Kinky Tax Policy and Abnormal Investment Behavior*

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Abstract

This paper documents tax-minimizing investment, in which firms accelerate capital purchases near 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. 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 accelerate capital purchases near 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 accelerate their investment near 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.

Supplementary data affirm that fiscal Q4 investment spikes do not merely represent reporting behavior by firms. 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 Census survey data from domestic manufacturers, spikes in aggregate capital goods shipments coincide with the months during which firms commonly have fiscal year-ends.

We interpret Q4 investment spikes through the lens of a quantitative investment model that embeds a tax-minimization motive. 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. Because tax positions can be better estimated close to fiscal year-end when most revenues and expenses for the year have been recorded, accelerating investment allows firms to maximize the tax benefit of depreciation. The sharp nature of Q4 spikes allows us to show that tax motives are driving an important part of this investment behavior.

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. 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 affected 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 in general 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 accelerate investment. Consistent with a tax-minimization motive, regression estimates confirm that after 1987, fiscal Q4 investment spikes are 5% to 10% lower than before.

In the last part of the paper, we ask what type of firm is more inclined to employ a tax-minimizing investment strategy. Firms relying heavily on internal funds to finance investment 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. We also decompose the widely documented correlation between investment and cash flow, which reveals that tax-minimizing investment likely confounds the interpretation of 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 on average. The last 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 are unlikely to explain differential behavior based on tax incentives.

We also study the cumulative impact of investment spikes on the level of investment. The exercise addresses the question of whether Q4 spikes have any medium- or long-term implications beyond the quarter following a spike. It also provides further evidence that spikes reflect time-varying opportunities for firms to offset tax bills associated with positive earnings shocks. We follow the average quarterly investment levels up to eight quarters after large Q4 spikes and confirm that investment spikes do not fully reverse in the subsequent quarters. Firm-years with Q4 spikes exceeding 200% show investment rates 6% higher (15% of the sample mean) than within-firm averages. Investment rates remain high the following year before reverting to pre-spike rates two years later. In addition, Q4 spikes are negatively autocorrelated over

[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.

longer horizons, which suggests a process with some mean reversion rather than mechanical repetition of spike patterns each year.

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, our goal is more to understand the underlying mechanism and less to measure a policy parameter. 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), Giroud and Rauh (2016), and Ohrn (Forthcoming) find meaningful effects of tax rate changes on firm location, investment, and employment; 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 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

[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), Giroud and Rauh (2016), and Ohrn (Forthcoming). Hassett and Hubbard (2002) survey the early research and offer a consensus view, which is mostly consistent with subsequent findings.

patterns in the data.[3]

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 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 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 (or "kink") in the marginal incentive

[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 (2016).

[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.

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 kink 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 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

[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.

[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).

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. 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 prevailing in the pre-TRA86 period raises this benefit by 12% to $2.28. The investment tax credit has a larger effect, raising the benefit by an additional $0.65 to $2.93. Thus, the overall benefit to accelerating the investment increases by 44% 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 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

[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, 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.

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 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

[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.

[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.

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 the corporate or budgetary complexity of firms.[17]

Finally, we draw data on equipment lending from the Equipment Leasing and Finance Association's (ELFA) Monthly Leasing and Finance Index (MLFI-25) and on aggregate investment from the Manufacturers' Shipments, Inventories, and Orders (M3) survey data from the Cen-

[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.

[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.

sus Bureau. 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.

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 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

[18]Figure 1(a) and other time series figures use the average within a firm's fiscal year 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.

[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 4.4. We thank Mitchell Petersen for comments on how to address this concern.

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.

To further confirm that investment spikes reflect real activity, we explore the possibility of Q4 spikes from the lending and borrowing perspective. Figure 2(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 ranged from $6 to 9 billion per month before December, and in December 2014 it increased sharply to around $13 billion. Similar December spikes can be seen throughout the whole decade of the sample.[22]

[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) conduct 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]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

One might be concerned that lending-side unobservables are driving December spikes in new business volume. If for some reason lenders offer cheaper loans in December, then December lending spikes may not be surprising. However, in a 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. 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 the sales season. The analysis of taxation and investment spikes in Section 3 provides further evidence that lending market cycles cannot account fully for Q4 spikes.

Figure 2(b) asks whether Q4 spikes appear to influence aggregate investment patterns using data from the Census Bureau's manufacturer shipments, inventories, and orders (M3) survey. For each month, we compute the ratio of monthly shipment value to the average monthly value within that month's calendar year. We plot the average for each calendar month over the period from 1958 to 2016. 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.

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 3 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 3, 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

year.

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 shift investment, 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 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 4(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. All regressions include firm and year fixed effects. Thus, the regressions

[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.

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, an effect size equal to 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 issue in Section 4.

When filing tax returns, firms can deduct net operating loss carryforwards if they enter the tax year with past losses.[24] 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 4(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.

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 in the U.S. TRA86 repealed the Investment Tax Credit (ITC), decreased the top corporate income tax rate, and introduced the less generous Modified Accelerated Cost Re-

[24]See IRS publication 536 for more details on the tax treatment of net operating losses.

covery 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 that shocks affecting the level of investment would also systematically shift investment toward a particular 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. 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. In Section 4.5, we explore a third alternative, "Use it or lose it" budgeting.

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% 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 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%, a modest but meaningful decrease relative to the 20.7% average before 1987.

Figure 4(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.

4 Cross-Sectional and Dynamic Drivers of Investment Spikes

This section develops a dynamic model of investment in the presence of a tax motivation to accelerate investment. We link the model to data and examine how different factors influence the magnitude of fiscal year-end investment spikes. 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 A Dynamic Model of Tax-Minimizing Investment

Beginning with a discrete time, neoclassical investment model with adjustment costs (Abel, 1982; Hayashi, 1982; Winberry, 2016), 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 parameters govern the magnitude and frequency of investment spikes?

Model. The model follows Winberry (2016), modified to include a tax asymmetry and two sub-periods within the fiscal year with different after-tax investment prices. 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 θ, ν, 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 a left-skewed distribution of profitability to fit the Compustat 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 two halves, I and II. In the first half, depreciation deductions on current investment are disallowed. Instead, these deductions carry forward into the second half of the year. Taxable income in each half is given by:

$$\text{(I)}\;\; TI = GOS - \hat{\delta}\hat{k} \qquad\qquad \text{(II)}\;\; TI' = GOS' - \hat{\delta}\hat{k'} - p\hat{\delta}i',$$

where $\hat{\delta}$ is the rate of tax depreciation, $\hat{k}$ and $\hat{k}'$ are the depreciation stocks, and p is the constant market price of investment. Depreciation stocks evolve according to analogous laws of motion to actual capital, except for the difference in deductibility across halves:[25]

$$\text{(I)} \;\; \hat{k}' = (1-\hat{\delta})\hat{k} + pi \qquad\qquad \text{(II)} \;\; \hat{k}'' = (1-\hat{\delta})\hat{k}' + p(1-\hat{\delta})i'.$$

We can now write the recursive firm problem for each half of the fiscal year. The firm's state variables are the capital stock k, stock of depreciation deductions $\hat{k}$, productivity ε, and profitability shifter ω. The first half value function is defined by the Bellman equation:

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

where the first two terms are constant with respect to the choice problem over i. The second half value function is defined by the Bellman equation:

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

We note two differences between the first half value function (1) and the second half 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) and (2), 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 a direct incentive and an option value for shifting investment between the first and second halves of the fiscal year. Furthermore, the

[25] 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.

value functions show how the incentive to use investment to minimize taxes is stronger in the second half because there is no uncertainty about the firm's tax position as a function of investment.

Solution and Calibration. We solve the model by value function iteration following Telyukova (2013), who solves a similar problem in which consumers deterministically alternate between goods markets with different credit arrangements. We first discretize the capital, depreciation allowance, productivity, and ω vectors. Then, we guess $V^I(k, \hat{k}, \varepsilon, \omega)$ and compute its numerical derivative with respect to k'' in each cell of the state space, which allows us to find a solution to (2) via first-order condition. We then substitute the optimal choice of k'' into $V^{II}(k', \hat{k}', \varepsilon', \omega')$, compute its numerical derivative with respect to k', and solve (1) via first-order condition. Finally, we substitute the optimal choice of k' into $V^I(k, \hat{k}, \varepsilon, \omega)$ and compare this to our initial guess. We iterate the process until global value function convergence.

