Kinky Tax Policy and Abnormal Investment Behavior

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Chicago Booth and NBER

*The views expressed here are the authors' and do not necessarily reflect those of the Internal Revenue Service.

Motivating Questions

Questions:

1. How do taxes affect business investment?
2. What are the key features of the underlying model?

Hall and Jorgenson (1967); Summers (1981); Feldstein (1982); Poterba and Summers (1983); Auerbach and Hassett (1992); Cummins, Hassett and Hubbard (1994, 1996); Chirinko, Fazzari and Meyer (1999); Desai and Goolsbee (2004); House and Shapiro (2008); Edgerton (2010); Devereux, Liu, and Loretz (2014); Yagan (2015); Suarez-Serrato and Zidar (2016); Zwick and Mahon (2017); Giroud and Rauh (2017); Ohrn (2017); Akcigit, Grigsby, Nicholas, and Stantcheva (2018)

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Challenges:

1. Tax policy changes are non-random
2. Quasi-experimental approaches leave room for interpretation

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2. What are the key features of the underlying model?

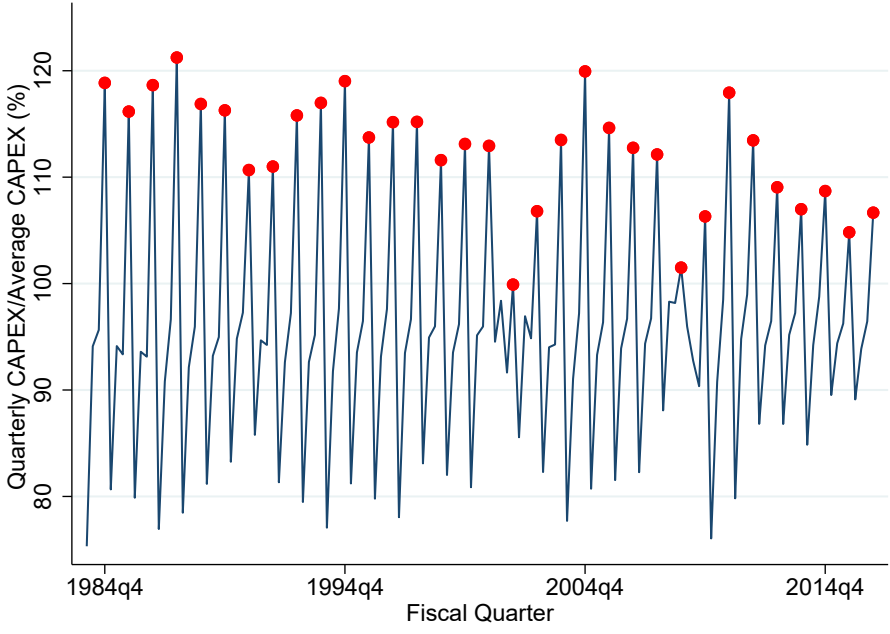
Challenges:

1. Tax policy changes are non-random
2. Quasi-experimental approaches leave room for interpretation

Solution: Novel measure of investment behavior

1. Simple and transparent
2. Orthogonal to low frequency firm and policy shocks
3. Applies to largest firms in economy
4. Not associated with one policy episode

Spikes in Fiscal Q4



Tax-Minimizing Investment

1. Depreciation Motive

- **Depreciation allowances** are deducted from firms' pre-tax income and hence reduce tax bill
- **Deduction conventions** allow firms to deduct year-end purchases as if they were made halfway through the year

2. Option Value Motive

- **Tax asymmetry**: an immediate incentive to offset only for firms with positive taxable income
- Tax positions can be better **estimated** at fiscal year-end

Post-TRA86 Tax Rate

A firm buys \$100 of computers. 7% discount rate. 200% DB

Expenditure in Year 1: Jan 1

Year	0	1	2	3	4	5	6	Total
Depreciation	0	20	32	19.2	11.5	11.5	5.8	100
Tax Savings ($\tau = 35\%$)	0	7	11.2	6.7	4	4	2	35

NPV of Tax Savings = 29.1

Expenditure Accelerated to Year 0: Dec 31

Year	0	1	2	3	4	5	6	Total
Depreciation	**20**	32	19.2	11.5	11.5	5.8	0	100
Tax Savings ($\tau = 35\%$)	**7**	11.2	6.7	4	4	2	0	35

NPV of Tax Savings = 31.1

Tax-Minimizing Investment: Identification

1. **Kink around zero taxable income**
   - Intuition: positive income $\Rightarrow$ immediate incentive to offset
   - Variation: realizing the benefit immediately vs. future years
   - **Finding**: large spikes for positive taxable income
2. **The Tax Reform Act of 1986**
   - Repealed the Investment Tax Credit (ITC)
   - Decreased corporate tax rate significantly
   - Lengthened depreciation periods
   - **Finding**: significant drop in Q4 investment spikes after 1987

