikes than the Full model because of differences across the model in simulated tax positions. In particular, $\omega = 0$ firm-years almost never experience tax losses, as they are able to adjust variable inputs to offset the effect of negative productivity shocks. In contrast, approximately thirty percent of Full model firm-years experience tax losses, which attenuate the tax-minimization motive. Consistent with tax policy-induced spikes, the Baseline model shows no systematic spike patterns.

We compute tax-policy-relevant comparative statics using model simulations after solving the model for different parameter values (Appendix Table B.4). The results confirm the basic intuition that spikes depend on the value of investment as a tax shield. This intuition emerges clearly upon comparing the firm problems between the first three quarters (1) and the last quarter (2). As the tax rate approaches zero, the decision problems converge. Thus, spikes are increasing in the tax rate and approach zero when the tax rate is low. Investment spikes are also increasing in the speed of tax depreciation for investment purchases. Third, investment spikes are larger in a version of the model that adds a non-refundable, 10% investment tax credit on top of accelerated depreciation.

Figure 8(a) uses the three versions of the model to decompose the persistence of investment spikes into contributions from the depreciation versus option value motives. For each model version, we first sample ten spike events per simulated firm sequence and then order the data in event time relative to the spike. Spikes are defined as investment ratios (Q4 investment divided by Q1–Q4 average) greater than the sample median. For each event, we compute cumulative average investment beginning in Q1 of the spike year and scale this cumulative series by the average investment rate across all simulated quarters in that event's respective model version, which serves as a measure of benchmark investment within the model. We then regress scaled cumulative investment on event time dummies and control for productivity with indicators for each level of productivity. These controls remove the effect of productivity persistence from the model simulations. We also control for the size of the initial spike interacted with event time dummies to control for different mean spikes across model versions.

Figure 8(a) plots the coefficients from these regressions for the Baseline, Depreciation, and Full models for a sample of simulated firm events. For the Depreciation and Full models, coefficients remain above zero and only partly reverse after the spike quarter. For the Baseline model, the coefficients decline quickly after the spike event and indicate short-run mean reversion. This pattern reflects the fact that spikes in the Baseline model, while rare, occur when the firm experiences a string of positive and increasing productivity shocks, which tend to reverse in subsequent periods. In contrast to this pattern, both model versions with tax motives display cumulative investment effects in excess of that predicted by the underlying productivity process.

The Full model displays larger persistence of spike-year investment with a coefficient in period 12 of 23% compared to 10% for the Depreciation model and -16% for the Baseline model. The graph displays these results for one particular sample of firm events, so to demonstrate their robustness, we generate a distribution of cumulative effects by bootstrapping these coefficients over 1,000 iterations. The mean period-12 effect in the Full model is 29.4% (s.d.=4.1), which considerably exceeds the effect in the Depreciation model of 4.9% (s.d.=3.4) and in the Baseline model of -14.7% (s.d.=2.3). The Depreciation model delivers persistence of spike-level investment approximately halfway between the Baseline and Full models. The model therefore implies the depreciation and option value motives each account for half of the post-spike persistence in investment in excess of that accounted for by underlying productivity persistence.

Figure 8(b) plots an alternative approach to demonstrating the importance of tax motives for the persistence of investment following spikes. We use simulations from the Full model to construct analogous regression coefficients to Table 7, column (5) for investment levels following Q3–Q4 and Q1–Q2 spikes. We then plot the cumulative difference in investment levels for late-year spikers less that for early-year spikers. Consistent with the empirical evidence, the plot shows the simulated model generates more investment persistence when spikes happen at the end of the year—which are more likely to be driven by tax motives—than when they happen at the start of the year—which are more likely to be driven by the evolution of productivity shocks.

The model helps clarify the intuition for the persistence of investment following spikes documented in both the data and model simulations. Part of the persistence reflects the underlying persistence of productivity shocks. However, productivity cannot account for the stronger persistence in the Full model versus the Baseline and Depreciation models. This fact reflects the increased option value of retiming investment when firms face a nontrivial risk of tax losses in future years. Baseline and Depreciation model firms do not face this risk, so investment spikes only reflect productivity shocks in the Baseline model and how productivity interacts with the time-varying, after-tax price of investment in the Depreciation model. In other words, investment spikes persist because the fiscal year-end is a "good time" to invest when the returns to investment are high—in the Depreciation model, it is a good time because the price is low; in the Full model, it is a good time because the price is low *and* there is a nontrivial chance the price will be higher in the coming years.

Figures 8(c) and 8(d) compare the three models in terms of the mean and variance of profitability. The Full model successfully matches the relationship in the data for both the within-firm earnings mean and variance. In the Depreciation model, these relationships are weaker or absent in the case of earnings volatility and of the wrong sign in the case of earnings means. Importantly, the Baseline model cannot match these relationships, which underscores the likely importance of tax asymmetries and immediate tax benefits in generating the empirical patterns we observe.

6 Implications of Tax-Minimizing Investment Behavior

6.1 Supply Effects via Inventories and Capital Goods Prices

In Figure 9 we study the within-year spiking patterns for aggregate capital goods shipments, total inventories, and prices. Data is obtained from the manufacturer shipments, inventories, and orders (M3) survey from the Census Bureau (1958–2016) and the Producer Price Index (PPI) from the Bureau of Labor Statistics (1998–2016). Panel (a) presents the comparisons between non-defense capital goods shipments and consumer goods shipments. For non-defense capital goods, the month of January consistently has the lowest shipment value, approximately 85% of the level for the year on average. March, June, September, and December, commonly used as fiscal year-ends, display significantly higher shipment values compared to other months.

The largest spikes occur in December at 112% and June at 110%, which correspond to the most common fiscal year-ends among firms in the Compustat sample. Importantly, we do not observe similar patterns for consumer goods, where tax incentives do not play a role.

In Figure 9(b), we examine whether capital goods suppliers build up inventories in anticipation of higher demand in Q4 by tracing the comovement between shipments and total inventories. The plot shows modest evidence of inventory buildup leading shipment spikes by approximately one month. Taking Q4 as an example, total inventories start to increase in October and peak in November in anticipation of the December shipment spike, then return to the average level in December. Overall within-year variation of inventories is smaller than for shipments, with the largest spikes shown in November at 102.3%. As for shipments, inventories are also lower in Q1, with January consistently displaying the lowest inventory value at 97.4%.

Figure 9(c) presents the within-year seasonality of shipments and capital goods prices measured by the PPI. The PPI records the selling prices received by domestic producers for their output and is linked to M3 using M3/NAICS-6 industry composition from the US Census.[34] We aggregate PPI ratios across all 15 M3 categories weighted by the shipment value of each category.[35] While shipments spike in March, June, September, and December, price indexes remain stable throughout the year. Thus, the spikes in sales and shipments are not associated with price fluctuations for capital goods.

Table 9 presents formal tests of the within-year seasonality captured in Figure 9 and the relation between capital goods shipments and prices. For each variable, we compute the ratio of the monthly value to the average monthly value within that month's calendar year to focus on within-year variation. In columns (1) and (2), the coefficient estimates on quarter-end months are above 20%, consistent with the large spikes in March, June, September, and December from Figure 9(a). Inventories show spikes one month earlier with smaller magnitudes (around 2%) in columns (3) and (4). In contrast, in columns (5) and (6), quarter-end months do not show significantly different price index levels. In column (7), we directly relate prices to shipment value and do not find shipment spikes to be associated with major price movements. Overall, the regression estimate from column (7) confirms the lack of correlation between aggregate

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[34] M3 non-defense capital goods include 27 categories, 15 of which can be matched to the PPI. This match corresponds to 40 NAICS-6 industries in total. PPI is set to be 100% in January 1998 as the baseline for each industry.

[35] Using the average without weighting by the shipment value generates similar results.

shipments and prices in Figure 9. The result is also consistent with previous findings, such as in House and Shapiro (2008), that tax-induced capital investment does not change market prices.[36]

We develop complementary evidence from firm-level data that suppliers build up inventories in anticipation of Q4 sales spikes. The Compustat Customer Segments database records all customers that represent 10% or more of a supplier's total sales with the names of the customers and sales figures on a quarterly basis. To focus on depreciation-related capital investment, we narrow the suppliers to be within the manufacturing and business equipment industries (based on the Fama French 12 industry classification). Figure 10 plots corporate customer Q4 CAPEX spikes against supplier Q4 sales and inventory spikes. Customer Q4 CAPEX spikes are positively associated with supplier Q4 sales spikes in panel (a), validating the major customer and supplier links. In panel (b), we relate customer Q4 CAPEX spikes to supplier inventory movement. Suppliers who witness Q4 sales spikes increase inventory stocks in fiscal Q4 correspondingly. The documented firm-level pattern provides micro-level support for the aggregate-level correlation in Figure 9 and Table 9, where inventories anticipate shipment spikes.

6.2 Supply Effects via Corporate Borrowing

To further trace the impact of investment spikes in adjacent markets and confirm that investment spikes reflect real activity, we explore implications of Q4 spikes for lending and borrowing behavior. Figure 11(a) plots monthly overall new business volume based on the Equipment Leasing and Financing Association's Monthly Leasing and Finance Index (MLFI-25). This business primarily covers loans and leases to small businesses, which typically have fiscal year-ends in December. Each year the month of December experiences significantly higher new business volume than previous months. For example, in 2014 new business volume ranges from \$6 to 9 billion per month before December, and in December 2014 it increases sharply to around \$13 billion. Similar December spikes can be seen throughout the whole decade of the sample.[37]

One might be concerned that lending-side unobservables are driving December spikes in

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[36] See Goolsbee (1998) for a setting in which prices do respond to investment tax credit changes.

[37] Appendix Table B.1 confirms that Q4 investment spikes coincide with new debt issuance in our sample. Appendix Figure B.1(d) shows higher book depreciation in the fourth quarter, indicating these patterns reflect real investment expenditures from the perspective of the firm's financial accounts. Financial accounting applies economic depreciation for new investment, rather than the half-year convention that applies for tax depreciation. Spikes in book depreciation thus indicate the spike expenditures are not just made on the last day of the fiscal year.

new business volume. If for some reason lenders offer cheaper loans in December, then December lending spikes may not be surprising. To address this concern, we acquire RateWatch data (part of S&P Global Market Intelligence), which tracks branch-level rates for banks with more than $100 million in assets on a monthly basis. Over 100,000 branch locations are covered in RateWatch, accounting for more than 75% of banks and credit unions in the United States. RateWatch is designed for financial institutions to access regional and national pricing trends. We focus on commercial equipment loans (below $250,000) and also include commercial real estate (at $1 million) and personal loans for comparison. For each loan type, the most populated maturity is kept: 36 months for commercial equipment loans, 60 months for commercial real estate loans, and 36 months for personal loans.

Figure 11(b) presents within-year movements of loan interest rates (net of Treasury yields of like maturity) for commercial equipment, commercial real estate, and personal loans, respectively. Across these three different loan types, late spring and early summer (June and July) show the lowest interest rates within a year, whereas November and December show higher interest rates. On average, within-year movement is relatively modest: both the low and high ends are approximately half a standard deviation of the corresponding series (7.7% for commercial equipment, 7.9% for commercial real estate, and 3.5% for personal loans).

Although Ratewatch provides comprehensive coverage for U.S. lenders, one drawback is the lack of loan- and borrower-specific characteristics. In a related study of the seasonal variation of syndicated loans, Murfin and Petersen (2016) show late spring and fall to be the “sales” seasons for these loans after controlling for firm and loan characteristics. Firms borrowing during sales season issue at 19 basis points cheaper than winter and summer borrowers (January/February and August). In particular, November and December do not belong to either sales season. In summary, both the survey evidence provided by the RateWatch data and the contract-level characteristics from Murfin and Petersen (2016) rule out lower interest rates attracting higher lending volume near the year end.

6.3 Interactions with Fiscal Stimulus Policy

Promoting intertemporal substitution of investment into the present from the future several years is a central motivation for many fiscal stimulus policies. Our results suggest that regimes in which the option value motive is stronger are likely to display greater responsiveness to such policies. Such a mechanism can help us understand the observed responses to fiscal stimulus documented in House and Shapiro (2008) and Zwick and Mahon (2017), which study a temporary switch from a slower depreciation baseline to more accelerated expensing of investment purchases. In addition, the option value motive can help account for the higher responses both for firms likely to face liquidity constraints and only for firms with sufficient taxable income to immediately draw deductions.