After solving the model, we simulate investment and capital paths for 10,000 firms with different productivity shock paths over $T = 500$. Our "Baseline" parameterization is as follows. We use the following parameters from Winberry (2016): output elasticities $\nu = .21$ and $\theta = .64$, discount rate $\beta = .98$, productivity persistence $\rho = .94$, the standard deviation of productivity $\sigma_\varepsilon = .026$, and convex adjustment costs $\phi = 2.69$. We parametrize ω as a skew-normal with a location parameter of 0, a scale parameter of $\sqrt{3}$, and a shape parameter of -2, jointly chosen to match the distribution of EBITDA/Assets in our Compustat sample.[26] In the Compustat data, the coefficient of variation for this variable is 1.8, while its simulated analog (GOS/Assets) has coefficient of variation of 1.9. The simulation generates a nontaxable share of 25%, compared to 31% for our matched analysis sample.[27] Notably, when we simulate the model with $\omega = 0$, the nontaxable share is approximately zero. Thus, our Baseline process matches the underlying variance of earnings and taxable income reasonably well.

We also follow Winberry (2016) and set economic depreciation $\delta = .05$ and tax depreciation $\hat{\delta} = .238$ 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

[26] In particular, let $\omega \equiv \omega(u, v) = u - v$, where u and v are independent and identically distributed with u drawn from a normal distribution, $\mathcal{N}(0, \sigma_u^2)$, and v drawn from a half-normal distribution, $\mathcal{HN}\left(\sqrt{\frac{2}{\pi}}\sigma_v, \left(1 - \frac{2}{\pi}\right)\sigma_v^2\right)$. The composed error formulation was initially proposed by Meeusen and van Den Broeck (1977) in the context of production function estimation.

[27] Relative to the 36% net operating loss share in Zwick (2018), the empirical nontaxable share is lower here because (1) it is computed before depreciation deductions and (2) it only includes larger public companies.

assets is 0.05 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 $\tau = .35$, the top statutory rate at the end of our sample.

Comparative Statics. The model delivers several comparative statics, which we explore first in simulated data and then in Compustat data. Figures 5(a)-(c) present key stylized facts from the simulated data. Figure 5(a) plots average fiscal second-half (H2) investment spikes, indicating that the model is able to match the data's quantitatively large spikes accelerated at the end of the fiscal year. We plot results for two versions of the model, a Baseline version following the parameterization above and an "$\omega = 0$" version which removes the profitability shifter from the model. The $\omega = 0$ model yields larger spikes than the Baseline 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 one-quarter of Baseline firm-years experience tax losses, which attenuate the tax-minimization motive.

Figure 5(b) plots median investment spikes for three model simulations with different discount factors for the Baseline and $\omega = 0$ productivity processes, respectively. The magnitude of investment spikes is increasing in the discount rate firms apply to depreciation deductions. A higher discount rate raises the value of accelerating deductions. This effect increases approximately 20% in the Baseline relative to the $\omega = 0$ specification, as immediate tax benefits are worth more when the firm faces risk of deferring those benefits due to potential future tax losses. In the next section, we explore the relationship between spikes and discount rates using proxies for high discount rates from the finance literature.

Figure 5(c) plots median investment spikes for model simulations with different tax rates. 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 half (1) and the second half (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. In contrast to the result for discount rates, the relationship between tax rates and spike patterns is stronger in the $\omega = 0$ specification. This result owes to the attenuation in average spike behavior in the Baseline specification due to a non-trivial share of firm-years with tax losses.

4.2 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: 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).

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%, whereas firms in the bottom quartile reduced Q4 spikes by 8.9%.[28] In columns (2) through (5), the effects are consistently at 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

[28] The top and bottom quartiles have mean ln(assets) equal to 8.25 and 3.42, respectively. Implied effects equal $14.24 - 1.56 \times 8.25 = 1.37$ and $14.24 - 1.56 \times 3.42 = 8.90$, respectively.

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 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.

4.3 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 spikes on average.

Figure 6(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 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. 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.

The tax-minimization hypothesis 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 6(b) and 6(c) 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.

Figure 6(d) replicates the analysis of investment duration in model-simulated data with different rates of economic depreciation. For both the Baseline and $\omega = 0$ process, investment spikes strongly increase in the duration of investment. As with the tax rate comparative static, the relationship between duration and investment spikes is stronger in the $\omega = 0$ simulations because of attenuation from tax losses in the Baseline simulations.

More interesting is the comparison between these productivity processes and the earnings relationships in Figures 6(e) and 6(f). The Baseline model successfully matches the relationship in the data for both the within-firm earnings mean and variance. These relationships are modestly stronger when the firm has a higher discount rate. Importantly, the $\omega = 0$ simulations cannot match these relationships, which underscores the likely importance of tax asymmetries and immediate tax benefits in generating the empirical patterns we observe.

Figures 7(a)-(c) provide 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 plot binned scatterplots with the median Q4 spike on the y-axis and different lagged Q4 spikes on the x-axis, ranging from one to five years prior. The plots present residuals after firm fixed effects have been removed and thus reveal the autocorrelation of investment spikes within-firm over time. The graphs indicate a negative slope that weakens to approximately zero after five years. The negative slope suggests that Q4 spikes do not fully persist year after year, instead reflecting a process with some mean reversion. Figures 7(d)-(f) explore this relationship in model-simulated data. For lagged spike levels below 200%, the patterns are qualitatively similar between the Baseline model and the data. However, the model cannot match the negative relationship for very high lagged spike levels. We conjecture that a model with fixed costs or a mix of short- and long-duration assets might account for this behavior.

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 8 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.[29] 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%. The result suggests that earnings management and tax planning are connected decisions, with an active trade-off margin operating between them.

4.4 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 Q4 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.

Figure 9(a) plots in event time the ratio of average quarterly CAPEX to average CAPEX in Q2 and Q3 of the base year for the subset of firms with spikes above the sample median. The dotted lines indicate 95% confidence intervals. We follow the average quarterly CAPEX relative to base up to eight quarters after Q4. Approximately one-third of the ratio reverses following the decrease in the next fiscal Q1 CAPEX; however, the cumulative level remains persistently above 100% even after 8 quarters. The series also shows a noticeable but smaller spike in the following fourth quarter.[30]

Figure 9(b) plots analogous relationships for model-simulated data. The graph yields similar results, with a weaker reversal in the Baseline and high discount rate simulations relative to the $\omega = 0$ simulation. This fact reflects the more valuable optionality of retiming investment when firms face a non-trivial risk of tax losses in future years.

Figure 9 suggests that the Q4 CAPEX spikes represent a higher level of investment during the spike year and not only high frequency intertemporal shifting. Table 7 presents firm-level regression estimates that confirm this finding. All regressions include firm fixed effects and

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

[30] Appendix Figure B.3(a) plots each quarter's CAPEX relative to average CAPEX in Q2 and Q3 of the base year, confirming that investment persists in the period after a spike. Appendix Figure B.3(b) presents a plot using the average quarterly CAPEX in the first three quarters of the base year as the benchmark. The results are very similar.

year fixed effects. Thus, the regressions compare within-firm investment levels around large spikes. We examine investment levels relative to lagged capital from one year before to two years after large spikes, where large spikes are defined as CAPEX 4/3 exceeding 119% (the sample median) in columns (1) and (2), CAPEX 4/3 exceeding 200% in columns (3) and (4), and CAPEX 4/3 exceeding 300% in columns (5) and (6). Columns (2), (4), and (6) add ln(assets), Market-to-Book, Cash/Assets, and EBITDA/Assets as additional controls to absorb the impact of time-varying firm characteristics and earnings shocks on investment levels.

Firm-years with large Q4 CAPEX spikes indeed experience higher investment levels. Interestingly, the spikes in investment levels are persistent and do not reverse for the large spikes even after two years. In terms of the economic magnitude, years with CAPEX 4/3 exceeding 200% show investment levels relative to lagged capital 6% higher than the average, or approximately 15% of the sample mean. In the following year, the investment level remains high, only reversing partly two years later. Furthermore, the reversal does not offset the level increase from the spike year. Adding additional firm controls does not alter this conclusion.

4.5 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 obviously explain the responsiveness of spikes to tax changes.

5 Conclusion

This paper studies a new channel through which taxes affect corporate investment behavior. Because tax positions can be better estimated close to fiscal year-end, accelerating investment expenditures 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. Furthermore, timing responses of the form highlighted here appear as a key class of investment responses to tax policy.

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).[31] 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.

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.

This paper proposes a modification that improves the explanatory power of the benchmark microeconomic model of firm behavior, but only briefly addresses 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.