Outline

1. **Data Sources**
2. **Investment Spikes in Fiscal Q4**
   - Robustness
   - International evidence
3. **Investment Spikes and Tax Policy**
   - Tax position
   - The Tax Reform Act of 1986 (TRA86)
4. **Cross-Sectional & Dynamic Drivers of Investment Spikes**
   - Financial constraints
   - Investment duration and earnings volatility
   - Cumulative effect
   - Alternative hypothesis: internal capital markets
5. **A Dynamic Model of Tax-Minimizing Investment**
   - Model (including model set-up)
   - Solution and calibration
6. **Implications of Tax-Minimizing Investment Behavior**

1. Data Sources

Data Sources

1. **Compustat**
   - Compustat North America
   - Compustat Fundamentals Quarterly
   - Compustat Global
   - Compustat Segments
   - Compustat Customer Segments
2. **Statistics of Income (SOI division of the IRS)**
   - Sample of corporate tax returns
   - Identify tax position using tax accounts
3. **Orbis Data (Bureau van Dijk)**
   - Number of layers of subsidiaries (proxy for importance of budget cycles)
4. **I/B/E/S**
   - Summary EPS forecasts with actuals - adjusted for stock splits

Data Sources

4. **Equipment Leasing and Finance Association (ELFA)**
   - Monthly Leasing and Finance Index (MLFI-25)
   - Commercial equipment lease and loan activity

5. **Census Bureau**
   - Manufacturers' Shipments, Inventories, and Orders (M3) survey data
   - M3 monthly survey of capital goods and consumer goods

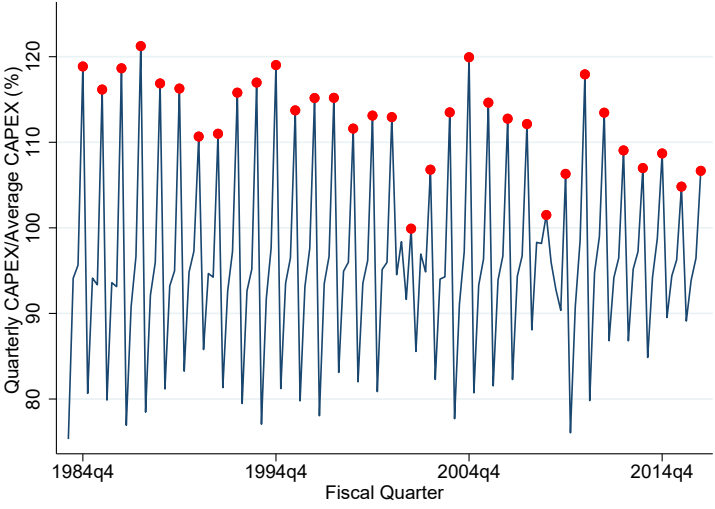
6. **Bureau of Labor Statistics**
   - Producer Price Index (PPI)

7. **RateWatch (part of S&P Global Market Intelligence)**
   - Interest rate data

2. Investment Spikes in Fiscal Q4

Time Series of Fiscal Q4 Spikes (1984-2016)

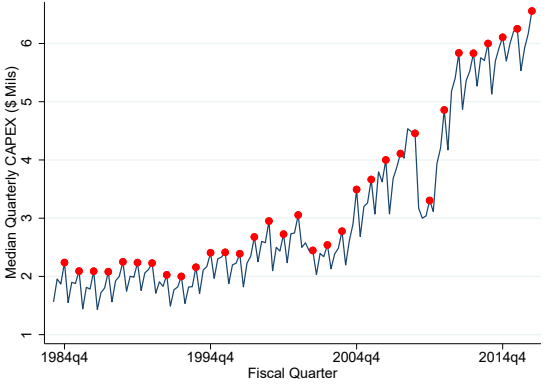
(a) Fiscal Q4 Investment Spikes



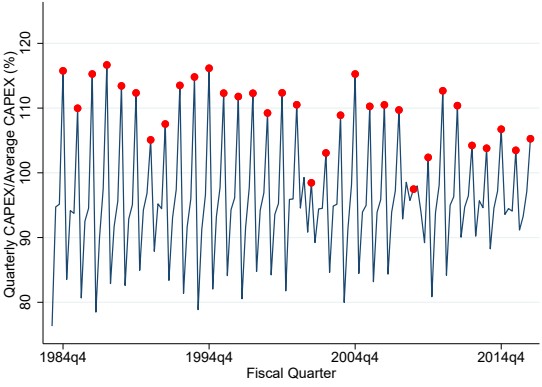
- **Spike** = Fiscal Q4 CAPEX / Mean Fiscal Q1-Q3 CAPEX
- Average spike = 137%; Median spike = 119%

Time Series of Fiscal Q4 Spikes (1984-2016)