Our results have implications for the design of temporary fiscal stimulus policies. First, policy stimulus usually comes in weak economic times when firms may have insufficient taxable income or sufficient alternative tax shields in the form of net operating loss (NOL) deductions. In the 2001 recession, policymakers introduced temporary bonus depreciation, which allowed firms to take additional deductions for eligible investment from 2001 to 2004. In our sample at the time, only 60% of firms had sufficient taxable income to benefit immediately from the policy change.[38] Thus, to the extent such stimulus policies do not provide purchase-year benefits, their impact will be mitigated by the tax-minimization motives we document.

Second, firms subject to the bonus depreciation policy in the early 2000s accumulated large NOL stocks to be used in future years. Thus, by the time the policy was reintroduced in 2008 to combat the next recession, nearly 50% of firms had sufficient NOLs to zero out their taxable income before taking depreciation into account. Policymakers therefore face trade-offs when deploying temporary investment incentives to target corporate investment. Such incentives may face "crowding out" by the impact of similar policies implemented in the past.

We note one important caveat to the foregoing discussion. The Q4 spikes we document may partly be the result of careful planning by firms. For example, perhaps many firms have adopted a policy of buying equipment primarily in Q4 for the reasons we have proposed. In this case, our results would not say much about investment responses to unanticipated government stimulus programs. However, even in this case, the importance of purchase-year incentives would carry over to thinking about the design of fiscal stimulus.

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[38] Appendix Figure B.4 plots the share of firms in our matched Compustat-SOI sample who have potential to immediately benefit from depreciation deductions, given their net income and stock of potential NOL deductions.

7 Conclusion

This paper studies a new channel, tax-minimization, through which taxes affect corporate investment behavior. First, firms face a depreciation motive—because purchases made later in the year face a lower effective after-tax price, firms making a fixed amount of investment are better off tilting that investment toward fiscal year-end than uniformly investing throughout the year. Second, firms face an option value motive—because tax positions can be better estimated close to fiscal year-end, investing near the fiscal year-end allows firms to maximize the tax benefit of depreciation. Tax-minimizing investment leads to robust and quantitatively significant spikes in fiscal Q4 CAPEX. Similar behavior occurs in many countries.

The analysis in this paper offers a rich portrait of the mechanism underlying tax-minimizing investment behavior. It is true that any model with an oscillating after-tax price of investment will produce investment spikes. However, the model we have presented further accounts for the additional cross-sectional and dynamic features of the data, and points to a specific way in which volatility matters for corporate investment. Tax asymmetry, time-varying shocks, and the structure of depreciation deductions jointly contribute to produce investment spikes that are larger for financially constrained firms and for firms more likely to find themselves in taxable position. Our analysis suggests that financially constrained firms and those that value immediate liquidity may be particularly sensitive to tax policy changes. The results are consistent with models in which firms use high effective discount rates to evaluate investment decisions, in particular the after-tax costs of those investments. Models of corporate behavior without a first-year, tax-minimization motive are unlikely to fit the patterns revealed in the data.

Tax asymmetry can also help account for the fact that the additional investment does not just substitute for investment the firm would have made in the next period, but represents a cumulative increase in investment persisting for several periods. This persistence weakens considerably in a model in which firms are always taxable, even though productivity shocks are autocorrelated. The option to reduce the firm's tax bill in good times through intertemporal substitution thus improves the loss offset feature of the tax code, enabling the firm to use potential losses incurred from future investments to reduce current tax liabilities. At the same time, such a mechanism may induce procyclical investment behavior, as tax positions are strongly correlated with the macroeconomy.

Our findings show that tax incentives that directly target investment expenditures have pronounced effects on investment planning decisions for even the largest firms in the economy. These effects are driven especially by how the code treats expenditures in the year of purchase. Policymakers may want to consider these factors as they debate the relative merits of proposals that lower corporate tax rates while slowing depreciation deductions versus proposals that accelerate depreciation deductions, such as in the cash flow tax proposal of Auerbach (2010).[39] However, because we focus on the timing of investment at a relatively high frequency, caution is warranted in drawing conclusions about the effect of taxes on aggregate investment.

While this paper proposes a modification that improves the explanatory power of the benchmark microeconomic model of firm behavior, we only briefly address the macroeconomic effects of tax-minimizing investment. Perhaps such behavior can provide a concrete microfoundation for the accelerator model of aggregate investment. Another natural question is whether fiscal Q4 spikes help account for the patterns of lumpy investment highlighted by Caballero and Engel (1999) and Cooper and Haltiwanger (2006). We hope to explore these ideas in future work.

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[39] Batchelder (2017) discusses in detail how behavioral factors and financial frictions should enter into cost-benefit analysis of these sorts of proposals.

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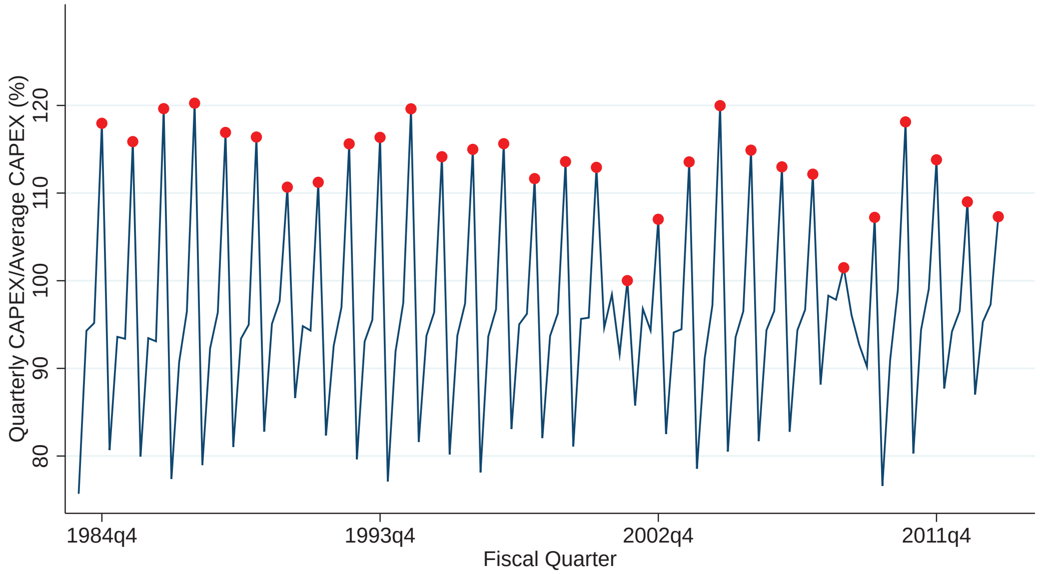
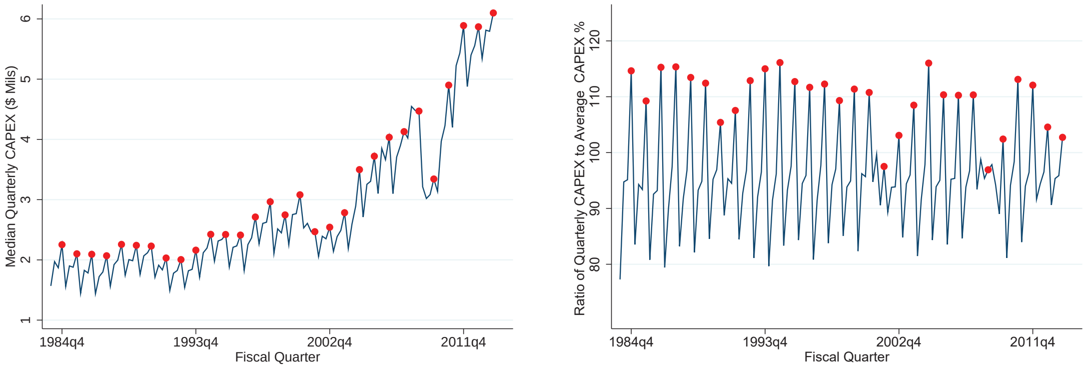
Figure 1: Time Series of Fiscal Q4 Investment Spikes (1984-2013)