[31] 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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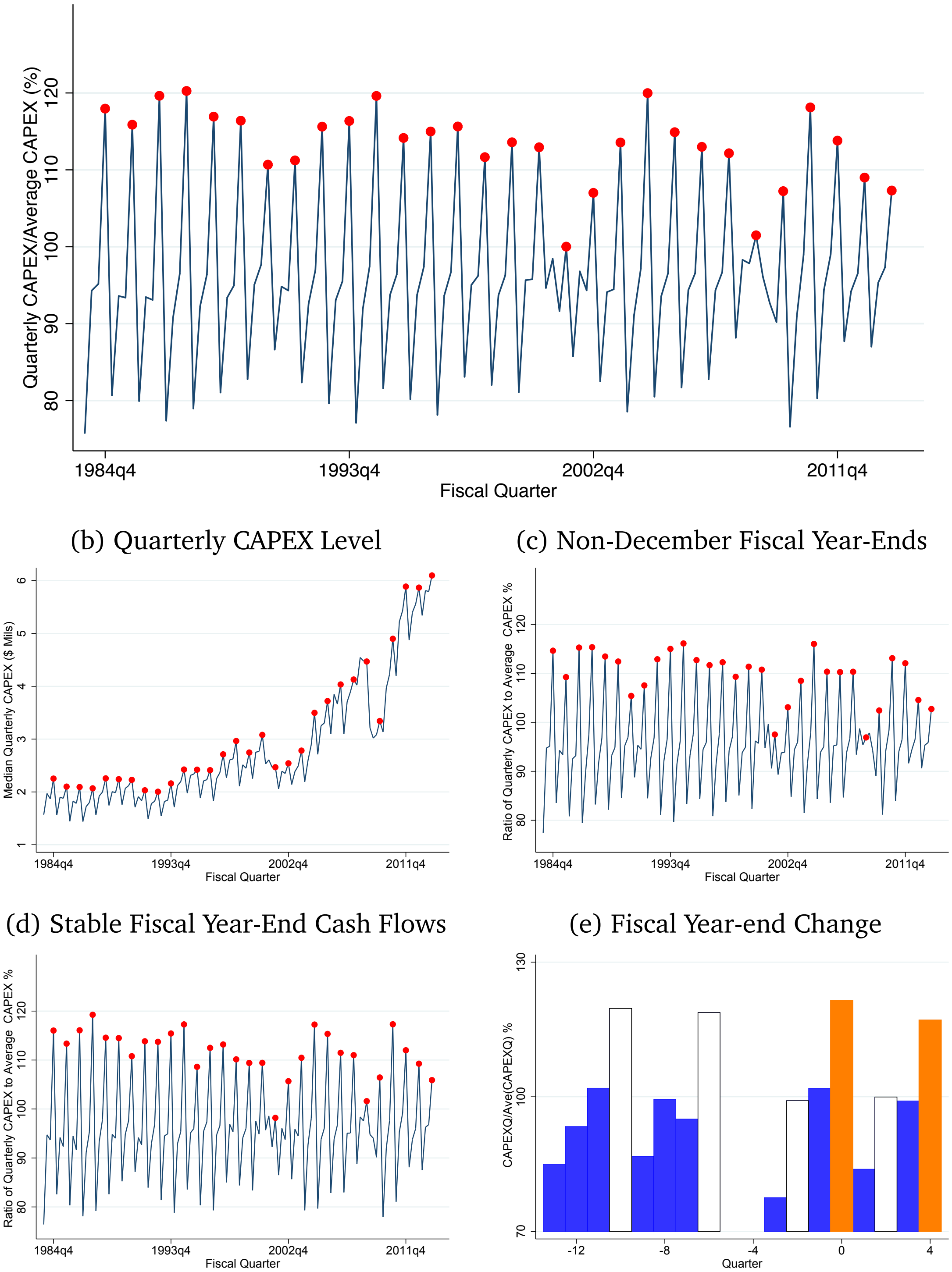
Figure 1: Time Series of Fiscal Q4 Investment Spikes (1984-2013)

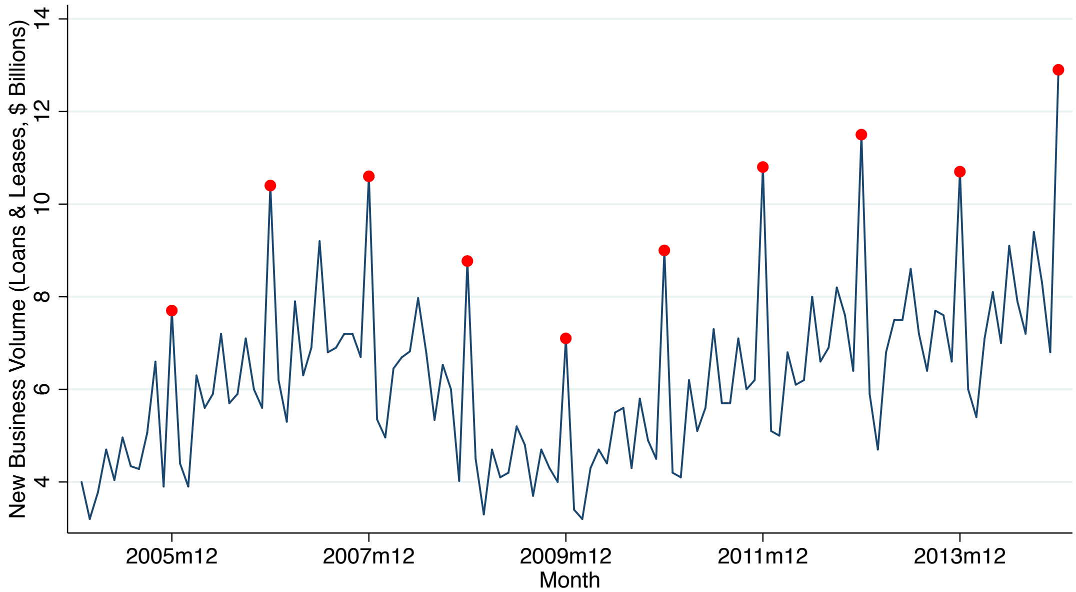
(a) Fiscal Q4 Investment Spikes



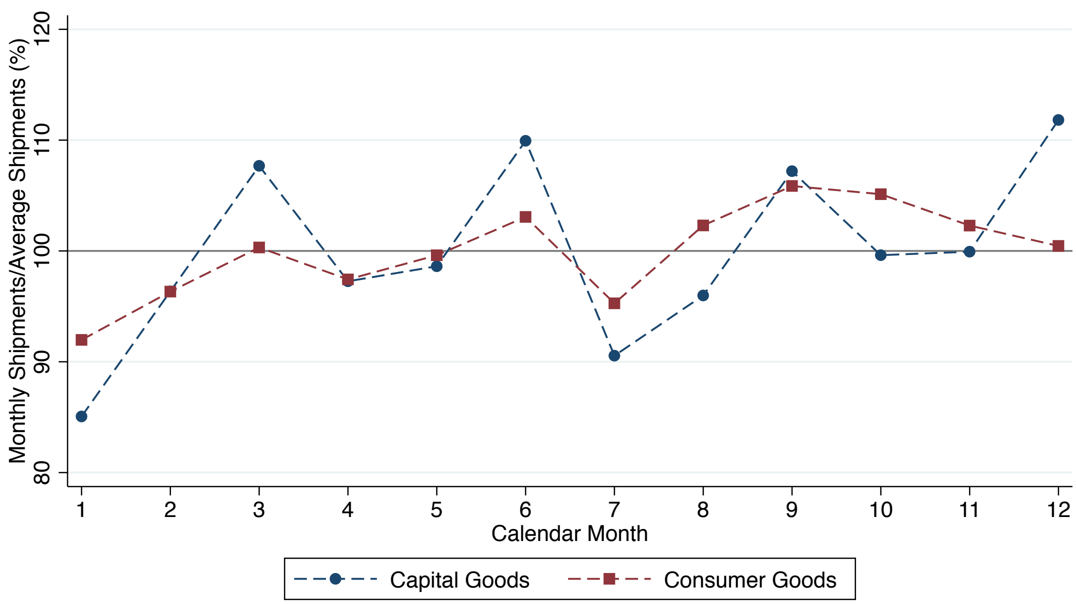
Notes: This figure documents fiscal fourth quarter (Q4) capital expenditure (CAPEX) spikes for U.S. firms in Compustat. Panel (a) plots the median ratio of quarterly CAPEX to the average CAPEX within a firm's fiscal year. Red dots indicate Q4. Panel (b) plots the median quarterly CAPEX level ($M). Panel (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: Spikes in Aggregate Investment Series

(a) Spikes in Capital Lending Volume (2004-2014)