(b) Quarterly CAPEX Level

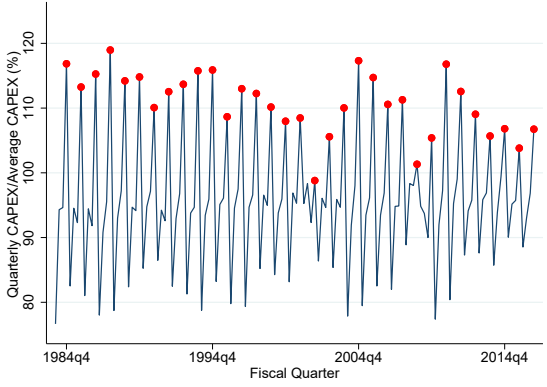


(c) Non-December Fiscal Year End

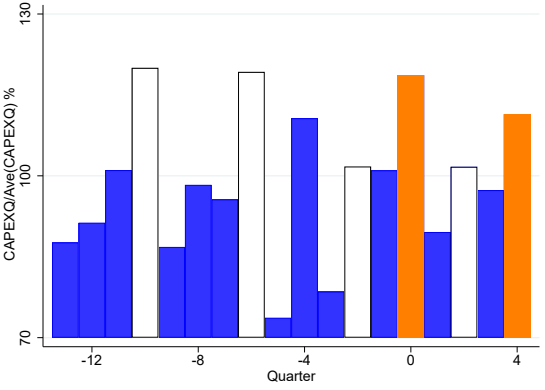


Time Series of Fiscal Q4 Spikes (1984-2016)