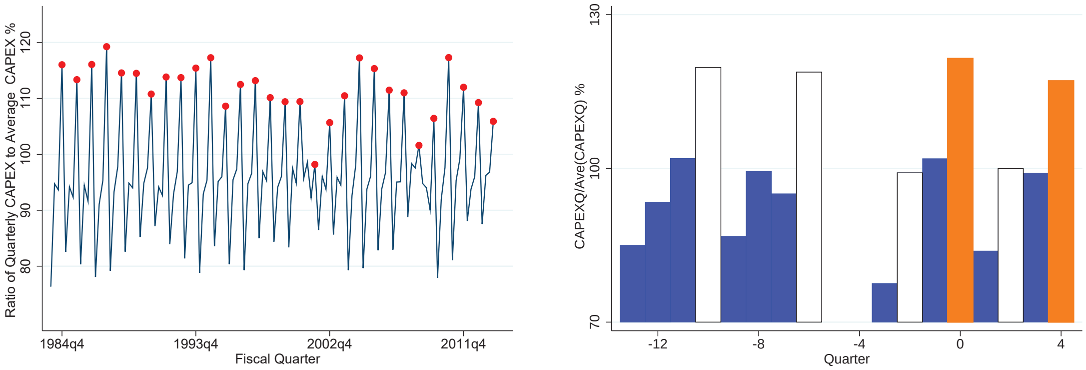


(a) Fiscal Q4 Investment Spikes



(b) Quarterly CAPEX Level

(c) Non-December Fiscal Year-Ends

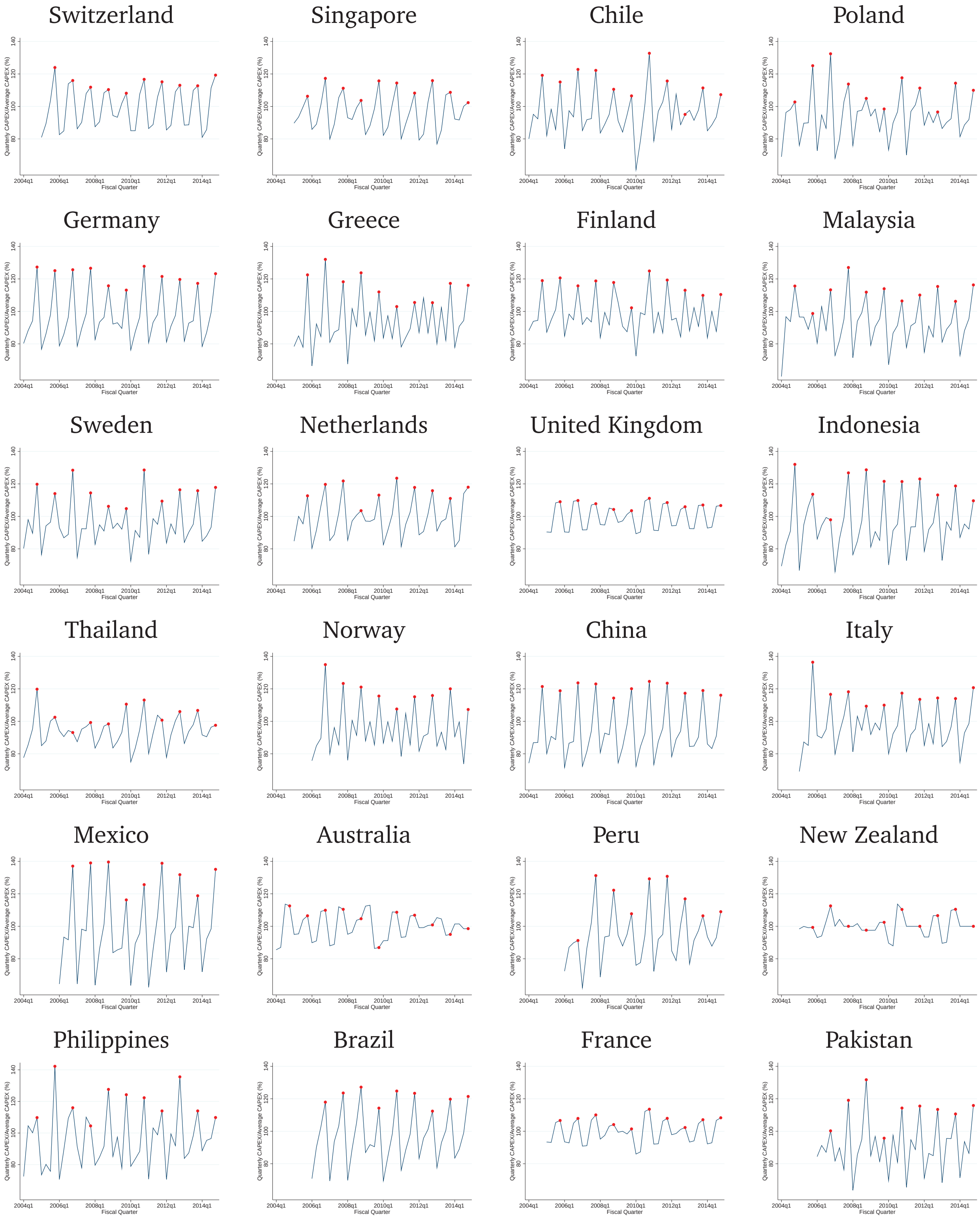


(d) Stable Fiscal Year-End Cash Flows

(e) Fiscal Year-end Change

Notes: This figure documents fiscal fourth quarter (Q4) capital expenditure (CAPEX) spikes for U.S. firms in Compustat. Panel (a) plots the median ratio of quarterly CAPEX to the average CAPEX within a firm's fiscal year. Red dots indicate Q4. Panel (b) plots the median quarterly CAPEX level ($M). Panel (c) plots the time series pattern of Q4 CAPEX spikes for firms with non-December fiscal year-ends. Panel (d) plots the time series of Q4 CAPEX spikes for firms with stable fiscal year-end cash flows, defined as firm-years for which fiscal Q4 cash flows are lower than the average of the first three fiscal quarters. Panel (e) plots the time series of CAPEX for 76 sample firms that switched their fiscal year ends to six months later. White bars indicate the old regime, and orange bars indicate the new regime.

Figure 2: International Evidence of Fiscal Q4 Spikes (2004-2014)



Switzerland

Singapore

Chile

Poland

Germany

Greece

Finland

Malaysia

Sweden

Netherlands

United Kingdom

Indonesia

Thailand

Norway

China

Italy

Mexico

Australia

Peru

New Zealand

Philippines

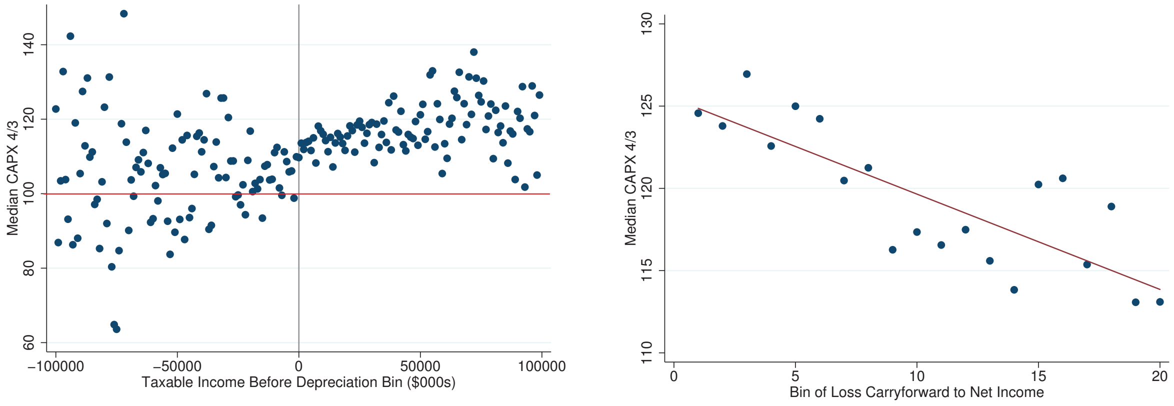
Brazil

France

Pakistan

Notes: This figure shows fourth quarter CAPEX spikes across country. Countries are sorted according to their average corporate income tax rate during the sample period: Switzerland has the lowest average corporate income tax rate (≈8%) while Pakistan has the highest (≈35%).

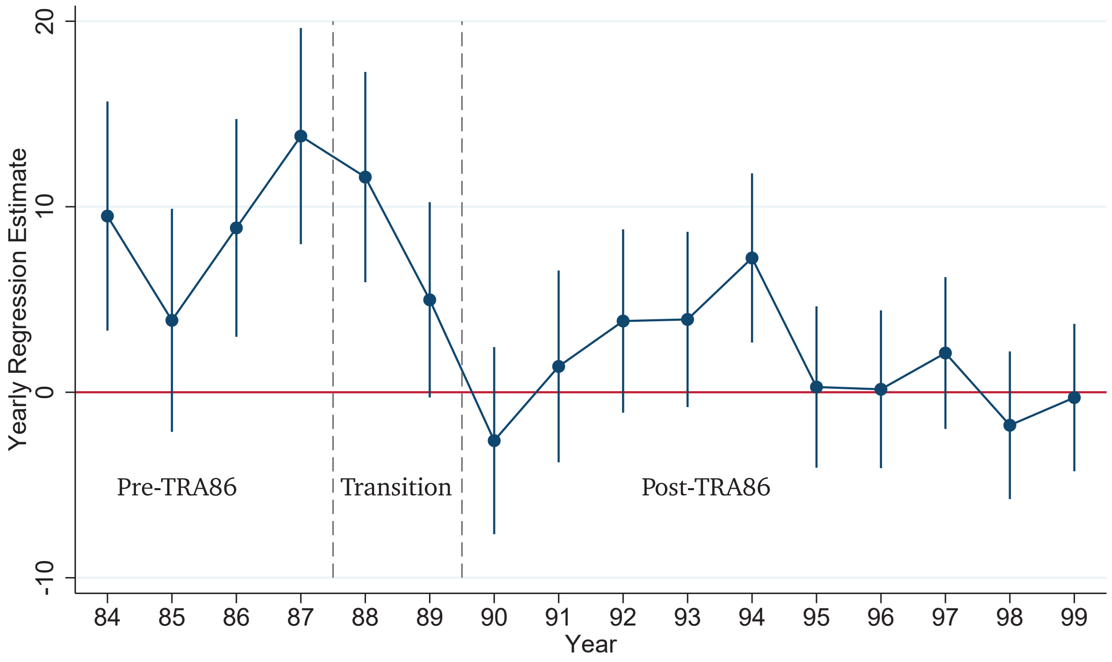
Figure 3: Fiscal Q4 Spikes and Tax Incentives



(a) Firm-Years Sorted by Tax Position

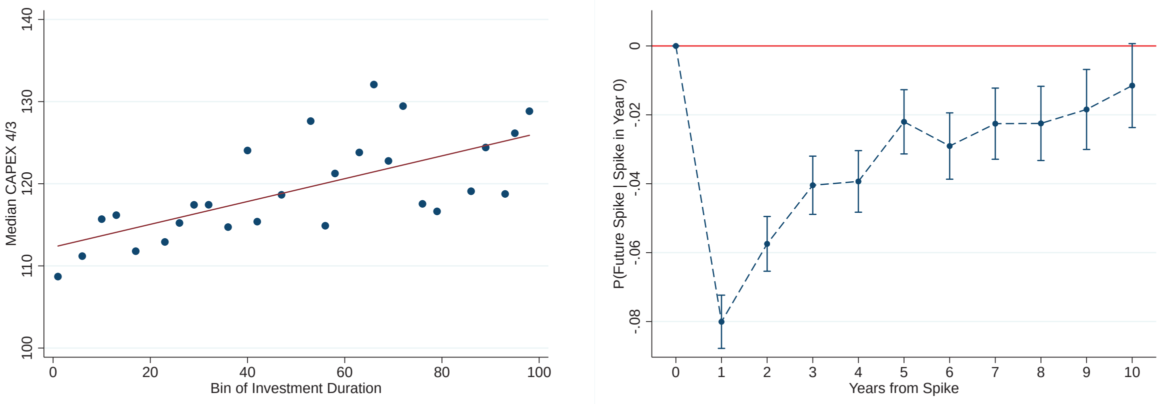
(b) Firm-Years Grouped by NOL Stock

(c) Spikes and the Tax Reform Act of 1986



Notes: This figure shows the relationship between fourth quarter capital expenditure (CAPEX) spikes and firm-level incentives to use investment as a tax shield. Both figures identify a firm's tax position by combining CAPEX spike data from Compustat with tax position data from corporate tax returns for the years 1993 through 2010. In Panel (a), we divide firms into $1,000 bins based on their taxable income before depreciation expense is taken into account and plot for each bin the median ratio of fourth fiscal quarter CAPEX to the average CAPEX of the first three fiscal quarters. In Panel (b), we focus only on firms with positive tax position and group firms by the ratio of the stock of net operating loss carryforwards to net income before depreciation. In Panel (c), we plot the year-to-year regression estimates of Q4 investment spikes (%) with 95% confidence intervals for the period of 1984 to 2000, with 2000 as the omitted benchmark year. The regression includes the following controls: ln(assets), Market-to-Book, Cash/Assets, CAPEX/PPE, and Sales 4/3. Firm fixed effects are included and standard errors are clustered at the firm level. The transition period following TRA86 includes a phase-in of the new lower corporate tax rate and a phase-out of investment tax credit eligibility for certain asset classes.

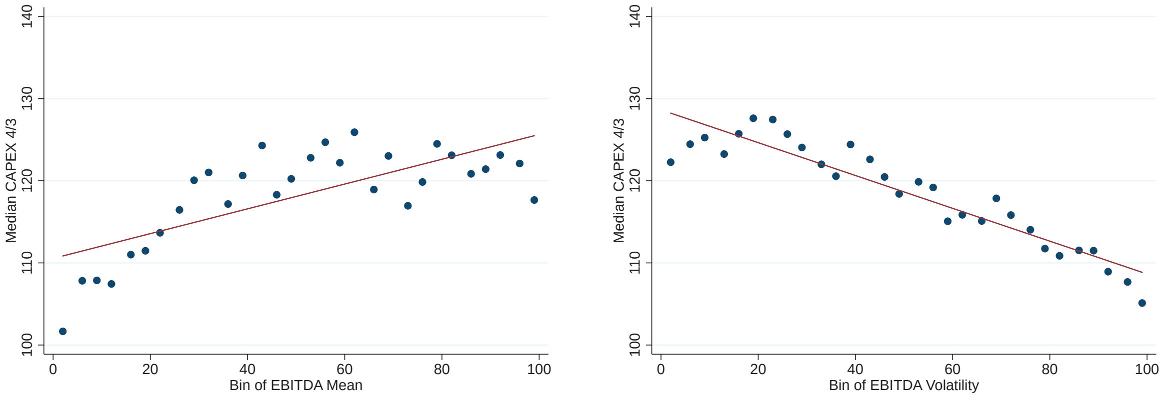
Figure 4: Cross-Sectional and Dynamic Determinants of Q4 Spikes


(a) Investment Duration

(b) Autocorrelation of Spikes

(c) Earnings Mean

(d) Earnings Volatility



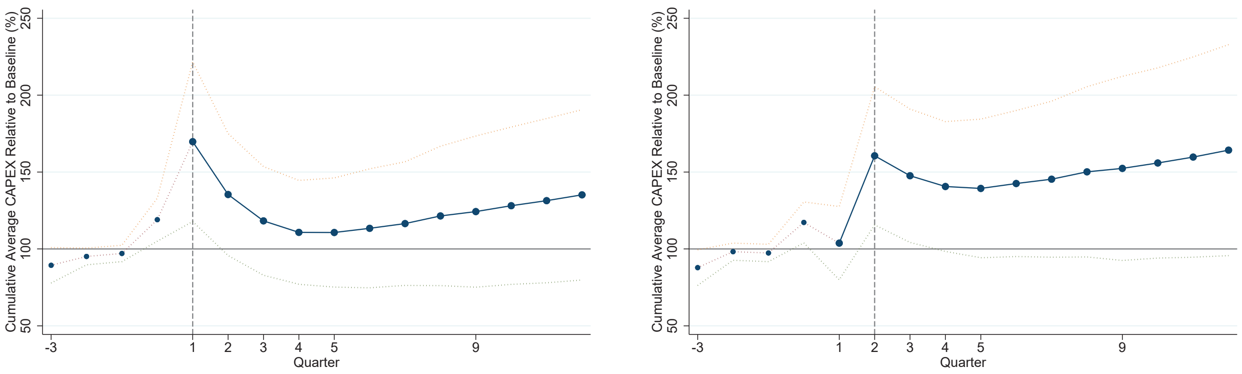
Notes: This figure documents the cross-sectional relationship between Q4 CAPEX spikes and investment duration and earnings volatility, and measures the average autocorrelation of spikes. In Panel (a), investment duration is derived from the inverse of the present value of depreciation deductions (via Zwick and Mahon (2017) at the NAICS four-digit level) with higher values representing longer equipment investment duration. In Panel (b), we estimate local projections at the firm-year level, regressing an indicator for a Q4 spike in a future year on an indicator for a Q4 spike in the current year. We include firm and year fixed effects to estimate the autocorrelation of spikes within firm over time. Panels (c) and (d) plot median Q4 spikes against the mean and variance of EBITDA/Assets, respectively.