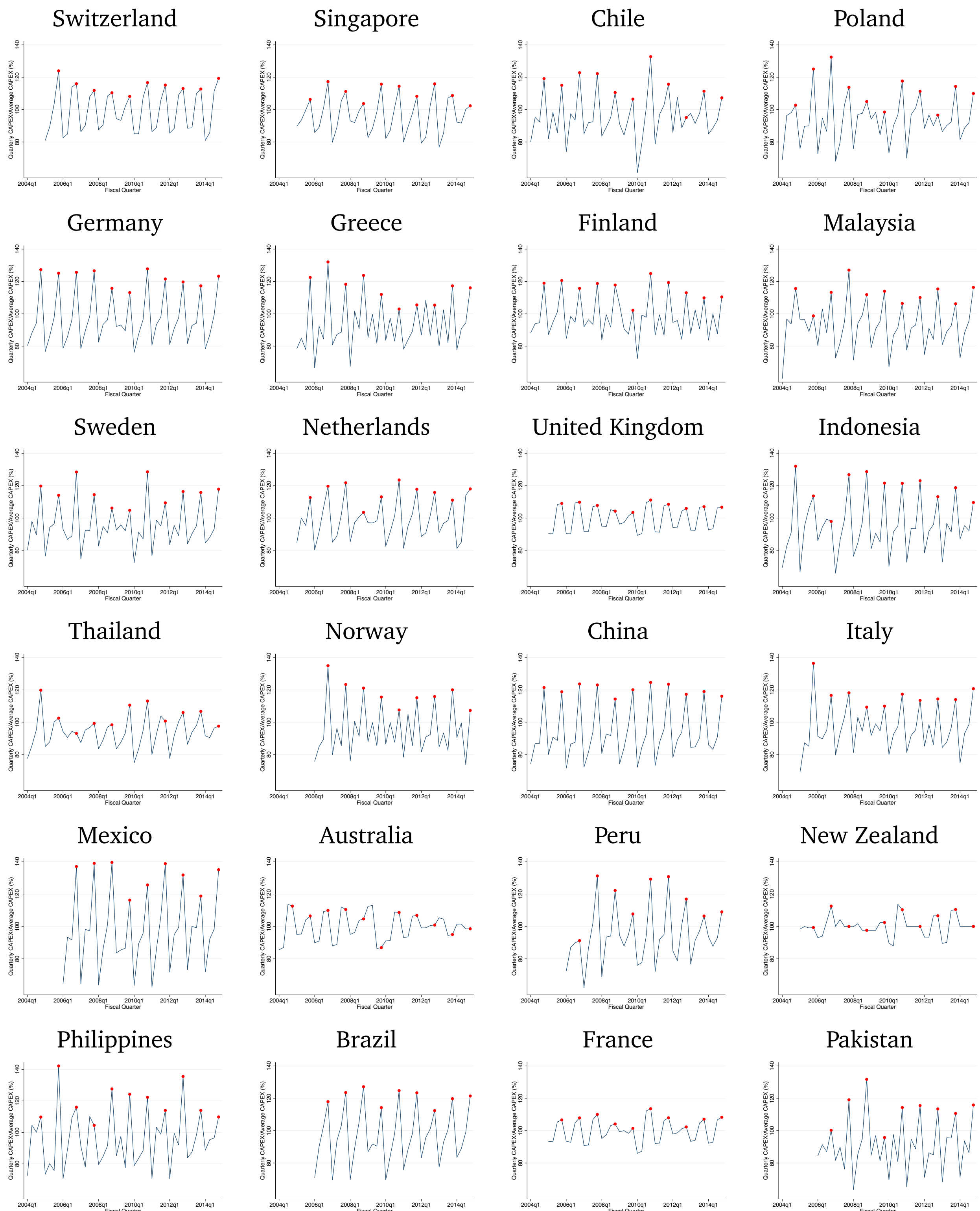


(b) Spikes in Capital Goods Shipments (1958-2016)



Notes: This figure provides evidence that Q4 investment spikes are not artifacts of financial reporting and may affect aggregate quantities. 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 aggregate non-defense capital goods and consumer goods. The data comes from the Census Bureau's manufacturer shipments, inventories, and orders (M3) survey of the domestic manufacturing sector. For each month, we compute the ratio of monthly shipment value to the average monthly value within that month's calendar year. We plot the average for each calendar month over the period from 1958 to 2016.

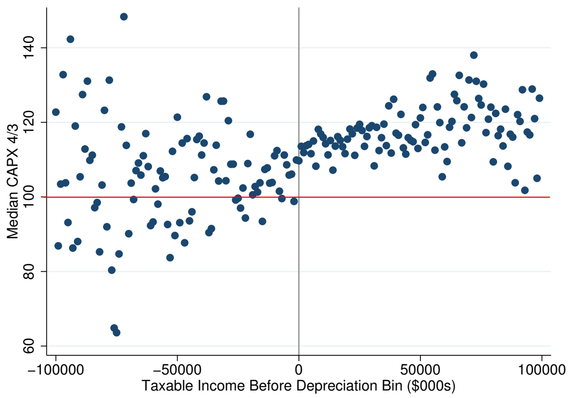
Figure 3: International Evidence of Fiscal Q4 Spikes (2004-2014)



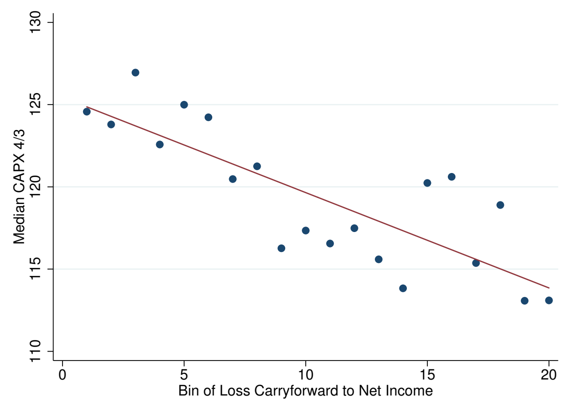
Notes: This figure shows fourth quarter CAPEX spikes across country. Countries are sorted according to their average corporate income tax rate during the sample period: Switzerland has the lowest average corporate income tax rate (≈8%) while Pakistan has the highest (≈35%).