(d) Stable Fiscal Year-End Cash Flows

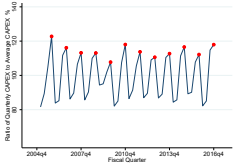


(e) Fiscal Year-end Change

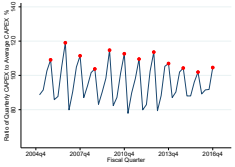


International Evidence of Fiscal Q4 Spikes

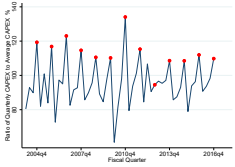
Switzerland



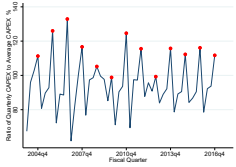
Singapore



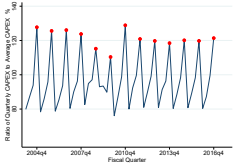
Chile



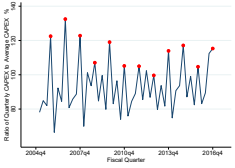
Poland



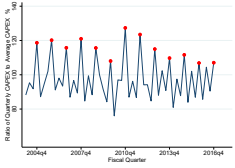
Germany



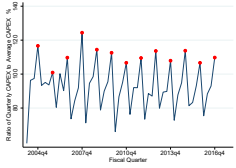
Greece



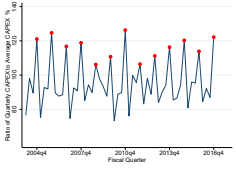
Finland



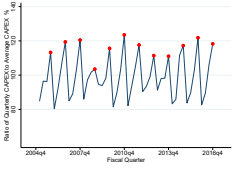
Malaysia



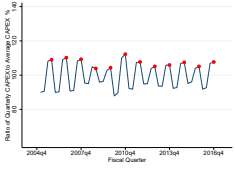
Sweden



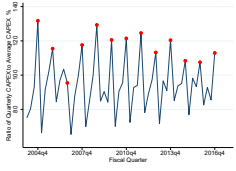
Netherlands



United Kingdom

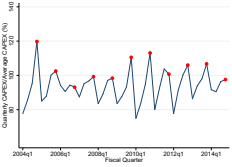


Indonesia

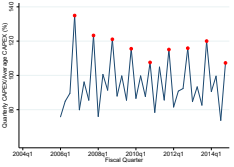


International Evidence of Fiscal Q4 Spikes

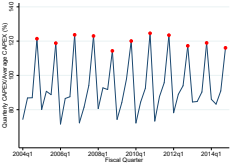
Thailand



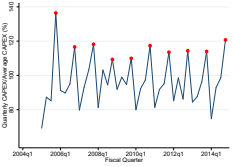
Norway



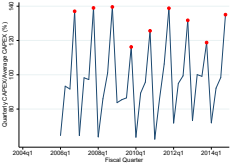
China



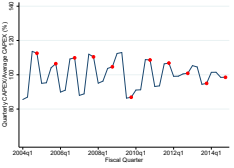
Italy



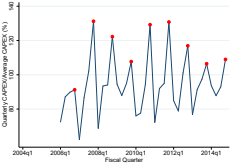
Mexico



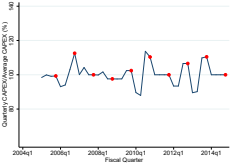
Australia



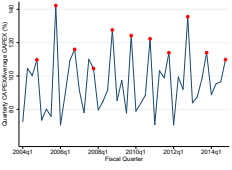
Peru



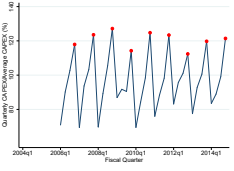
New Zealand



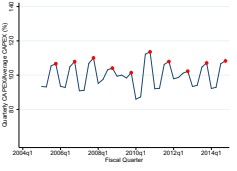
Philippines



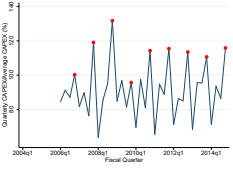
Brazil



France



Pakistan



3. Investment Spikes and Tax Policy

Identification

- $CAPEX_{i,t} = \alpha + \beta \; Tax_{i,t} + Firm\ FE + ... + \epsilon_{i,t}$

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Omitted Variables: Macro factors, etc.

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- **Identification Strategy One**

$$CAPEX\frac{Q4}{Ave(Q1-Q3)}_{i,t} = \alpha_i + \beta D(Taxable)_{i,t} + \delta_t + .. + \epsilon_{i,t}$$

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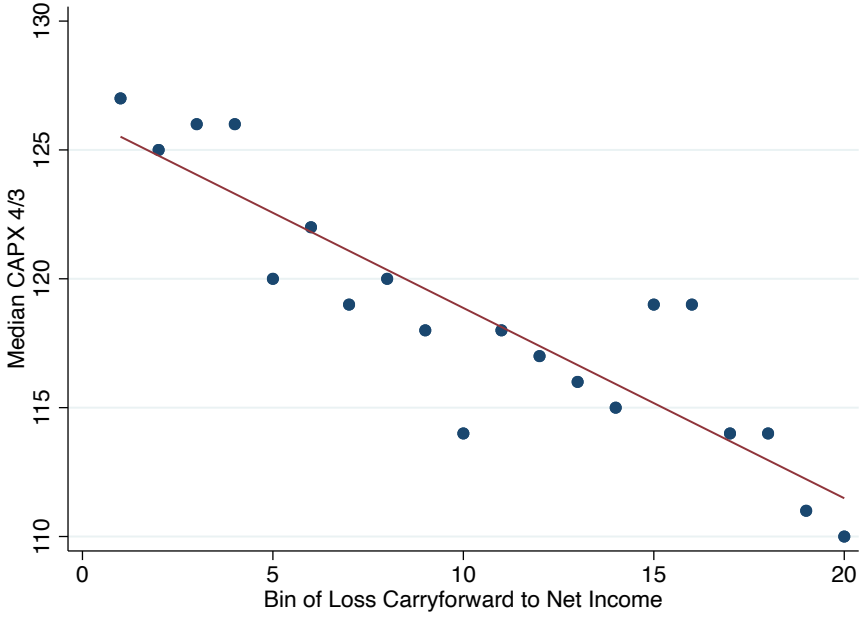
  $$CAPEX_{\frac{Q4}{Ave(Q1-Q3)}_{i,t}} = \alpha_i + \beta D(Taxable)_{i,t} + \delta_t + .. + \epsilon_{i,t}$$

- **Identification Assumption**

  Confounding factors that affect investment timing during the fiscal year do not vary with tax position prior to depreciation.

Firm-Years Sorted by Tax Position

Firm-Years Grouped by NOL Stock



Identification

- $CAPEX_{i,t} = \alpha + \beta\ Tax_{i,t} + Firm\ FE + ... + \epsilon_{i,t}$

  Omitted Variables: Macro factors, etc.

- **Identification Strategy Two**

$$CAPEX \frac{Q4}{Ave(Q1-Q3)}_{i,t} = \alpha_i + \gamma D(PreTRA86)_t + .. + \epsilon_{i,t}$$

1. Repealed the Investment Tax Credit (ITC)
2. Decreased top corporate income tax rate sharply
3. ACRS to MACRS: Slower deductions, mid-quarter convention

- **Identification Assumption**

  Confounding factors do not systematically shift investment toward a particular part of the fiscal year.

Post-TRA86 Tax Rate

A firm buys \$100 of computers. 7% discount rate. 200% DB

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Year	0	1	2	3	4	5	6	Total
Depreciation	0	20	32	19.2	11.5	11.5	5.8	100
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Expenditure Accelerated to Year 0: Dec 31

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NPV of Tax Savings = 31.1

Pre-TRA86 Tax Rate and ITC

Expenditure in Year 1: Jan 1

Year	0	1	2	3	4	Total
Depreciation	0	33.3	44.5	14.8	7.4	100
Tax Savings ($\tau = 46\%$)	0	15.3	20.5	6.8	3.4	46
ITC	0	10	0	0	0	10