Figure 5: Q4 Spikes and Earnings Management

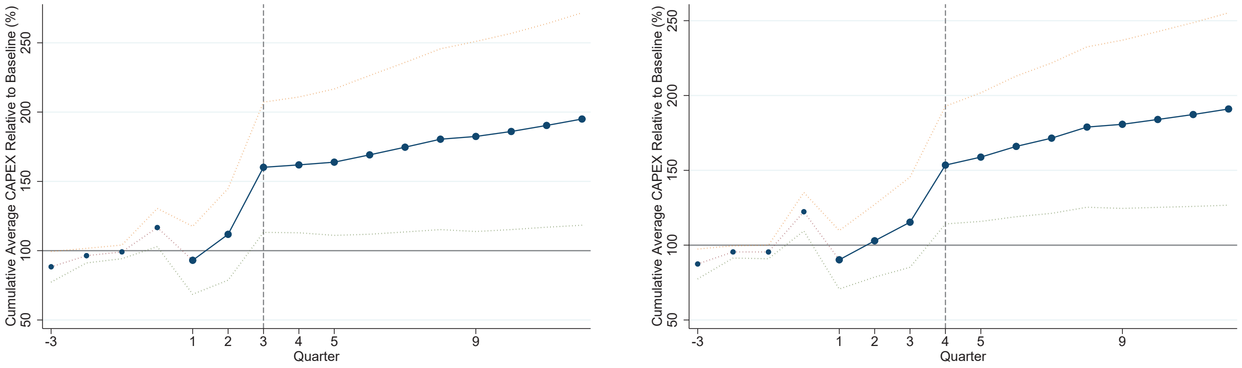
Notes: This figure presents binned scatterplots of median sample firm Q4 CAPEX spikes against earnings surprises. The gray line with earnings surprise equal to zero indicates that firms exactly meet the median analyst forecast.

Figure 6: Cumulative Investment after Spikes

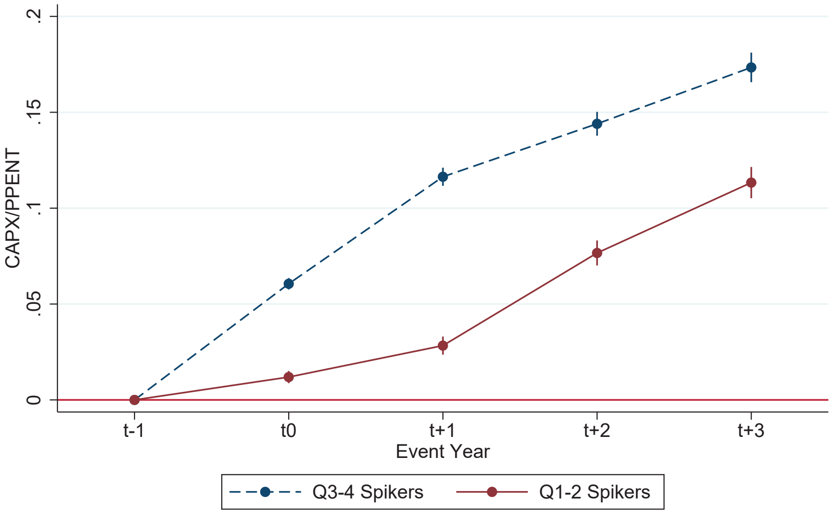
(a) Fiscal Q1 Spikers (b) Fiscal Q2 Spikers



(c) Fiscal Q3 Spikers (d) Fiscal Q4 Spikers

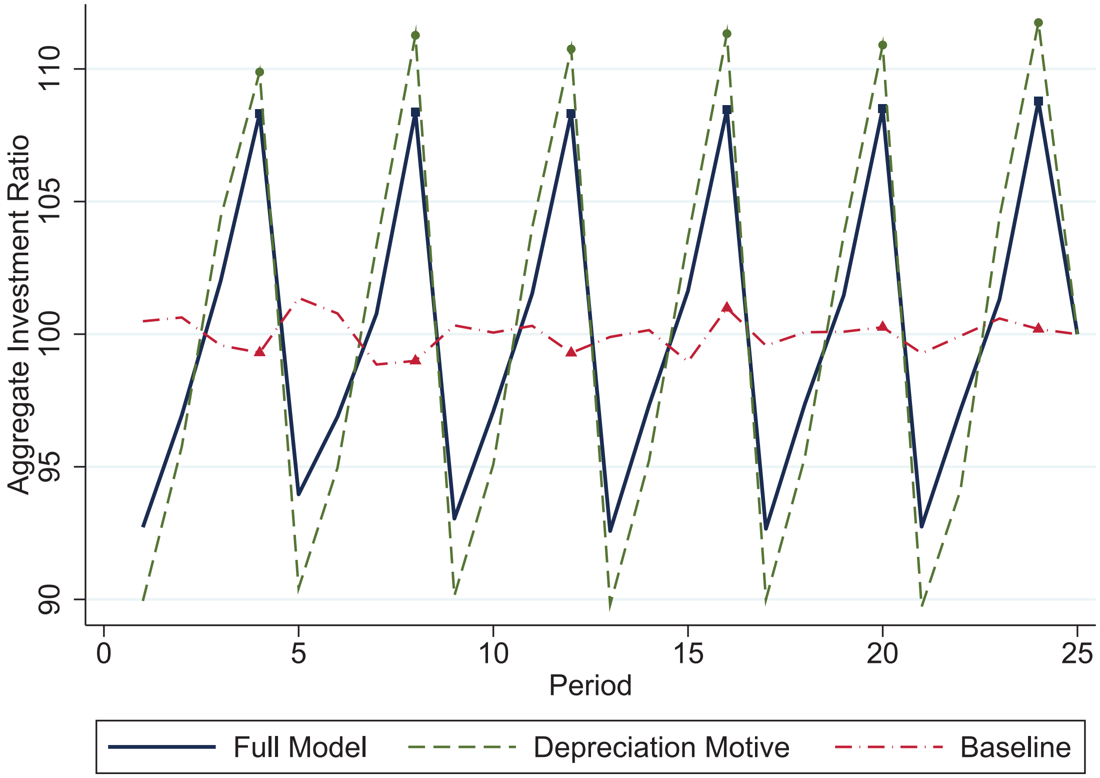


(e) Investment level for Q1-2 and Q3-4 Spikers



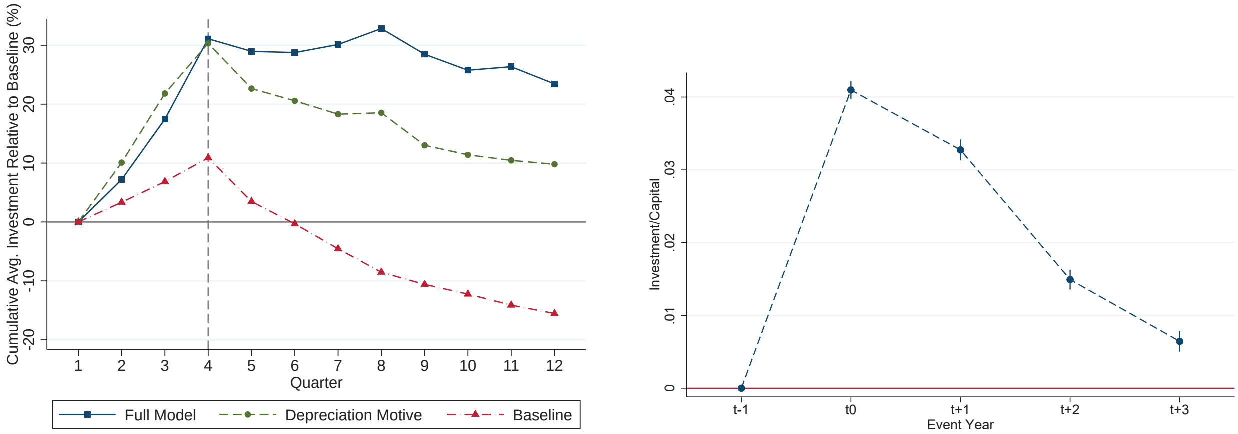
Notes: This figure presents the cumulative level of investment after large spikes in Q1, Q2, Q3, and Q4 in panels (a)-(d), respectively. Large spikes are defined as event quarter spikes CAPEX Q/Ave(Q1-Q4) exceeding 113.65% (the sample median Q4 spike level). The baseline (denominator) is average quarterly CAPEX in the year before spikes (t from -3 to 0). The numerator is calculated as the average quarterly CAPEX starting from quarter 1 of the spiking year: CAPEX Q1 for quarter 1 ($t = 1$), CAPEX $\frac{Q1+Q2}{2}$ for quarter 2 ($t = 2$), CAPEX $\frac{Q1+Q2+Q3}{3}$ for quarter 3 ($t = 3$), and so on. The dotted lines are 95% confidence intervals. Panel (e) presents investment levels for Q1-2 versus Q3-4 spikers by plotting coefficient estimates and 95% confidence intervals based on the specifications in columns (2) and (4) of Table 7.

Figure 7: Fiscal Q4 Spikes in Model Simulated Data



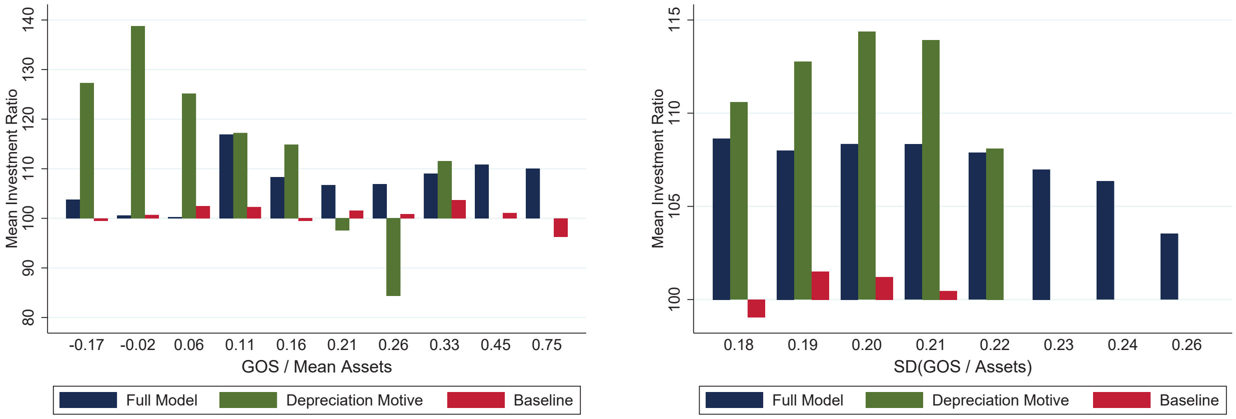
Notes: This figure plots aggregate fiscal Q4 investment spikes for simulated firm data based on the model in Section 5. We plot the ratio of average investment across all simulated firms in a given quarter to average investment across firms in the fiscal year. For the Depreciation Motive version of the model, we set the profitability shifter to zero. We compare the Full and Depreciation Motive models to a Baseline model in which depreciation deductions start whenever the investment is made, and in which even firms with losses receive tax credits for depreciation.