Figure 4: Fiscal Q4 Spikes and Tax Incentives

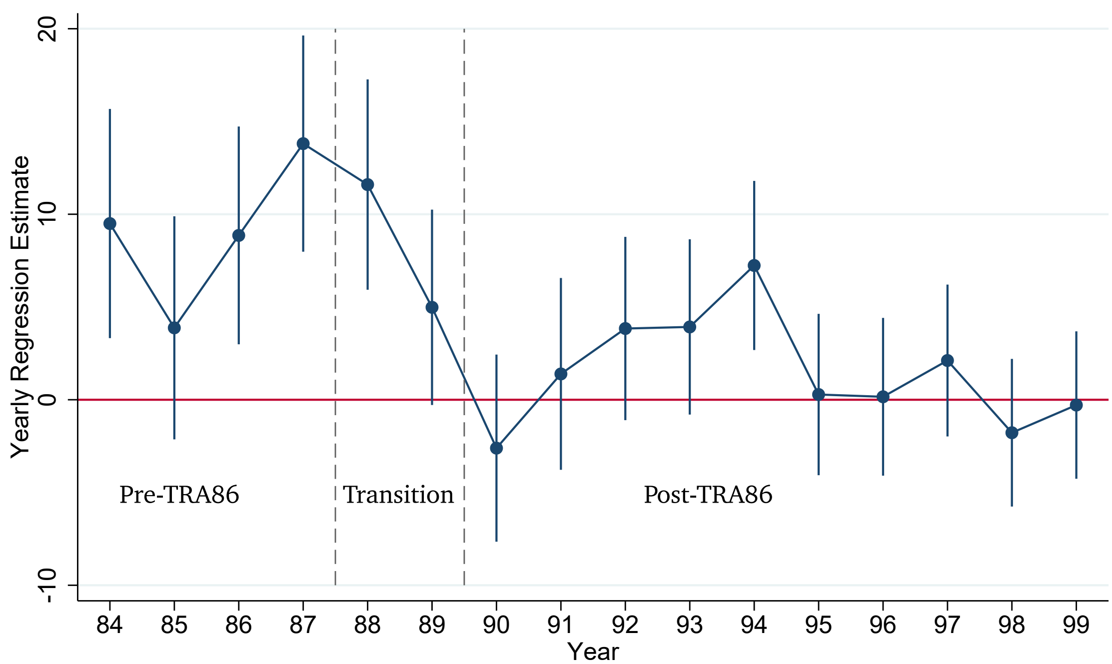
(a) Firm-Years Sorted by Tax Position



(b) Firm-Years Grouped by NOL Stock



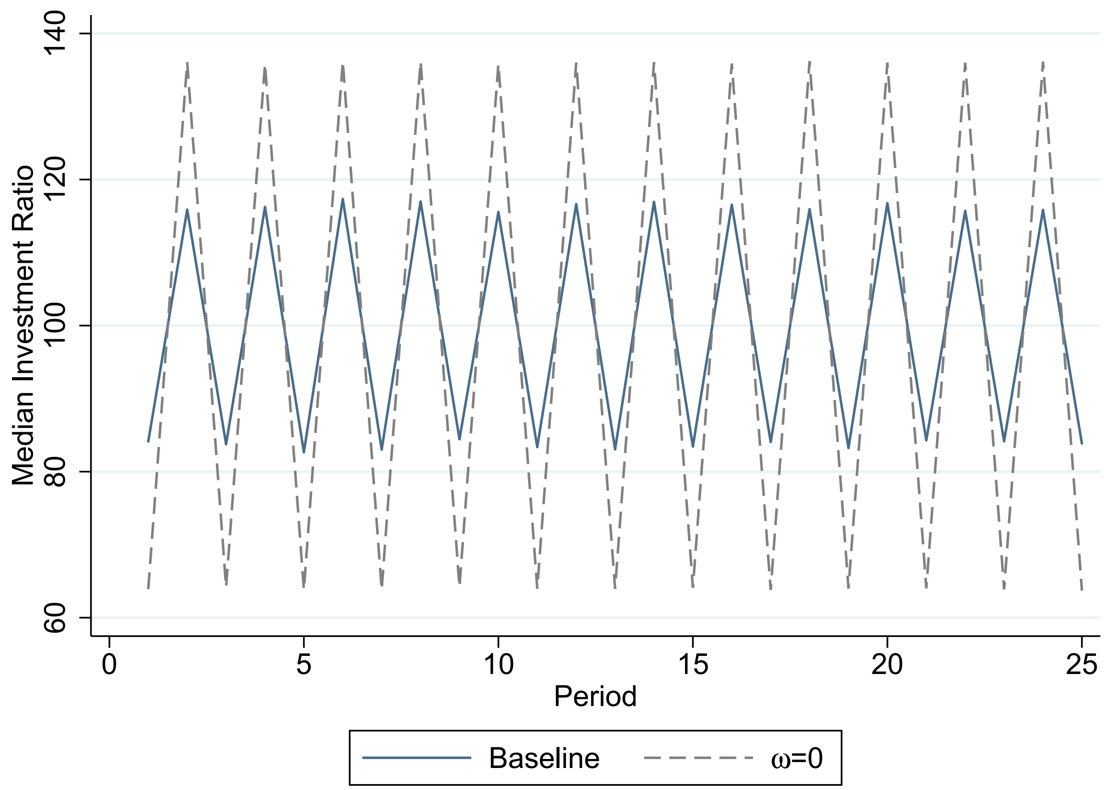
(c) Spikes and the Tax Reform Act of 1986



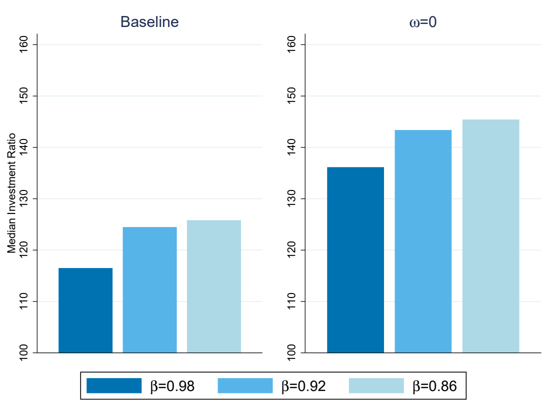
Notes: This figure shows the relationship between fourth quarter capital expenditure (CAPEX) spikes and firm-level incentives to use investment as a tax shield. Both figures identify a firm's tax position by combining CAPEX spike data from Compustat with tax position data from corporate tax returns for 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 5: Comparative Statics in Model Simulated Data