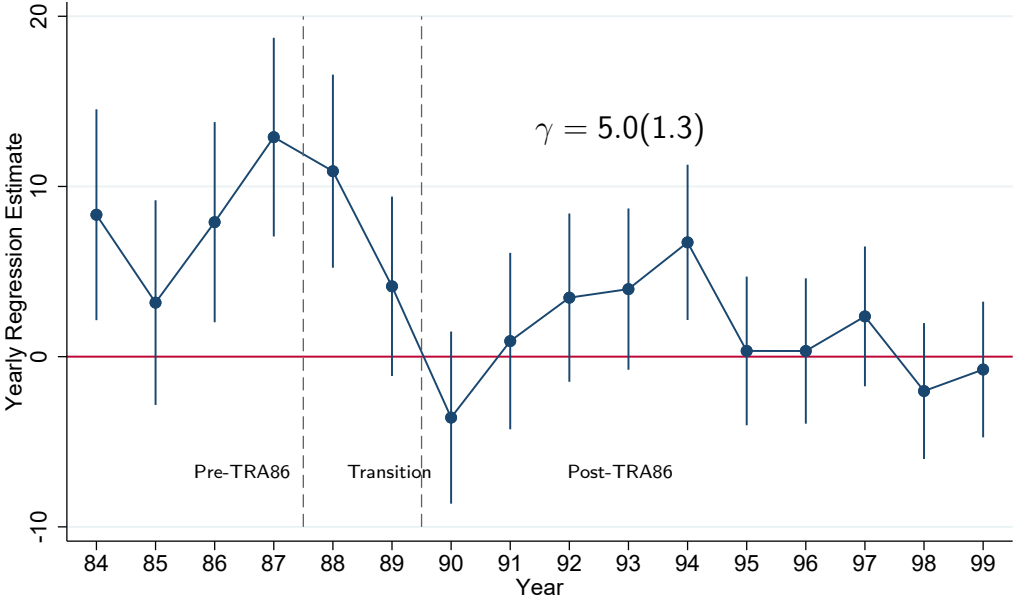
NPV of Tax Savings, No ITC = 40.4
NPV of Tax Savings, ITC = 49.7

Expenditure Accelerated to Year 0: Dec 31

Year	0	1	2	3	Total
Depreciation	**33.3**	44.5	14.8	7.4	100
Tax Savings ($\tau = 46\%$)	**15.3**	20.5	6.8	3.4	46
ITC	**10**	0	0	0	10

NPV of Tax Savings, No ITC = 43.2
NPV of Tax Savings, ITC = 53.2

Spikes and the Tax Reform Act of 1986



4. Cross-Sectional and Dynamic Drivers of Investment Spikes

Cross-Sectional & Dynamic Drivers of Spikes

Investigate: Different factors influencing magnitude of fiscal year-end investment spikes across firms and within firms over time

Consider intertemporal decision-making via:

1. Discount rate used to evaluate investment decisions
2. Incentive to re-time investment from short- and medium-term future

Consider whether investment spikes reflect:

1. High-frequency re-timing of investment across fiscal quarters
2. Combine high- and lower-frequency adjustments in capital stock

Also: What role does capital budgeting play in determining Q4 spikes?

Mechanisms

Question: If using investment as a tax shield, what firms should show larger spikes?

1. Firms with more elastic investment
2. Firms with higher discount rates

Question: If time-varying opportunity, what happens over time?

1. Spike sizes should be negatively correlated over time
2. Level of investment need not fully reverse

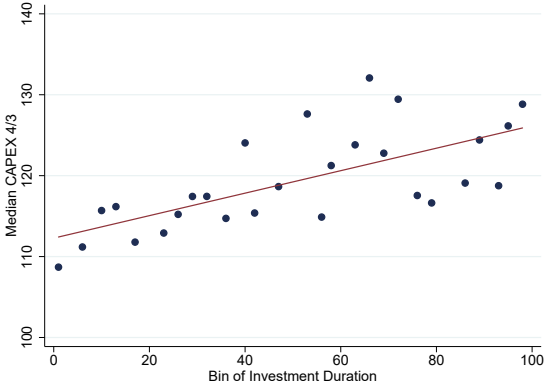
Investment Spikes and Financial Constraints

	(1)	(2)	(3)	(4)	(5)
D(84-87)	13.96***	3.67***	-1.38	3.61**	4.03***
	(3.80)	(1.39)	(2.12)	(1.59)	(1.41)
D(1984-1987)*ln(assets)	-1.58***				
	(0.61)				
D(1984-1987)*nodiv		5.08**			
		(2.51)			
D(1984-1987)*junkrating			8.58**		
			(4.15)		
D(1984-1987)*fp				4.84**	
				(2.18)	
D(1984-1987)*fp2					5.05**
					(2.32)
Observations	118303	118303	30739	116933	116933
Adjusted R^2	0.08	0.08	0.16	0.08	0.08
Controls	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No
Firm FE	Yes	Yes	Yes	Yes	Yes