Figure 8: Depreciation versus Option Value Motives in Model Simulations



(a) Cumulative across Models

(b) Q1-2 vs. Q3-4 Spikes, Full model



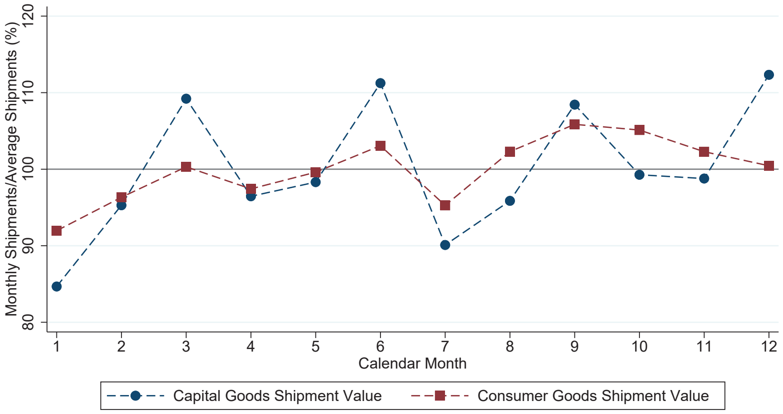
(c) Earnings Mean across Models

(d) Earnings Volatility across Models

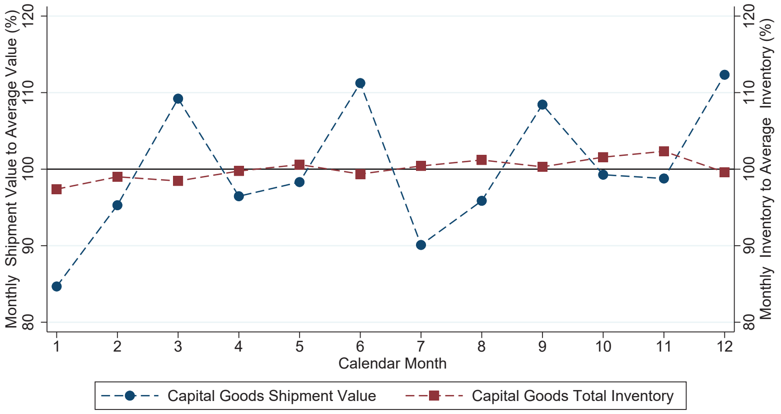
Notes: This figure presents analysis of simulated data based on the the model in Section 5. Panel (a) evaluates the cumulative investment effect following spikes, while controlling for underlying productivity persistence. For each model version, we first sample ten spike events per simulated firm sequence and then order the data in event time relative to the spike. Spikes are defined as investment ratios (Q4 investment divided by Q1–Q4 average) greater than the sample median. For each event, we compute cumulative average investment beginning in Q1 of the spike year and scale this cumulative series by the average investment rate across all simulated quarters, which serves as a measure of benchmark investment within the model. We then regress scaled cumulative investment on event time dummies and plot the dummies, while controlling for productivity and the initial spike size (to account for differences in spike means across models). Panel (b) uses simulations from the Full model to construct analogous series to Table 7, column (5) for investment levels following Q3–Q4 versus Q1–Q2 spikes, defined as CAPEX Q/Ave(Q1-Q4) greater than the sample median. We run a regression with year and event fixed effects where the left-hand-side variable is annual investment divided by total capital in the year before the spike, and the right-hand-side variables are dummy variables for each year interacted with an indicator for the spike happening in Q3 or Q4. We then plot the coefficient estimates on these interactions. Panels (c) and (d) plot model analogues to Figures 4(c) and 4(d). For each model version, we sort firm-quarters using either GOS/Mean Assets or SD(GOS/Assets). We then calculate the deciles of GOS/Mean Assets and SD(GOS/Assets) for the Full version, and plot the mean investment ratio of firm-years within these deciles against average values of these GOS variables within the deciles.

Figure 9: Spikes in Capital Goods Shipments, Inventories, and Prices

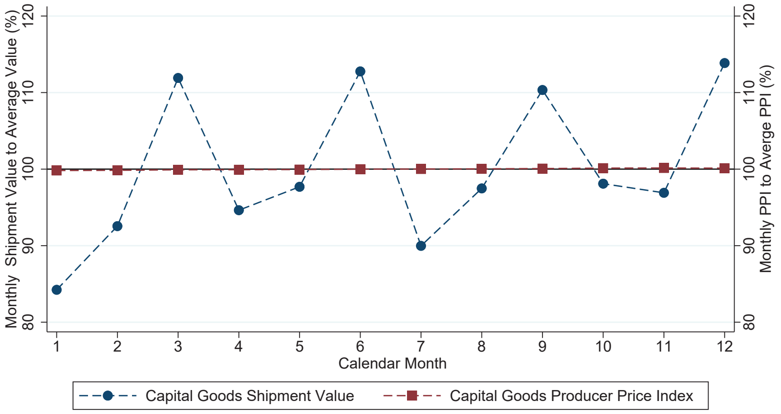
(a) Spikes in Capital Goods Shipments (1958–2016)



(b) Spikes in Capital Goods Shipments and Inventories (1958–2016)

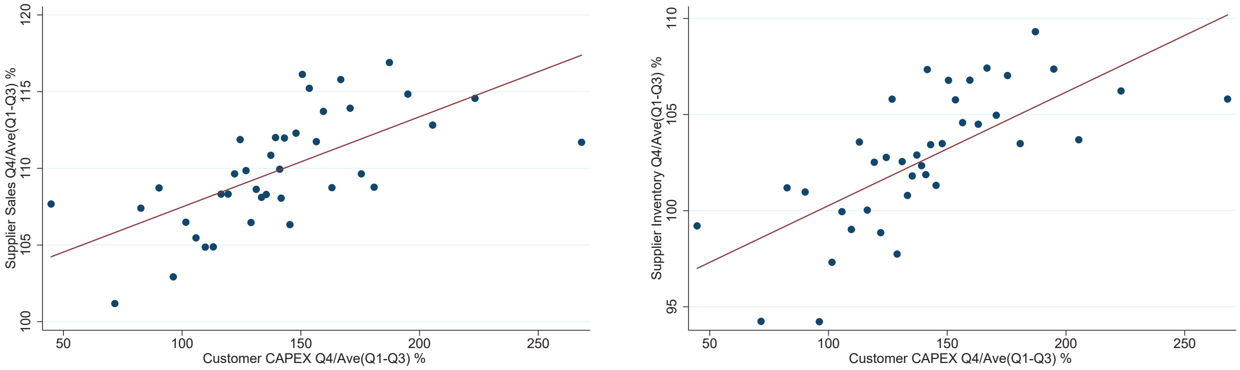


(c) Spikes in Capital Goods Shipments and Prices (1998–2016)



Notes: This figure presents within-year seasonality of aggregate non-defense capital goods shipments, total inventories, and prices. Shipment and inventory data come from the Census Bureau's manufacturer shipments, inventories, and orders (M3) survey of the domestic manufacturing sector. Capital goods price is measured by the Producer Price Index (PPI) provided by the Bureau of Labor Statistics, which records the selling prices received by domestic producers for their output at the NAICS6 level. PPI is linked to M3 using M3/NAICS-6 industry composition from the Census. Panel (a) presents shipments of non-defense capital goods and consumer goods. Panel (b) presents shipments and total inventories and Panel (c) presents shipments and prices for non-defense capital goods. For each variable, we compute the ratio of monthly value to the average monthly value within that month's calendar year.

Figure 10: Supplier Q4 Inventory and Sales Spikes



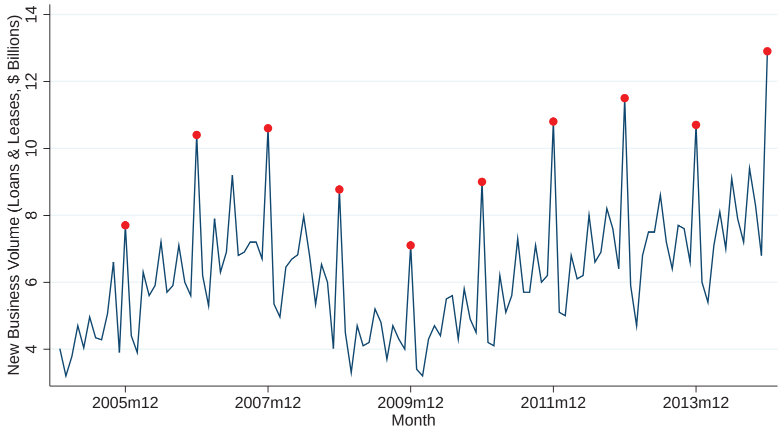
(a) Supplier Q4 Sales Spikes

(b) Supplier Q4 Inventory Spikes

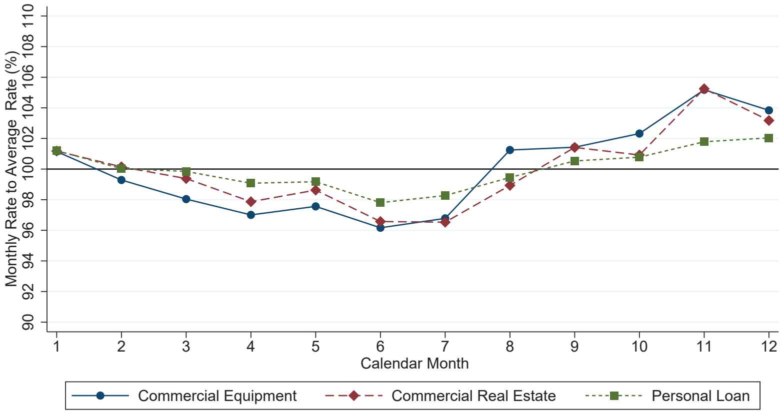
Notes: This figure shows the relationship between corporate customer Q4 CAPEX spikes and supplier Q4 sales and inventory spikes. Corporate customer information comes from the Compustat Segments Customer database, which records all customers that represent 10% or more of a firm's total sales with the names of the customers and their sales figures. We only keep suppliers in manufacturing and business equipment industries in this figure.

Figure 11: Capital Lending Volume and Interest Rate (2005–2014)

(a) Capital Lending Volume



(b) Interest Rate Seasonality



Notes: This figure presents within-year seasonality of capital financing volume and rates. Panel (a) plots monthly overall new business volume from the Equipment Leasing and Finance Association's (ELFA) Monthly Leasing and Finance Index (MLFI-25, available at `http://www.elfaonline.org/data/MLFI`). The MLFI-25 measures monthly commercial equipment lease and loan activity reported by participating ELFA member companies, which represent a cross section of the equipment finance sector. Red dots indicate the month of December. Panel (b) presents the within-year seasonality of interest rates for commercial equipment (60 months), commercial real estate (60 months), and personal loans (36 months), respectively. The data comes from RateWatch (part of S&P Global Market Intelligence) and tracks branch-level rates for over 75% of banks and credit unions in the United States. For each category, the interest rate is net of the treasury rate of the same maturity. For each month, we take the median rate across all lenders, and then compute the ratio of monthly rate to the average monthly rate within that month's calendar year.