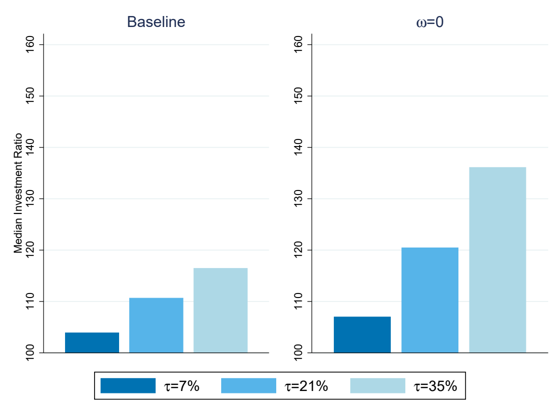
(a) Fiscal H2 Spikes



(b) Spikes Increase in Discount Rates

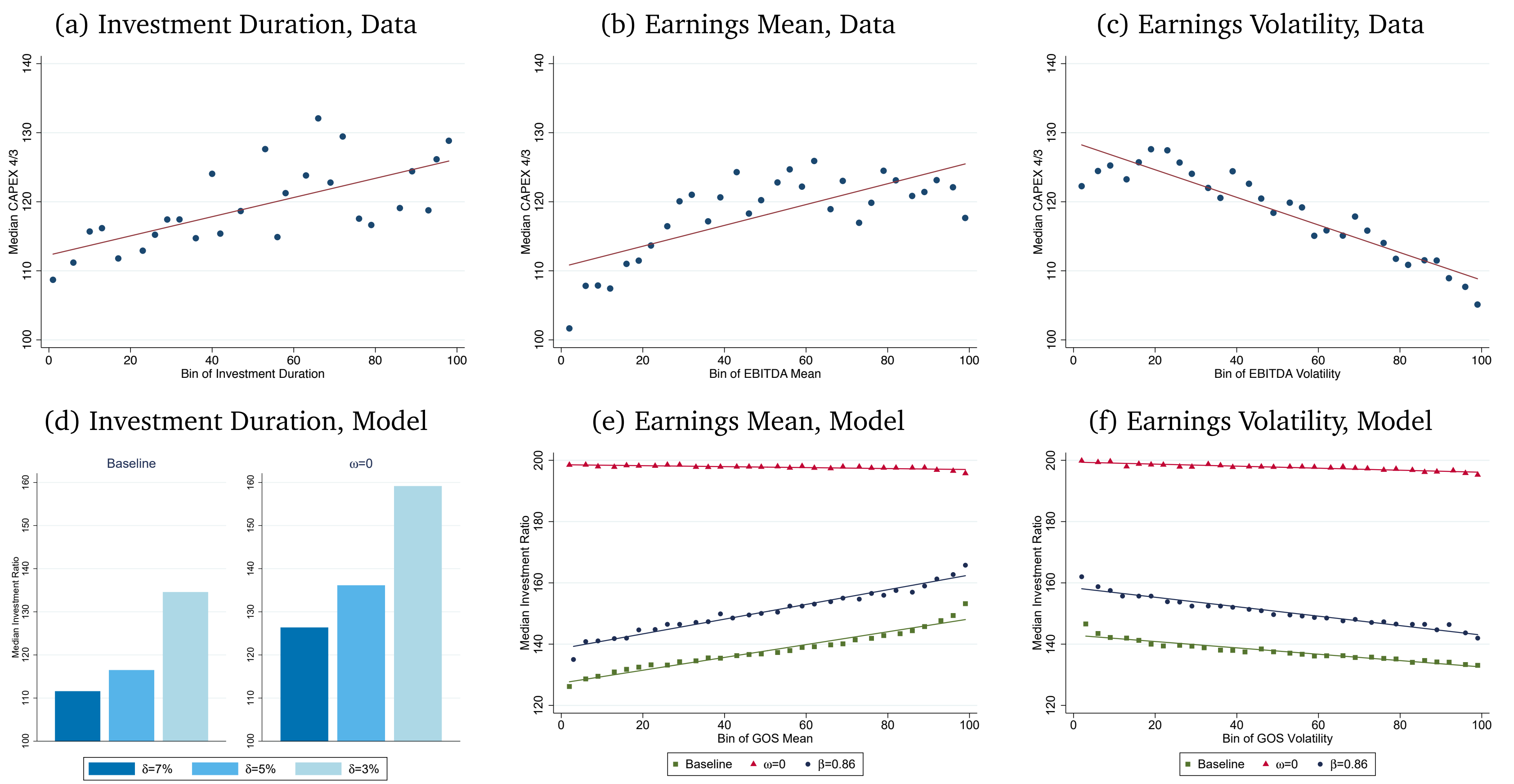


(c) Spikes Increase in Tax Rates



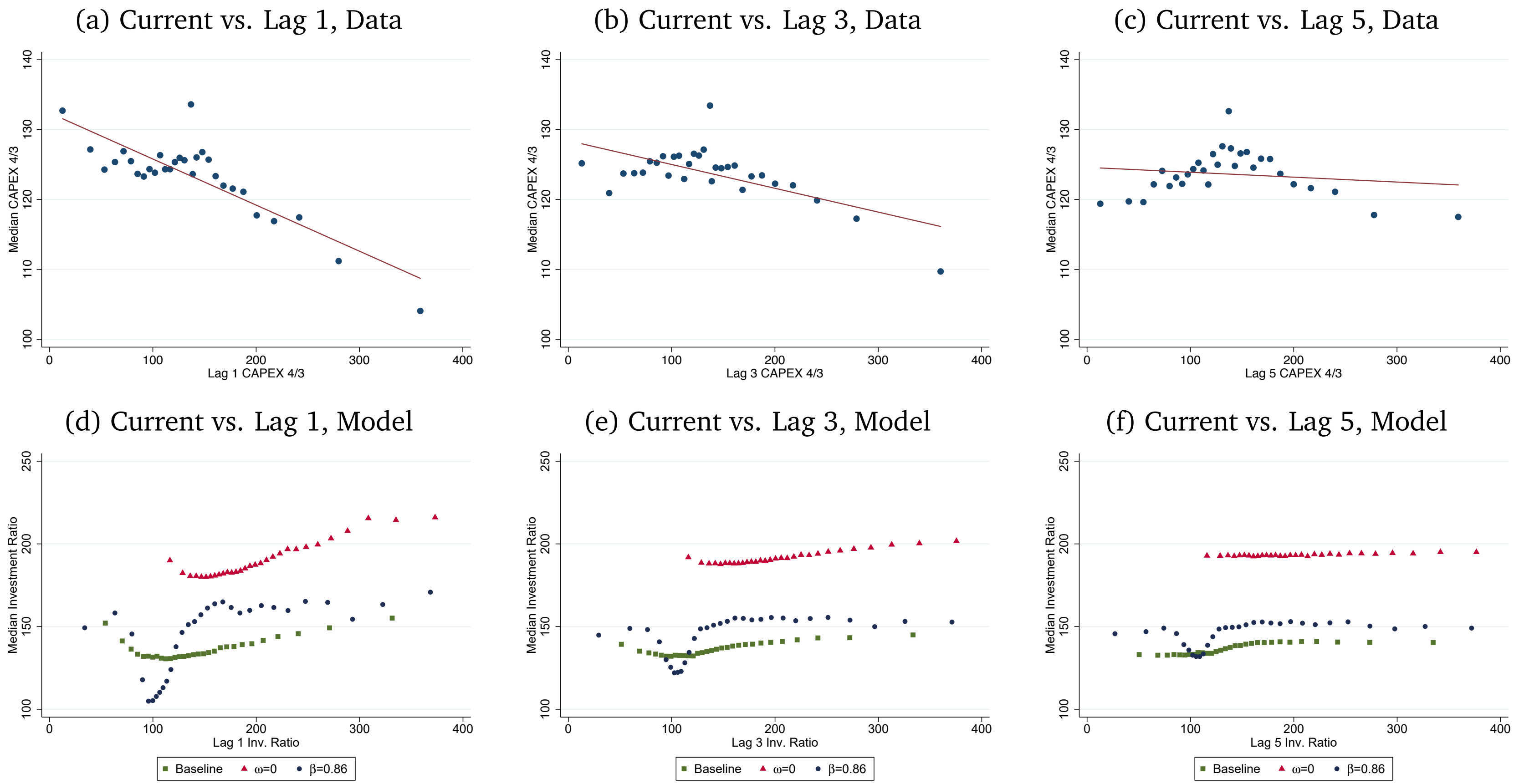
Notes: This figure presents stylized facts and comparative statics from simulated data based on the model in Section 4.1. Panel (a) plots average fiscal second-half (H2) investment spikes for simulated firm data. We plot the median ratio of semiannual investment to average investment within a fiscal year. For the "$\omega = 0$" version of the model, we set the profitability shifter to zero. Panel (b) plots median investment spikes for three simulated versions with different discount factors for the Baseline productivity and $\omega = 0$ productivity process, respectively. Panel (c) plots median investment spikes for three simulated versions with different assumed tax rates for the Baseline productivity and $\omega = 0$ productivity processes, respectively.

Figure 6: Cross-Sectional Determinants of Q4 Spikes



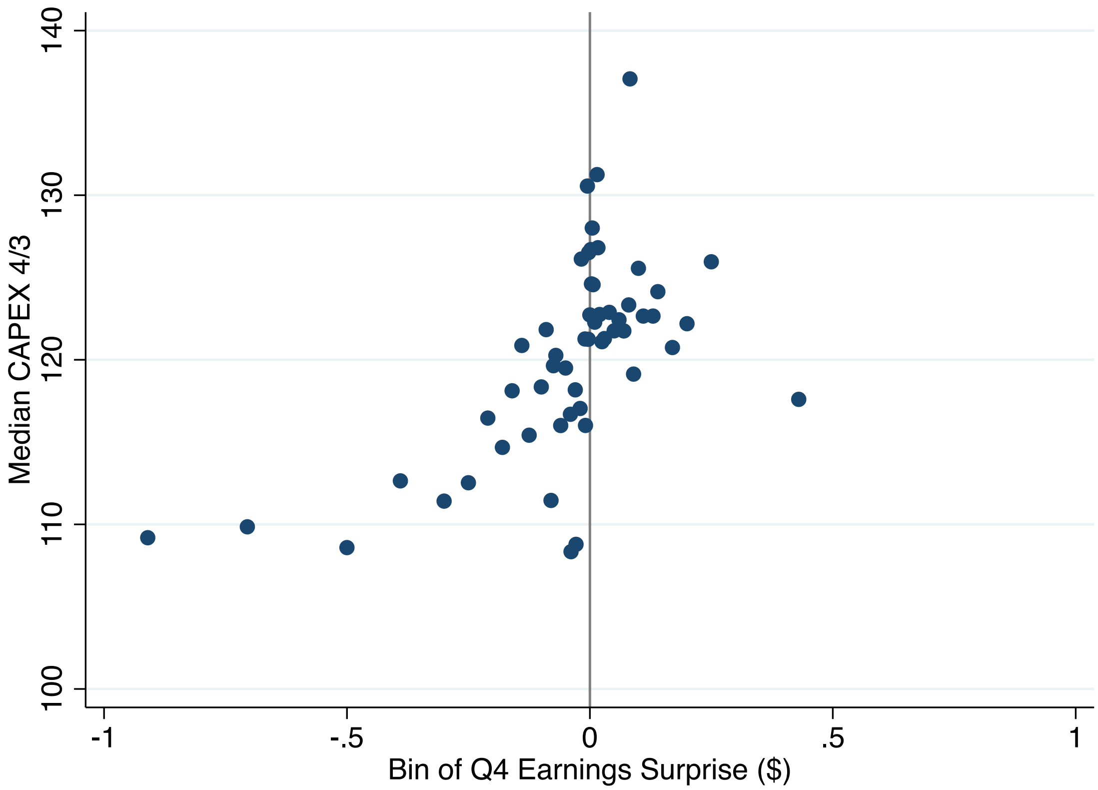
Notes: This figure documents the cross-sectional relationship between Q4 CAPEX spikes and investment duration and earnings volatility, and compares these patterns to model-simulated data. In panel (a), investment duration is derived from the inverse of the present value of depreciation deductions (via Zwick and Mahon (2017) at the NAICS four-digit level) with higher values representing longer equipment investment duration. Panels (b) and (c) plot median Q4 spikes against the mean and variance of EBITDA/Assets, respectively. Panel (d) plots median investment spikes from model simulations with three different assumed economic depreciation rates for the Baseline productivity and $\omega = 0$ productivity processes, respectively. Panels (e) and (f) plot median investment spikes from model simulations with the Baseline parameterization, the $\omega = 0$ process, and the Baseline process with a higher discount rate ($\beta = 0.86$ instead of 0.98). Panel (e) sorts firms by mean gross operating surplus. Panel (f) sorts firms by the variance of gross operating surplus.

Figure 7: Q4 Spikes Autocorrelation



Notes: This figure presents binned scatter plots of the autocorrelation of Q4 CAPEX spikes within firm over time, and compares these patterns to model-simulated data. Panels (a)-(c) plot the median Q4 spike versus lagged spikes for one, three, and five years after absorbing firm fixed effects. Panels (d)-(f) plot analogous relationships for model simulations with the Baseline parameterization, the $\omega = 0$ process, and the Baseline process with a higher discount rate ($\beta = 0.86$ instead of 0.98).