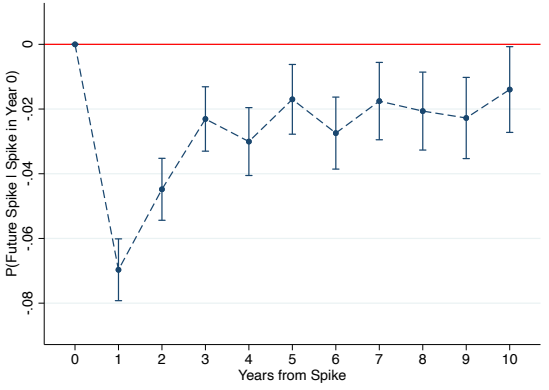
Takeaway: Firms that are more constrained experience a larger drop in their Q4 spikes after 1987.

Cross-Sectional & Dynamic Determinants

(a) Investment Duration



(b) Autocorrelation of Spikes

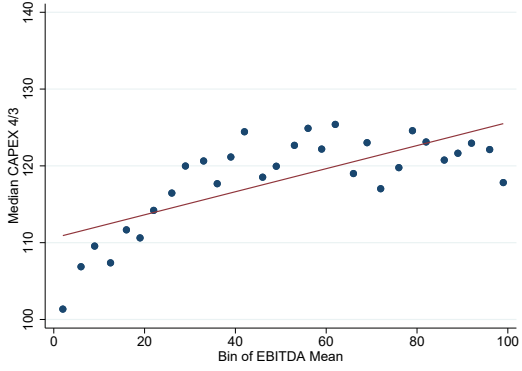


Takeaway: Firms in long-duration industries are able to better capitalize on the option value from re-timing investments and spikes reflect a process with mean reversion and time variation in the value of spiking.

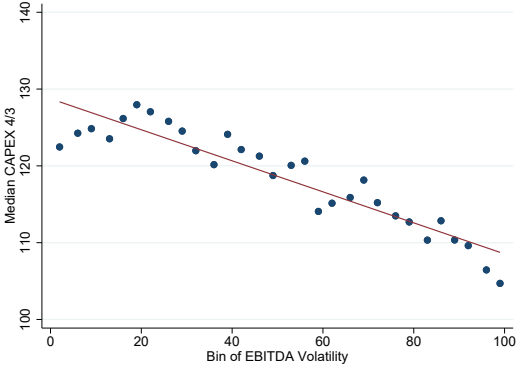
- Median Q4 spikes: 10% to 20% higher for firms in long-duration industries
- In year following spike, probability of spiking falls by 7 percentage points, corresponding to 20% reduction in the probability that a firm spikes in the next year & decline approximately zero over time