Table 1: Tax Benefits of Accelerating Investment for Five-Year Items

(a) Scenarios with Post-TRA86 Tax Rate

Year	0	1	2	3	4	5	6	Total
Expenditure in Year 1								
Depreciation	0	20	32	19.2	11.5	11.5	5.8	100
Tax Savings ($\tau = 35\%$)	0	7	11.2	6.72	4.03	4.03	2.02	35
NPV of Tax Savings								29.10
Expenditure Accelerated to Year 0								
Depreciation	20	32	19.2	11.5	11.5	5.8	0	100
Tax Savings ($\tau = 35\%$)	7	11.2	6.72	4.03	4.03	2.02	0	35
NPV of Tax Savings								31.14
Benefit to Accelerating								2.04

(b) Scenarios with Pre-TRA86 Tax Rate and Investment Tax Credit

Year	0	1	2	3	4	Total
Expenditure in Year 1						
Depreciation	0	33.33	44.45	14.81	7.41	100
Tax Savings ($\tau = 46\%$)	0	15.33	20.45	6.81	3.41	46
Investment Tax Credit (ITC)	0	10	0	0	0	10
NPV of Tax Savings, No ITC						40.35
NPV of Tax Savings, ITC						49.70
Expenditure Accelerated to Year 0						
Depreciation	33.33	44.45	14.81	7.41		100
Tax Savings ($\tau = 46\%$)	15.33	20.45	6.81	3.41		46
Investment Tax Credit (ITC)	10	0	0	0		10
NPV of Tax Savings, No ITC						43.17
NPV of Tax Savings, ITC						53.17
Benefit to Accelerating, No ITC						2.82
Benefit to Accelerating, ITC						3.48

Notes: This table displays year-by-year deductions and tax benefits for a $100 investment in computers, a five-year item, depreciable according to the Modified Accelerated Cost Recovery System (MACRS). Panel (a) considers the tax rate prevailing during the time period after the Tax Reform Act of 1986, which covers the bulk of our sample. Panel (b) considers the tax rate and Investment Tax Credit regime in effect prior to the 1986 reform. Each panel compares an investment put in place on December 31st (Year 0) to one put in place on January 1st (Year 1). This comparison illustrates the incentive to accelerate purchases into the fourth fiscal quarter from subsequent years. NPV calculations apply a 7 percent discount rate. See IRS publication 946 for the recovery periods and schedules applying to other class lives.

Table 2: Summary Statistics

(a) U.S. Sample (1984-2013)

	N	Mean	Median	SD	P10	P90
Assets ($M)	119,386	2,701.59	219.00	15,697.69	27.51	3,875.80
Depreciation ($M)	119,194	126.15	9.03	708.88	0.78	177.78
CAPEX ($M)	119,372	171.85	10.97	1,080.88	0.78	232.54
PPE ($M)	119,323	939.52	50.52	5,534.65	3.45	1,326.50
Sales ($M)	119,379	2,318.03	212.47	12,055.00	17.13	3,646.90
M/B	114,357	1.88	1.42	1.39	0.88	3.37
Cash Flow/Assets	115,896	0.05	0.09	0.23	-0.13	0.22
Cash/Assets	119,307	0.17	0.08	0.21	0.01	0.47
EBITDA/Assets	119,146	0.09	0.12	0.16	-0.08	0.23
CAPEX/PPE	117,581	0.40	0.23	0.59	0.07	0.83
CAPEX 4/3 (%)	119,386	136.97	119.07	85.46	47.76	248.63
Sales 4/3 (%)	115,915	111.70	107.05	27.86	84.90	143.44

(b) International Sample (2004-2014)

	N	Mean	Median	SD	P10	P90
M/B	52,788	1.89	1.29	2.08	0.75	3.28
Cash Flow/Assets	79,310	0.04	0.07	0.21	-0.12	0.20
Cash/Assets	80,303	0.18	0.12	0.18	0.02	0.42
EBITDA/Assets	79,812	0.06	0.09	0.22	-0.10	0.23
CAPEX/PPE	79,556	0.46	0.19	1.12	0.04	0.81
CAPEX 4/3 (%)	80,303	134.58	114.80	89.57	40.13	256.53
Sales 4/3 (%)	77,281	113.24	106.09	37.67	80.19	151.58

Notes: Panel (a) presents summary statistics for the sample of U.S. firms. There are 17,527 firms with 158,859 firm-years during the period 1984-2013. Panel (b) presents summary statistics for the sample of international firms from 33 countries during the period of 2004-2013. 15,764 unique firms and 88,067 firm-years are included in the international sample. CAPEX 4/3 and Sales 4/3 are censored at 500%, which excludes approximately 2% of the data. Financial ratios are winsorized at the top and bottom 1% level.

Table 3: Fiscal Q4 CAPEX Spikes and Tax Status

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(taxable)	7.6***	6.3***	2.9**	10.8***	6.7**	6.8***	6.3***
	(1.4)	(1.4)	(1.5)	(3.1)	(3.1)	(1.7)	(1.8)
CAPEX/PPE		4.7***	4.5***		4.4**		5.0***
		(1.2)	(1.2)		(2.2)		(1.8)
EBITDA/Assets			34.4***				
			(5.6)				
Observations	49178	47582	47524	19429	18744	29749	28838
R^2	0.0779	0.0981	0.0996	0.103	0.127	0.0832	0.0972
Controls	No	1	2	No	1	No	1
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period				Pre-2000	Pre-2000	Post-2000	Post-2000

Notes: This table presents regression estimates of firm Q4 CAPEX spikes on firm tax position by combining CAPEX spike data from Compustat with tax position data from corporate tax returns for the years 1993 through 2010. We follow Zwick and Mahon (2017) and define D(taxable) as an indicator for whether a firm has positive income before depreciation expense and thus an immediate incentive to offset taxable income with additional investment. All columns include firm and year fixed effects. Columns (2), (5), and (7) include the following controls: ln(assets), Market-to-Book, Cash/Assets, CAPEX/PPE, and Sales 4/3. Column (3) adds EBITDA/Assets as an additional control. Columns (4) and (5) are run using just the years 1993 through 2000, and columns (6) and (7) use the years from 2001 to 2010. Standard errors are clustered at the firm level.

Table 4: Fiscal Q4 CAPEX Spikes and the Tax Reform Act of 1986

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D(1984-1987)	10.2***	5.0***	10.0***	5.4***	10.6***	6.0***	4.3***	1.6***
	(1.3)	(1.5)	(1.2)	(1.3)	(1.2)	(1.2)	(0.5)	(0.5)
Observations	24744	22886	61262	56986	117155	107924	117155	107924
Adjusted R^2	0.07	0.08	0.06	0.08	0.06	0.08	0.06	0.07
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period	84-92	84-92	84-00	84-00	84-13	84-13	84-13	84-13

Notes: This table presents regression estimates of firm Q4 CAPEX spikes around the Tax Reform Act of 1986. The top corporate tax rate was 46% in 1984-1986, 40% in 1987, 34% in 1988-1992 and 35% in 1993-2013. The Tax Reform Act of 1986 also repealed the Investment Tax Credit and lengthened the depreciation periods for property. In addition, it required the mid-quarter convention if property placed in service during Q4 is over 40% of the whole tax year. D(84-87) is a dummy variable equal to 1 for the years 1984-1987. The dependent variable is Q4 CAPEX spike measure in columns (1)-(6), and is a dummy variable indicating Q4 investment is over the 40% threshold in columns (7) and (8). Columns (1) and (2) include the period from 1984 to 1992, columns (3) and (4) include the period from 1984 to 2000, and columns (5) and (6) include the period from 1984 to 2013. Columns (1), (3), (5), and (7) only include firm fixed effects, while columns (2), (4), (6) and (8) include the following controls: ln(assets), Market-to-Book, Cash/Assets, CAPEX/PPE, and Sales 4/3. Standard errors are clustered at the firm level.

Table 5: Investment Spikes and Financial Constraints

	(1)	(2)	(3)	(4)	(5)
D(84-87)	14.13***	4.24***	0.16	3.87**	4.30***
	(3.81)	(1.45)	(2.12)	(1.58)	(1.40)
D(1984-1987)*ln(assets)	-1.55**				
	(0.61)				
D(1984-1987)*nodiv		4.50*			
		(2.38)			
D(1984-1987)*junkrating			7.68*		
			(4.18)		
D(1984-1987)*fp				4.82**	
				(2.18)	
D(1984-1987)*fp2					5.14**
					(2.32)
Observations	107924	107924	27368	106764	106764
Adjusted R^2	0.08	0.08	0.15	0.08	0.08
Controls	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes

Notes: This table presents regression estimates relating the magnitude of firm Q4 investment spikes to various proxies for financial constraints used in prior work: log(assets) where small firms are more constrained, a non-dividend payer dummy, a speculative grade dummy, a dummy variable indicating CAPEX exceeding internal cash flow, and a dummy variable indicating CAPEX exceeding internal cash flow and not having an S&P rating (Faulkender and Petersen (2012)). Columns (1) through (5) interact financial constraint proxies with tax policy changes around the Tax Reform Act of 1986. Control variables include ln(assets), Market-to-Book, Cash/Assets, CAPEX/PPE, and Sales 4/3. Firm fixed effects are included. Standard errors are clustered at the firm level.

Table 6: Decomposing the Investment-Cash Flow Sensitivity

	(1)	(2)	(3)
$\frac{CashFlow}{Asset}$	0.035***	0.025***	0.011***
	(0.004)	(0.002)	(0.002)
$\frac{CashFlow}{Asset} * Q2$			0.013***
			(0.002)
$\frac{CashFlow}{Asset} * Q3$			0.024***
			(0.002)
$\frac{CashFlow}{Asset} * Q4$		0.020***	0.034***
		(0.002)	(0.002)
Tobin's Q	0.011***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)
Observations	129286	482301	482301
Adj R-Squared	0.530	0.444	0.445
Firm FE	Yes	Yes	Yes
Year FE	Yes		
Year-Quarter FE		Yes	Yes

Notes: This table presents regression estimates of investment-cash flow sensitivity using either annual or quarterly investment measures. To enable comparison to past work, column (1) presents estimates at an annual frequency with CAPEX/Assets as the left hand side variable and annual Cash Flow/Assets and Tobin's Q as key right-hand-side variables, and includes firm and year fixed effects. Columns (2) and (3) use quarterly CAPEX/Assets as the left-hand-side variable and include firm and year-by-quarter fixed effects. Column (2) interacts a fiscal Q4 dummy with Cash Flow/Assets. Column (3) interacts dummies for each fiscal quarter with Cash Flow/Assets. Standard errors are clustered at the firm level.

Table 7: Cumulative Effect of Q4 CAPEX Spikes

	Q1-2 Spikers		Q3-4 Spikers		All	
	(1)	(2)	(3)	(4)	(5)	(6)
D(Spike Y)	0.011***	0.012***	0.061***	0.061***	0.011***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
D(Forward 1Y)	0.026***	0.028***	0.118***	0.116***	0.027***	0.029***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
D(Forward 2Y)	0.074***	0.077***	0.146***	0.144***	0.076***	0.078***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
D(Forward 3Y)	0.111***	0.113***	0.175***	0.173***	0.113***	0.115***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
D(Spike Y)*Q34 Spiker					0.049***	0.048***
					(0.002)	(0.002)
D(Forward 1Y)*Q34 Spiker					0.091***	0.087***
					(0.002)	(0.002)
D(Forward 2Y)*Q34 Spiker					0.070***	0.066***
					(0.003)	(0.003)
D(Forward 3Y)*Q34 Spiker					0.061***	0.057***
					(0.003)	(0.003)
M/B		-0.006**		-0.015***		-0.011***
		(0.003)		(0.003)		(0.003)
Cash/Assets		-0.481***		-0.600***		-0.548***
		(0.027)		(0.028)		(0.026)
EBITDA/Assets		0.206***		0.244***		0.227***
		(0.023)		(0.025)		(0.023)
Observations	182500	177190	276300	267846	458800	445036
Adj R-Squared	0.523	0.536	0.558	0.571	0.546	0.559
Event FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table examines the investment level around firm-years with large CAPEX spikes in different fiscal quarters, where large spikes are defined as CAPEX Q/Ave(Q1-Q4) exceeding 113.65% (the sample median Q4 spike level). Dummy variables indicate the time period from the spiking year to three years after large spikes. The dependent variable is CAPEX divided by total capital level (PPENT) in the year before spikes. The omitted benchmark year is the year before spikes. Columns (5) and (6) compare firm-years with large spikes in Q3 and Q4 to firm-years with large spikes in Q1 and Q2. Spike event fixed effects and year fixed effects are included. Standard errors are clustered at the firm level.

Table 8: Investment Spikes and Complicated Firms: Use it or Lose it?