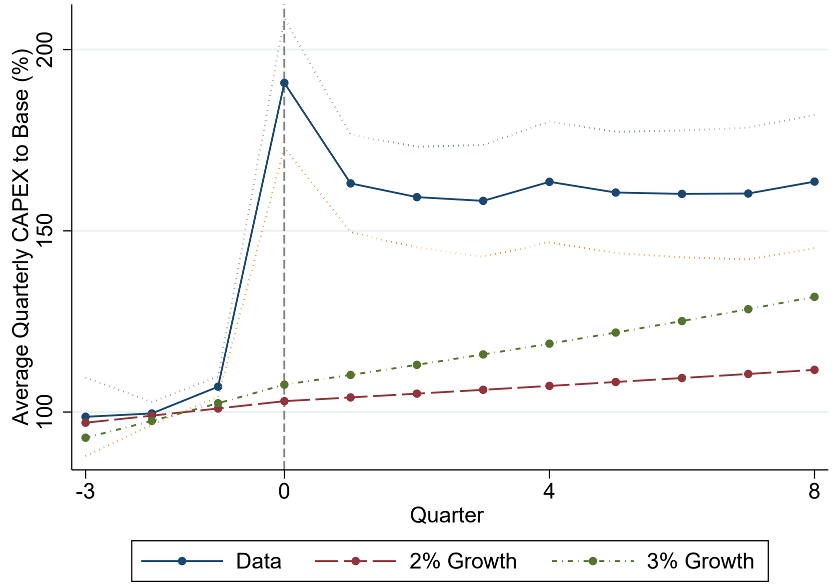
Figure 8: Q4 Spikes and Earnings Management



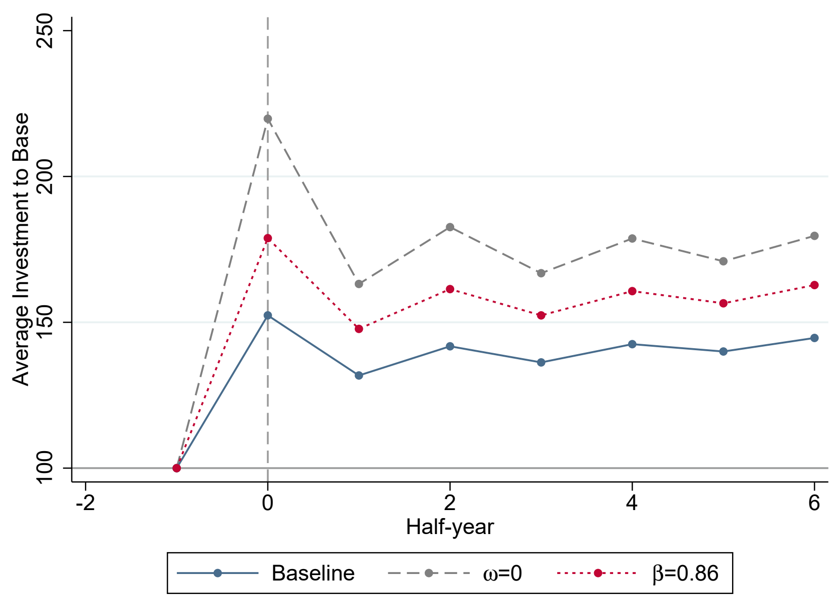
Notes: This figure presents binned scatterplots of median sample firm Q4 CAPEX spikes against earnings surprises. The gray line with earnings surprise equal to zero indicates that firms exactly meet the median analyst forecast.

Figure 9: Cumulative Investment after Fiscal Q4 Spikes

(a) Average Cumulative Investment, Data



(b) Average Cumulative Investment, Model



Notes: This figure presents the cumulative level of investment after large fiscal Q4 spikes, and compares this pattern to model-simulated data. Panel (a) plots the ratio of average quarterly CAPEX to CAPEX$\frac{Q2+Q3}{2}$ in the base year. The numerator is calculated as the average quarterly CAPEX starting from Q4 of the base year: for quarter 4 ($t = 0$) the numerator is CAPEX Q4, for next fiscal year quarter 1 ($t = 1$) the numerator is CAPEX$\frac{Q4+F.Q1}{2}$, for next fiscal year quarter 2 ($t = 2$) the numerator is CAPEX$\frac{Q4+F.Q1+F.Q2}{3}$, and so on. We limit observations to firm-years with base year Q4 spikes larger than the sample median (119%). The dotted lines are 95% confidence intervals. The dashed lines plot the counterfactual investment series with steady investment growth of 2% and 3% per quarter. Panel (b) plots analogous relationships for model simulations with the Baseline parameterization, the $\omega = 0$ process, and the Baseline process with a higher discount rate ($\beta = 0.86$ instead of 0.98).

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	5	6	Total
Expenditure in Year 1								
Depreciation	0	20	32	19.2	11.5	11.5	5.8	100
Tax Savings ($\tau = 46\%$)	0	9.2	14.72	8.83	5.29	5.29	2.67	46
Investment Tax Credit (ITC)	0	10	0	0	0	0	0	10
NPV of Tax Savings, No ITC								38.25
NPV of Tax Savings, ITC								47.60
Expenditure Accelerated to Year 0								
Depreciation	20	32	18.2	11.5	11.5	5.8	0	100
Tax Savings ($\tau = 46\%$)	9.2	14.72	8.37	5.29	5.29	2.67	0	46
Investment Tax Credit (ITC)	10	0	0	0	0	0	0	10
NPV of Tax Savings, No ITC								40.53
NPV of Tax Savings, ITC								50.53
Benefit to Accelerating, No ITC								2.28
Benefit to Accelerating, ITC								2.93

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 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-present. 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)	14.2***	4.2***	0.2	3.9**	4.3***
	(3.8)	(1.5)	(2.1)	(1.6)	(1.4)
D(1984-1987)*ln(assets)	-1.6**				
	(0.6)				
D(1984-1987)*nodiv		4.6*			
		(2.4)			
D(1984-1987)*junkrating			7.7*		
			(4.2)		
D(1984-1987)*fp				4.8**	
				(2.2)	
D(1984-1987)*fp2					5.2**
					(2.3)
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

	LHS Variable is CAPEX/Assets		
	(1)	(2)	(3)
$\frac{CashFlow}{Asset}$	0.034***	0.007***	0.007***
	(0.005)	(0.001)	(0.001)
$\frac{CashFlow}{Asset} * Q2$			0.001
			(0.001)
$\frac{CashFlow}{Asset} * Q3$			0.001
			(0.001)
$\frac{CashFlow}{Asset} * Q4$		0.006***	0.007***
		(0.001)	(0.001)
Tobin's Q	0.012***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)
Observations	129728	470825	470825
Adj R-Squared	0.529	0.435	0.435
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

	(1)	(2)	(3)	(4)	(5)	(6)
D(Lagged 1Y)	-0.017***	-0.023***				
	(0.003)	(0.003)				
D(Spike≥119%)	0.040***	0.023***				
	(0.003)	(0.003)				
D(Forward 1Y)	0.014***	0.018***				
	(0.003)	(0.003)				
D(Forward 2Y)	-0.061***	-0.053***				
	(0.003)	(0.003)				
D(Lagged 1Y)			-0.025***	-0.027***		
			(0.005)	(0.005)		
D(Spike≥200%)			0.060***	0.044***		
			(0.005)	(0.005)		
D(Forward 1Y)			0.033***	0.037***		
			(0.005)	(0.005)		
D(Forward 2Y)			-0.049***	-0.043***		
			(0.004)	(0.004)		
D(Lagged 1Y)					-0.028***	-0.026***
					(0.008)	(0.008)
D(Spike≥300%)					0.076***	0.064***
					(0.010)	(0.009)
D(Forward 1Y)					0.039***	0.047***
					(0.008)	(0.008)
D(Forward 2Y)					-0.054***	-0.045***
					(0.007)	(0.007)
Observations	115288	110683	115288	110683	115288	110683
Adjusted R^2	0.32	0.35	0.32	0.35	0.32	0.35
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes

Notes: This table examines the level of CAPEX/PPE around firm-years with large Q4 CAPEX spikes. Dummy variables indicate the time period from one year before to two years after large spikes. Columns (1) and (2) use a spike threshold of 119% (the sample median). Columns (3) and (4) use a threshold of 200%. Columns (5) and (6) use a threshold of 300%. Columns (2), (4), and (6) include ln(assets), Market-to-Book, Cash/Assets, and EBITDA/Assets as controls. Firm 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.