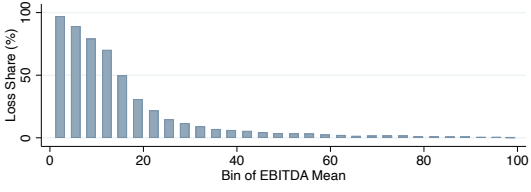
Cross-Sectional & Dynamic Determinants

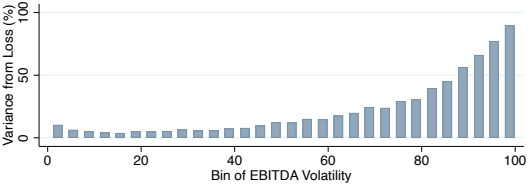
(c) Earnings Mean



(d) Earnings Volatility

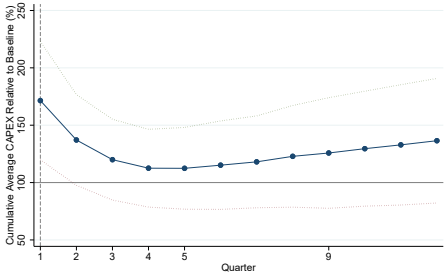




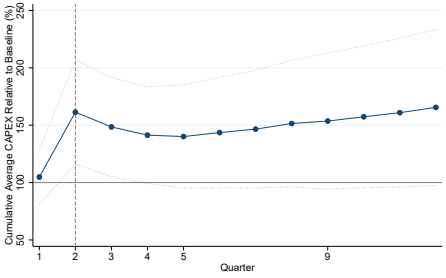


Cumulative Investment after Spikes

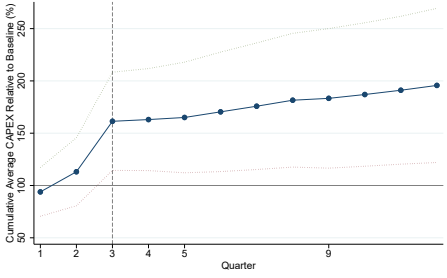
(a) Fiscal Q1 Spikers



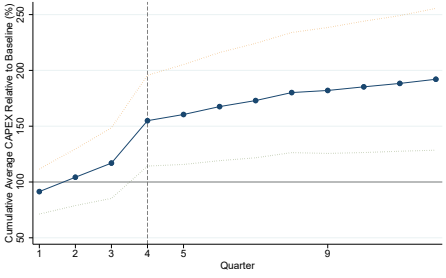
(b) Fiscal Q2 Spikers



(c) Fiscal Q3 Spikers

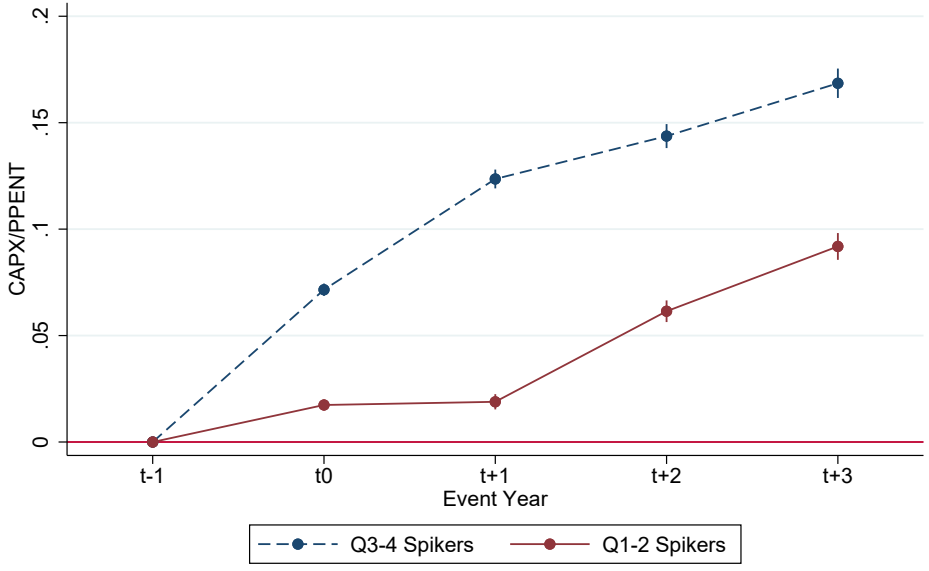


(d) Fiscal Q4 Spikers



Cumulative Investment after Spikes

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



Spikes and Internal Capital Markets

	(1)	(2)	(3)	(4)
# Segments	2.3***			
	(0.3)			
# SIC2		1.5***		
		(0.3)		
# Layers			3.7***	
			(0.7)	
Exec Own %				-2.7***
				(0.5)
Observations	102256	102239	23215	34941
Adjusted R^2	0.02	0.02	0.02	0.03
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Takeaway: While "Use it or Lose it" cannot account for tax effects, likely both tax incentives and internal budgeting are important for explaining Q4 spikes.

5. A Dynamic Model of Tax-Minimizing Investment

Dynamic Model of Tax-Minimizing Investment

Recall Question: If using investment as a tax shield, what firms should show larger spikes?

1. Firms with more elastic investment
2. Firms with higher discount rates

Recall Question: If time-varying opportunity, what happens over time?

1. Spike sizes should be negatively correlated over time
2. Level of investment need not fully reverse

Paper: Dynamic model follows Winberry (2021) to show points formally

1. Tax asymmetry
2. Half-year convention for depreciating current year investment
3. Four sub-periods within the fiscal year
4. Potential for tax losses

Dynamic Model of Tax-Minimizing Investment

Build dynamic model:

1. Predictable time variation in the value of the investment tax shield
2. Calibrate to match partial equilibrium investment moments quantitatively

Apply model to answer:

1. Can a standard calibration deliver investment spikes that are quantitatively comparable to those observed in the data?
2. What is the relative importance of the depreciation motive and option value motive in accounting for the evidence, especially the persistence of cumulative investment following spikes?

Model Set-up

1. Given labor n and capital k, the labor choice is static:

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

   where ε is a productivity shock and θ, ν, and w are parameters.

2. Productivity evolves according to the AR(1) process: $\varepsilon = \rho\varepsilon_{-1} + \xi$, where $\xi \sim \mathcal{N}(0,\sigma_{\varepsilon}^2)$, $|\rho|<1$.

3. Investment, i, yields capital for next period (law of motion): $k' = (1-\delta)k + i$.

4. Adjustment costs follow the standard convex form: $-\frac{\phi}{2}\left(\frac{i}{k}\right)^2 k$.

5. Firm's gross operating surplus (GOS) prior to depreciation:

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

   where ω can be either a random overhead fixed cost or accounting adjustment.