	(1)	(2)
# Segments	2.6***	
	(0.3)	
# SIC2		1.6***
		(0.3)
Observations	94280	94262
Adjusted R^2	0.02	0.02
Controls	Yes	Yes
Year FE	Yes	Yes

Notes: This table presents regression estimates relating firm Q4 investment spikes to measures of corporate budgetary complexity. These measures include: (1) the number of segments; (2) the number of two digit SIC codes in the corporate segments. Control variables include ln(Assets), Market-to-Book, Cash/Assets, CAPEX/PPE, and Sales 4/3. The right-hand-side variables are standardized for ease of interpretation. Year fixed effects are included. Standard errors are clustered at the firm level.

Table 9: Spikes in Capital Goods Shipments, Inventories, and Prices

	Shipments (%)		Lagged Inventories (%)		PPI (%)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Month 3/6/9/12	22.1***		2.38***		-0.020		
	(5.4)		(0.49)		(0.102)		
March		24.3***		2.29***		0.057	
		(4.6)		(0.74)		(0.241)	
June		22.6***		2.45***		0.050	
		(5.5)		(0.63)		(0.035)	
September		20.1***		2.37***		-0.109	
		(5.3)		(0.72)		(0.261)	
December		21.6***		2.41***		-0.076	
		(6.6)		(0.43)		(0.411)	
Shipments (%)							-0.004
							(0.003)
Observations	3,348	3,348	3,333	3,333	3,348	3,348	3,348
R-Squared	0.36	0.36	0.07	0.07	0.01	0.01	0.01

Notes: This table presents regression estimates of the within industry-year seasonality of capital goods shipments, inventories, and prices. The unit of observation is at the industry–month level. For each variable, we compute the ratio of monthly value to the average monthly value within that month's calendar year. Standard errors are clustered at the industry level.

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A Institutional Background and Variable Definitions

Table A.1: Historical U.S. Corporate Income Tax Rate and Bonus Depreciation

Year	Income Bracket	Tax Rate (%)
1984-1986	First $25,000	15
	$25,000 to $50,000	18
	$50,000 to $75,000	30
	$75,000 to $100,000	40
	$100,000 to $1,000,000	46
	$1,000,000 to $1,405,000	51(a)
	Over $1,405,000	46
1987	First $25,000	15
	$25,000 to $50,000	16.5
	$50,000 to $75,000	27.5
	$75,000 to $100,000	37
	$100,000 to $335,000	42.5
	$335,000 to $1,000,000	40
	$1,000,000 to $1,405,000	42.5
	Over $1,405,000	46
1988-1992	First $50,000	15
	$50,000 to $75,000	25
	$75,000 to $100,000	34
	$100,000 to $335,000	39(b)
	Over $335,000	34
1993-2013	First $50,000	15
	$50,000 to $75,000	25
	$75,000 to $100,000	34
	$100,000 to $335,000	39(c)
	$335,000 to $10,000,000	34
	$10,000,000 to $15,000,000	35
	$15,000,000 to $18,333,333	38(d)
	Over $18,333,333	35

Year	Bonus Depreciation
2001-02	30% Tax years ending after 9/10/01
2003	50% Tax years ending after 5/3/03
2004	50%
2008-09	50% Tax years ending after 12/31/07
2010-11	100% Tax years ending after 9/8/10
2012-13	50%

Notes:

(a) The Deficit Reduction Act of 1984 added an additional 5 percent to the tax rate in order to phase out the benefit of the lower graduated rates for corporations with taxable income between $1,000,000 and 1,405,000. Corporations with taxable income above $1,405,000, in effect, pay a flat marginal rate of 46 percent.

(b) Rates shown effective for tax years beginning on or after July 1, 1987. Taxable income before July 1, 1987 was subject to a two tax rate schedule or a blended tax rate.

(c) An additional 5 percent tax, not exceeding $11,750, is imposed on taxable income between $100,000 and $335,000 in order to phase out the benefits of the lower graduated rates.

(d) An additional 3 percent tax, not exceeding $100,000, is imposed on taxable income between $15,000,000 and $18,333,333 in order to phase out the benefits of the lower graduated rates.

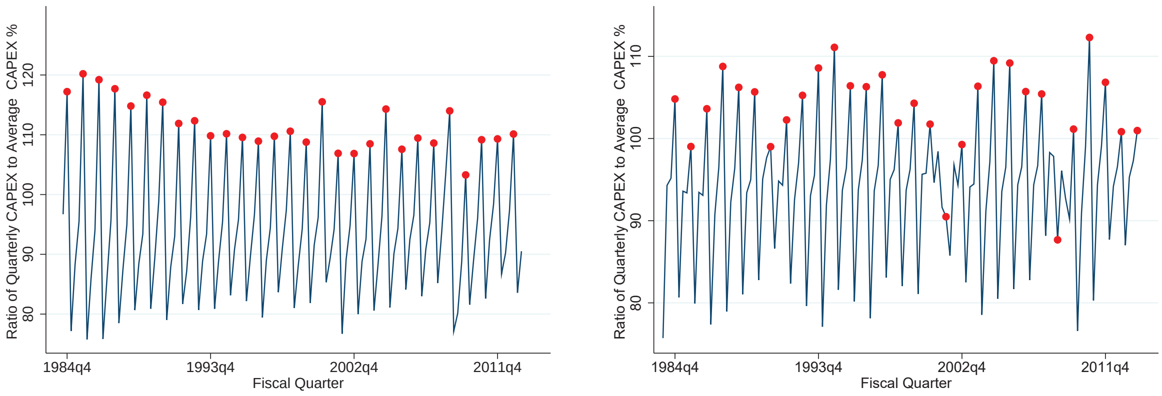
Source: IRS

Table A.2: Variable Definitions

CAPEX/ PPE	Capital Expenditures/ Property, Plant and Equipment
CAPEX Q4 Spike	Ratio of Q4 CAPEX to the average of Q1 through Q3
Cash/Assets	Cash and Short-term Investment/L.Assets
Cash Flow/Assets	(Income Before Extraordinary Items+Depreciation and Amortization)/L.Assets
Dividend Payers	A dummy variable = 1 if a firm pays dividend in a given year
EBITDA/Assets	Earnings before interest, tax, depreciation and amortization/L.Assets
Faulkender-Petersen I	A dummy variable = 1 if a firm's investment expenditures exceed its internal cash flow
Faulkender-Petersen II	Faulkender-Petersen I × A dummy variable = 1 if a firm does not have an S&P domestic long term issuer credit rating
Investment Duration	The inverse of the present value of future depreciation deductions (at NAICS four-digit level)
Leverage	(Debt in Current Liabilities + Long-Term Debt)/ (Debt in Current Liabilities + Long-Term Debt+ Common Equity)
Market-to-Book	(Total Assets − Common Equity + Common Shares Outstanding × Closing Price (Fiscal Year))/Assets
Sales Volatility	Standard deviation of a firm's sales, normalized by the average sales
Sales Q4 Spike	Ratio of Q4 sales to the average of Q1 through Q3
Speculative Grade	A dummy variable = 1 if a firm receives an S&P long-term issuer credit rating below or equal to BB+ in a given year
Tobin's Q	(Total Assets + Common Shares Outstanding × Closing Price (Fiscal Year) − Common Equity − Deferred Taxes)/Asset

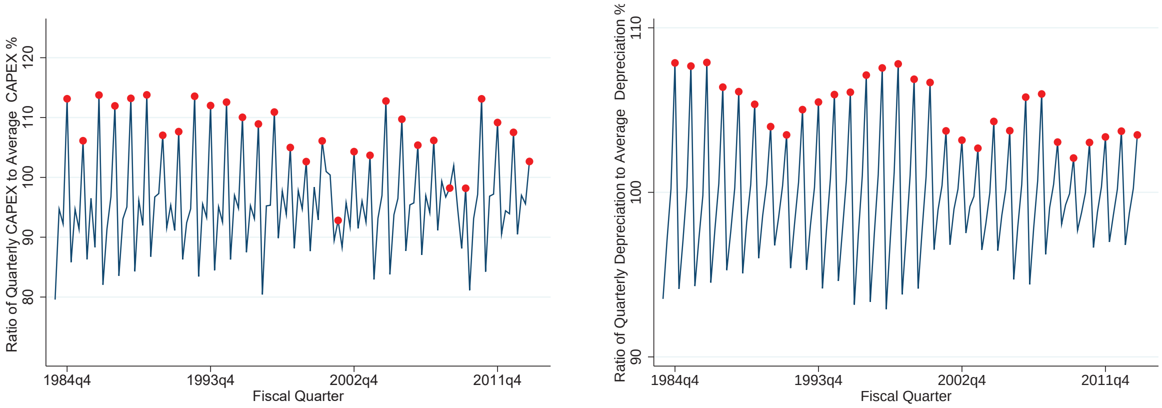
B Appendix Exhibits

Figure B.1: Robustness of Q4 Investment Spikes



(a) Alternative Spike Measure

(b) Fiscal Q1 Drop

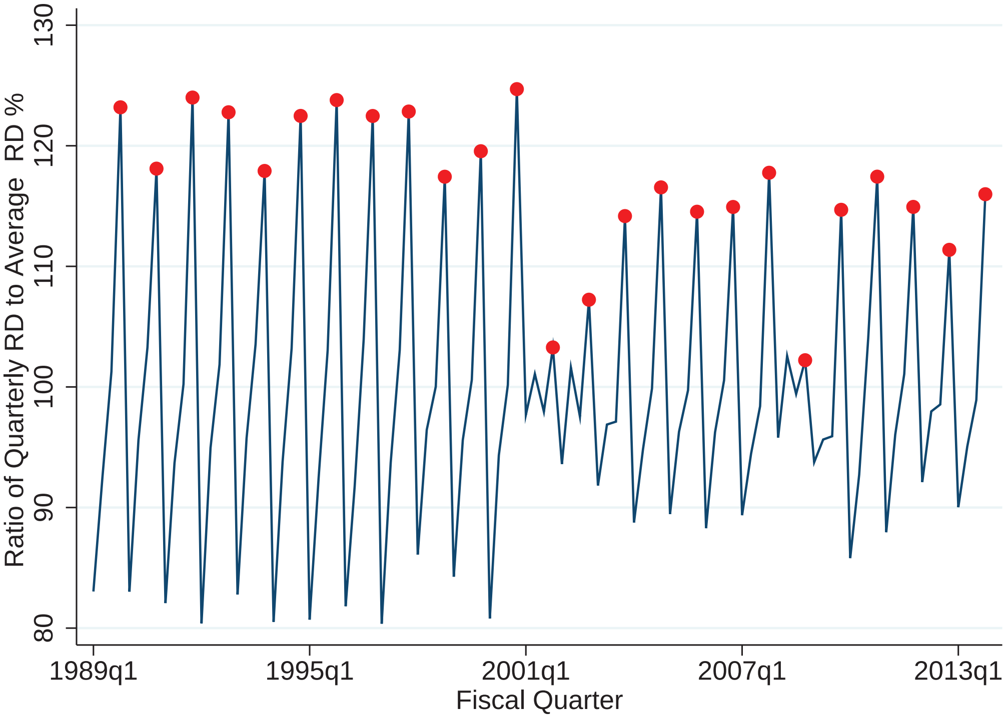


(d) Stable Fiscal Year-End Sales

(d) Fiscal Q4 Book Depreciation Spikes

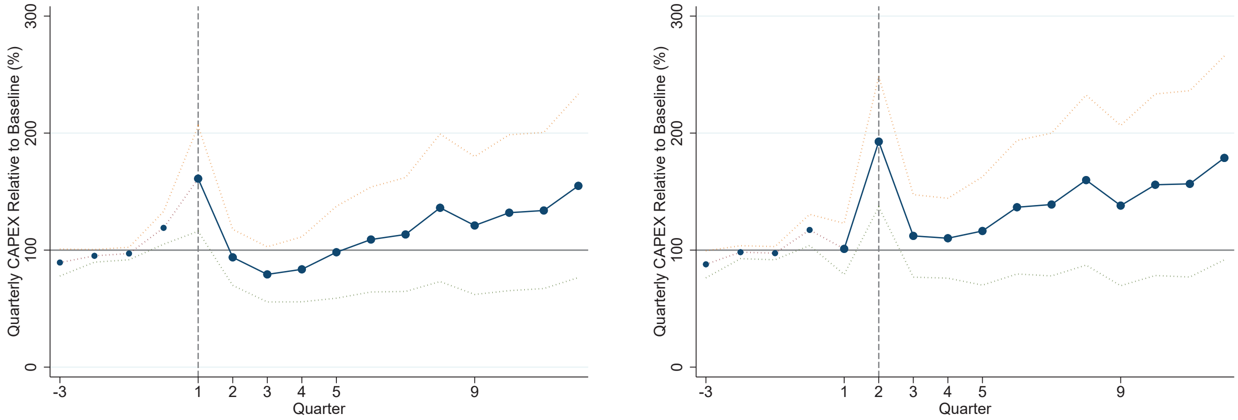
Notes: This figure illustrates the robustness of fiscal Q4 CAPEX spikes. Panel (a) plots the median ratio of quarterly CAPEX to $\frac{l2.CAPEX+l1.CAPEX+f1.CAPEX+f2.CAPEX}{4}$. Panel (b) plots the Q4 CAPEX spikes with red dots being the average of Q4 and next fiscal Q1 to the average CAPEX within a firm's fiscal year. Panel (c) plots the time series of Q4 CAPEX spikes for firms with stable fiscal year-end sales, defined as firm-years for which fiscal Q4 sales are lower than the average of the first three fiscal quarters. Panel (d) plots the median ratio of quarterly book depreciation to the average book depreciation within a firm's fiscal year.