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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 placed 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

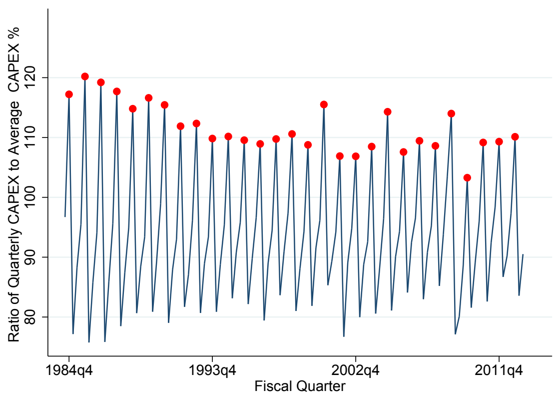
Table A.2: Variable Definitions

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

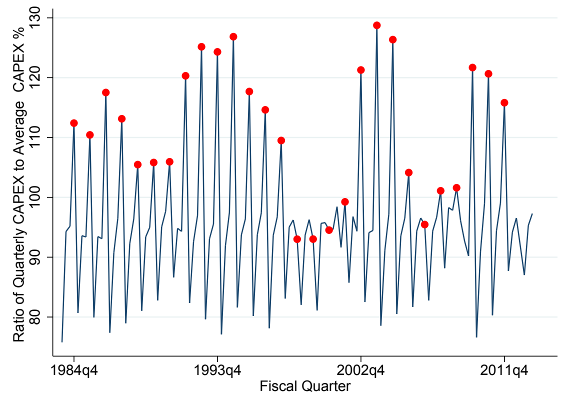
B Additional Robustness

Figure B.1: Robustness of Q4 Investment Spikes

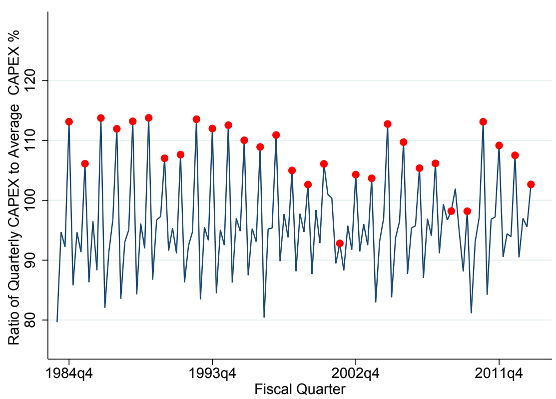
(a) Alternative Spike Measure



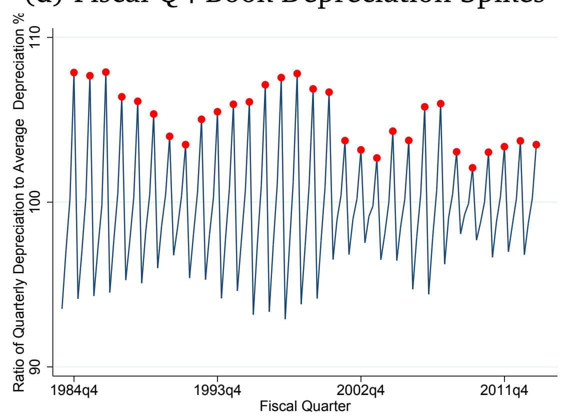
(b) Fiscal Q1 Drop



(d) Stable Fiscal Year-End Sales

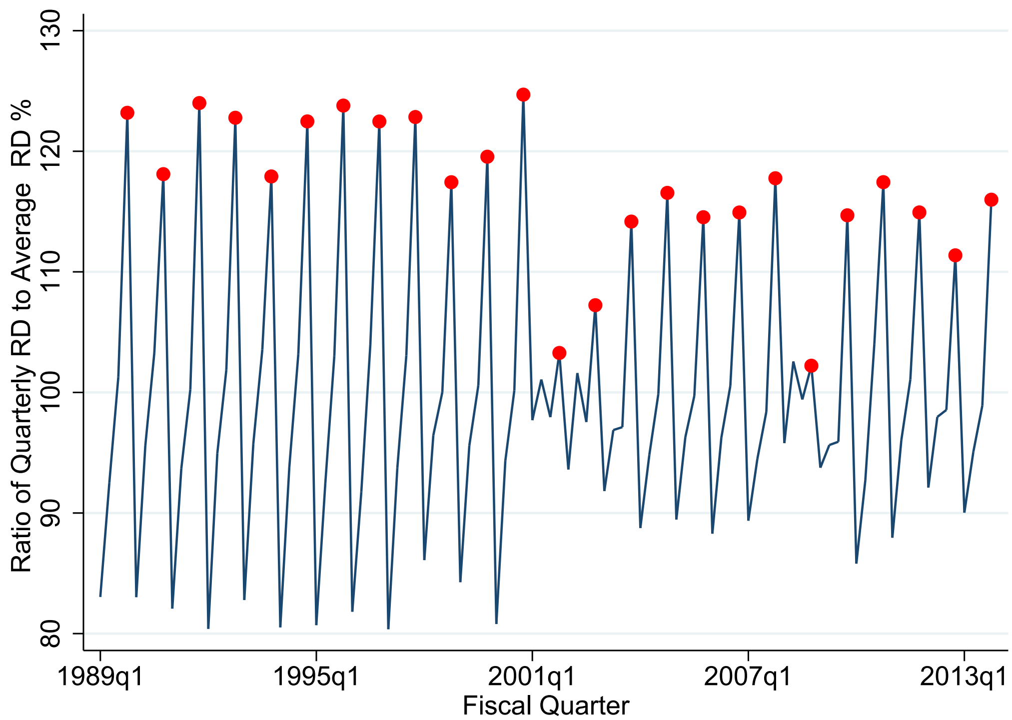


(d) Fiscal Q4 Book Depreciation Spikes



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.

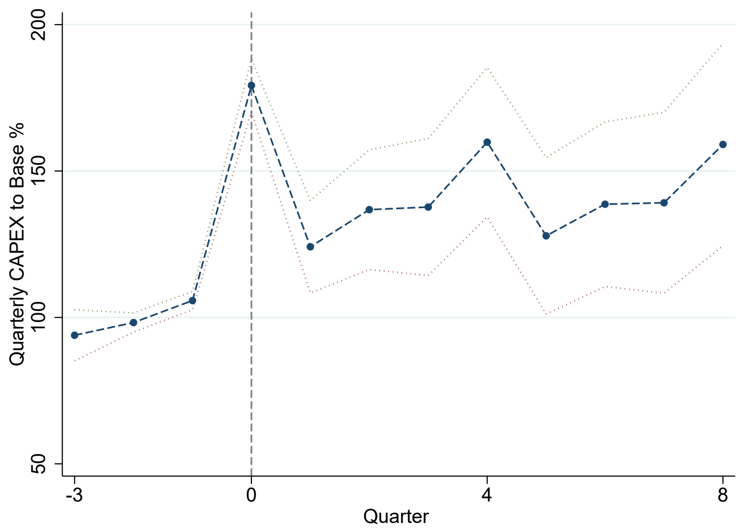
Figure B.2: Time Series of Fiscal Q4 R&D Spikes



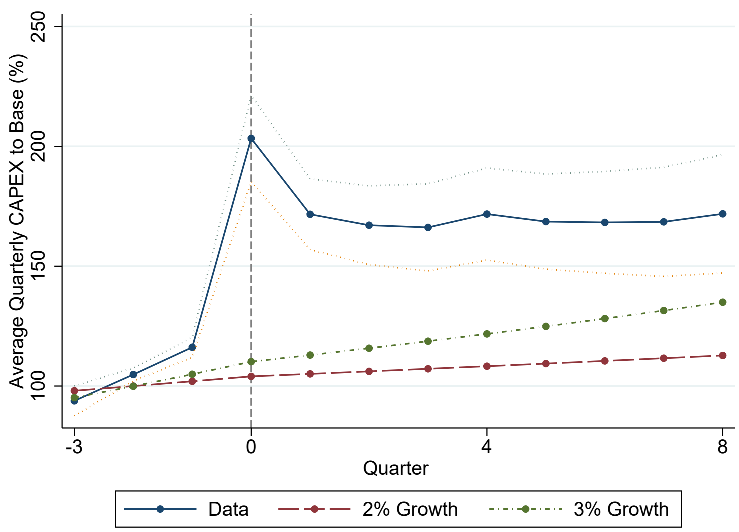
Notes: This figure shows fourth quarter Research and Development (R&D) spikes for U.S. firms in Compustat between 1989 and 2013. We plot the median ratio of quarterly R&D to the average R&D within a firm's fiscal year. Red dots indicate the fourth fiscal quarter. R&D is net of R&D related salary and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

Figure B.3: Cumulative Effect of Q4 CAPEX Spikes

(a) Quarterly CAPEX



(b) Average Quarterly CAPEX



Notes: This figure presents the level of investment after large fiscal Q4 spikes. Panel (a) plots the ratio of quarterly CAPEX to CAPEX$\frac{Q2+Q3}{2}$ in the base year. Panel (b) plots the ratio of average quarterly CAPEX to CAPEX$\frac{Q1+Q2+Q3}{2}$ in the base year. The numerator is calculated as the average quarterly CAPEX starting from Q4 of the base year: for quarter 4 ($t = 0$) the numerator is CAPEX Q4, for next fiscal year quarter 1 ($t = 1$) the numerator is CAPEX$\frac{Q4+F.Q1}{2}$, for next fiscal year quarter 2 ($t = 2$) the numerator is CAPEX$\frac{Q4+F.Q1+F.Q2}{3}$, and so on. We limit observations to firm-years with base year Q4 spikes larger than the sample median (119%). The dotted lines are 95% confidence intervals. The dashed lines plot the counterfactual investment series with steady investment growth of 2% and 3% per quarter.

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.