Figure B.2: Time Series of Fiscal Q4 R&D Spikes



Notes: This figure shows fourth quarter Research and Development (R&D) spikes for U.S. firms in Compustat between 1989 and 2013. We plot the median ratio of quarterly R&D to the average R&D within a firm's fiscal year. Red dots indicate the fourth fiscal quarter. R&D is net of R&D related salary and benefit expenses, calculated as the industry average according to the Business Research and Development and Innovation Survey (BRDIS) conducted by the National Science Foundation.

Figure B.3: Quarterly Investment after Spikes

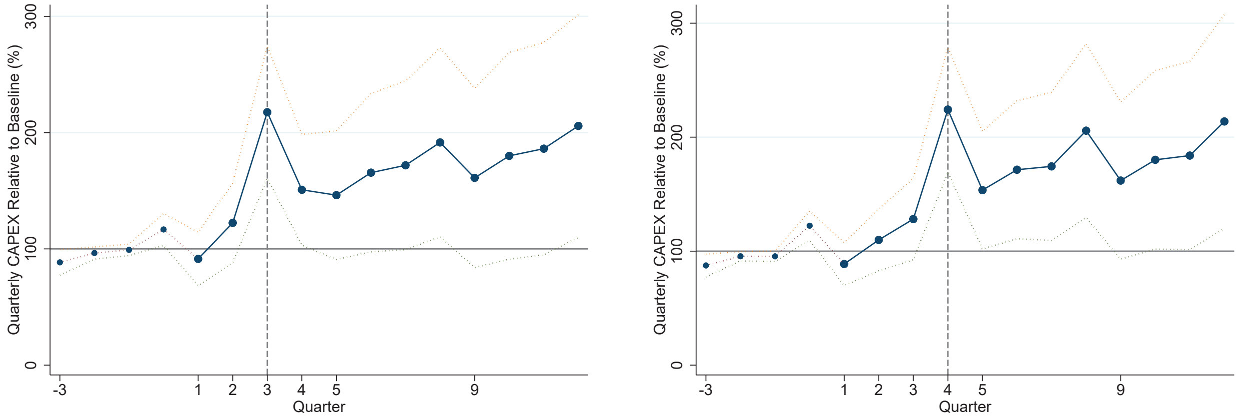


(a) Fiscal Q1 Spikers

(b) Fiscal Q2 Spikers

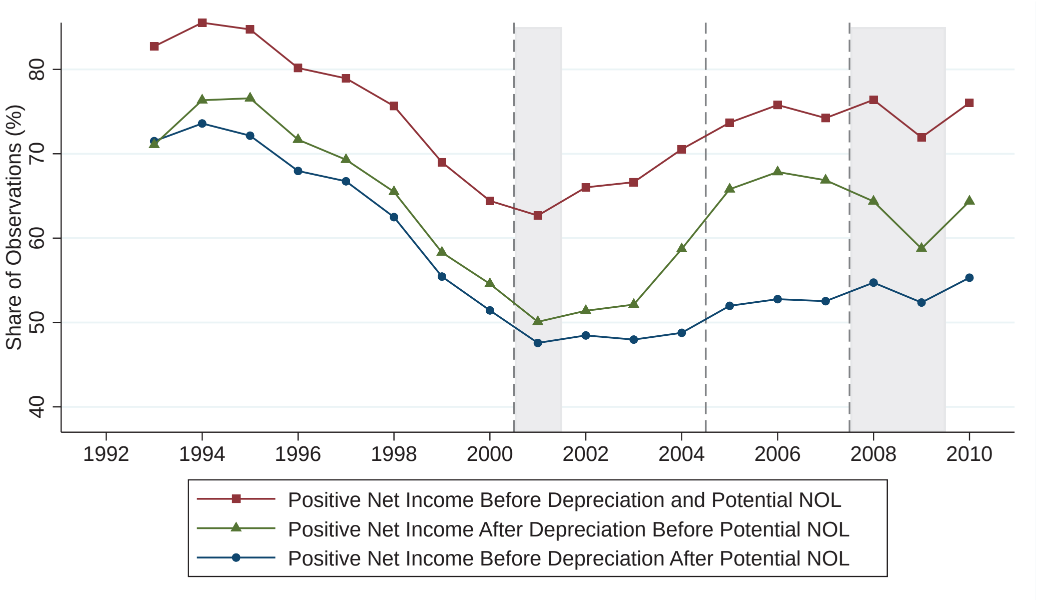
(c) Fiscal Q3 Spikers

(d) Fiscal Q4 Spikers



Notes: This figure presents the quarterly investment level after large spikes in Q1, Q2, Q3, and Q4 in panels (a)-(d), respectively. Large spikes are defines as event quarter spikes CAPEX Q/Ave(Q1-Q4) exceeding 113.65% (the sample median Q4 spike level). The baseline (denominator) is the average quarterly CAPEX in the year before spikes (t from -3 to 0), and the numerator is the quarterly CAPEX. The dotted lines are 95% confidence intervals.

Figure B.4: Time Series of Immediate Benefits from Depreciation



Notes: This figure shows the share of firms in our matched Compustat-SOI sample who have potential to immediately benefit from depreciation deductions. We plot the share of firms with positive net income before depreciation and potential net operating loss (NOL) deductions, the share after depreciation but before potential NOL deductions, and the share before depreciation but after potential NOL deductions. The dashed lines correspond to the two periods of "bonus" accelerated depreciation in our sample (2001–2004 and 2008–2010). The shaded regions denote NBER recession windows.

Table B.1: Investment Spikes and Debt Spikes

(a) Debt Spikes for all Sample Firms

	(1) Debt Issues 4/3 (%)	(2) Long-term Debt 4/3 (%)	(3) Current Debt 4/3 (%)	(4) Total Debt 4/3 (%)
CAPEX 4/3 (%)	7.56***	3.25***	1.35**	2.46***
	(0.63)	(0.27)	(0.56)	(0.22)
Observations	47879	92252	85738	92182
Adjusted R^2	0.07	0.04	0.03	0.07
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

(b) Debt Spikes for Firms with non-December Fiscal Year-End

	(1) Debt Issues 4/3 (%)	(2) Long-term Debt 4/3(%)	(3) Current Debt 4/3 (%)	(4) Total Debt 4/3 (%)
CAPEX 4/3 (%)	5.50***	2.14***	0.72	1.56***
	(1.03)	(0.42)	(0.89)	(0.35)
Observations	16486	33383	31689	33266
Adjusted R^2	0.07	0.03	0.05	0.08
Year FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes

Notes: This table presents regression estimates relating the magnitude of firm Q4 investment spikes to Q4 debt spikes. Firm and year fixed effects are included. Firm Q4 investment spikes are standardized for ease of interpretation. Standard errors are clustered at the firm level.

Table B.2: Fiscal Q4 CAPEX Spikes and Tax Status (Alternative Specifications)

(a) CAPEX Q4/Ave (Q1-Q4)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(taxable)	5.8***	5.2***	2.8***	7.2***	5.0***	5.2***	4.9***
	(0.8)	(0.8)	(0.8)	(1.7)	(1.7)	(1.0)	(1.0)
CAPEX/PPE		2.2***	2.0***		2.3**		2.3**
		(0.6)	(0.6)		(1.2)		(1.0)
EBITDA/Assets			23.4***				
			(2.9)				
Observations	49178	47582	47524	19429	18744	29749	28838
R^2	0.0825	0.104	0.106	0.0901	0.116	0.0943	0.110
Controls	No	1	2	No	1	No	1
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period				Pre-2000	Pre-2000	Post-2000	Post-2000

(b)CAPEX Q4/Total CAPEX

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(taxable)	1.5***	1.3***	0.7***	1.8***	1.2***	1.3***	1.2***
	(0.2)	(0.2)	(0.2)	(0.4)	(0.4)	(0.2)	(0.2)
CAPEX/PPE		0.5***	0.5***		0.6**		0.6**
		(0.2)	(0.2)		(0.3)		(0.2)
EBITDA/Assets			5.9***				
			(0.7)				
Observations	49178	47582	47524	19429	18744	29749	28838
R^2	0.0825	0.104	0.106	0.0901	0.116	0.0943	0.110
Controls	No	1	2	No	1	No	1
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Period				Pre-2000	Pre-2000	Post-2000	Post-2000

Notes: This table presents regression estimates of firm Q4 CAPEX spikes on firm tax position by combining CAPEX spike data from Compustat with tax position data from corporate tax returns for the years 1993 through 2010. Specifications follow Table 3 with alternative spike specifications.

Table B.3: Fiscal Q4 CAPEX Spikes and the Tax Reform Act of 1986 (Alternative Specifications)

(a) CAPEX Q4/Ave (Q1-Q4)

	(1)	(2)	(3)	(4)	(5)	(6)
D(1984-1987)	5.2***	2.5***	4.8***	2.5***	5.1***	3.2***
	(0.7)	(0.8)	(0.6)	(0.7)	(0.6)	(0.7)
Observations	24744	22886	61262	56986	117155	107924
Adjusted R^2	0.08	0.08	0.06	0.08	0.07	0.09
Controls	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Period	84-92	84-92	84-00	84-00	84-13	84-13

(b) CAPEX Q4/Total CAPEX

	(1)	(2)	(3)	(4)	(5)	(6)
D(1984-1987)	1.3***	0.6***	1.2***	0.6***	1.3***	0.8***
	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Observations	24744	22886	61262	56986	117155	107924
Adjusted R^2	0.08	0.08	0.06	0.08	0.07	0.09
Controls	No	Yes	No	Yes	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Period	84-92	84-92	84-00	84-00	84-13	84-13

Notes: This table presents regression estimates of firm Q4 CAPEX spikes around the Tax Reform Act of 1986. Specifications follow Table 4 columns (1)-(6) with alternative spike specifications.

Table B.4: Comparative Statics for the Full Model

Model Version	$\hat{\delta}$	τ	Tax Credit?	Mean Investment Ratio
Full	0.119	0.35	NO	107.30
Low Tax Depreciation Rate	0.06	0.35	NO	103.73
High Tax Depreciation Rate	0.18	0.35	NO	119.34
Low Tax Rate	0.119	0.21	NO	103.15
High Tax Rate	0.119	0.46	NO	108.11
Tax Credit	0.119	0.35	YES	117.78

Notes: This table shows how changing the parameters of the Full model affects the average magnitude of fiscal Q4 investment spikes. The mean investment ratio is defined as the mean value of CAPEX Q4/Ave(Q1-Q4) over all firm-years in the simulated model output. The first row presents the parameterization and mean investment ratio of the Full model, while the other rows present this information for versions of the Full model with either a modified tax depreciation rate, a modified corporate income tax rate, or the inclusion of a tax credit.