Model Set-up

6. Firm's tax bill equals a linear tax τ on taxable income: $TB = \tau \max\{TI, 0\}$.

7. Current stock of gross operating surplus, g, evolves as:

$$\text{(Q1–Q3)} \quad g' = g + GOS(k, \varepsilon, \omega) \qquad\qquad \text{(Q4)} \quad g' = 0.$$

8. Taxable income in all quarters:

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

where $\hat{\delta}$ is the rate of tax depreciation, p is the constant market price of investment, $\hat{k}$ is the current depreciation stock, and $\bar{k}$ is the start-of-year depreciation stock carried over from last fiscal year.

9. Depreciation stock evolves based on the rules for deductibility during the fiscal year:

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

Model

Value functions in first three quarters (defined by Bellman equation):

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

where $V^C(\cdot) = V^N(\cdot)$ for Q1 and Q2 and $V^C(\cdot) = V^T(\cdot)$ for Q3, marking the transition to when taxes are determined and paid.

Value function in last quarter (defined by Bellman equation):

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

Model

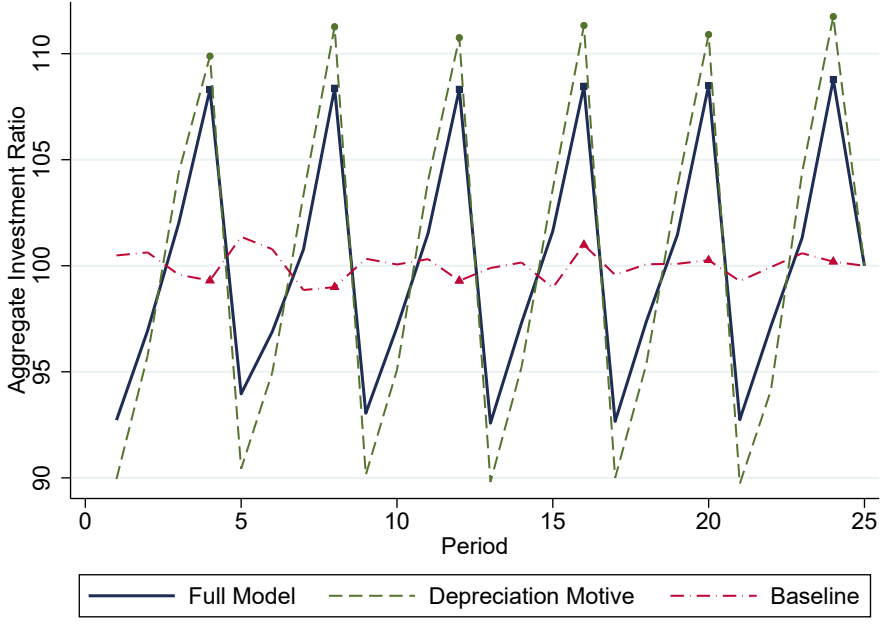
Baseline model (firm's problem is identical each quarter and defined by Bellman equation):

$$V(k, \hat{k}, \varepsilon, \omega) = GOS(k, \varepsilon, \omega) + \max_i \left\{ -\tau \left[GOS(k, \varepsilon, \omega) - \hat{\delta}(\hat{k} + pi) \right] - pi - \frac{\phi}{2} \left(\frac{i}{k} \right)^2 k + \beta \mathbb{E}_{\varepsilon' | \varepsilon, \omega'} V(k', \hat{k}', \varepsilon', \omega') \right\} \quad (3)$$

$$\text{s.t.} \quad \hat{k}' = (1 - \hat{\delta})(\hat{k} + pi) \qquad k' = (1 - \delta)k + i \qquad i \geq 0.$$

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

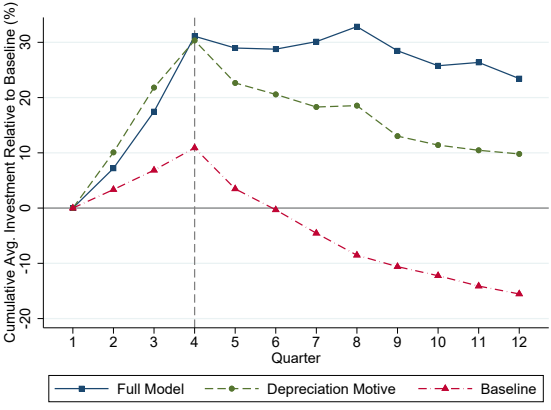
Fiscal Q4 Spikers in Model Simulated Data



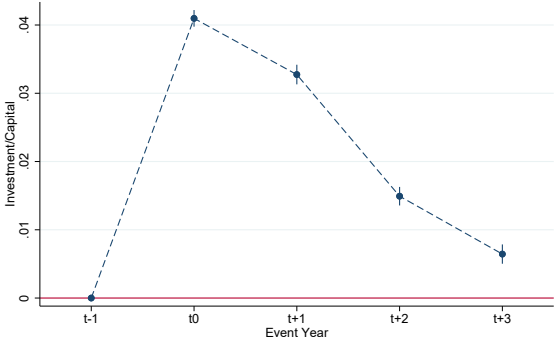
Depreciation Versus Option Value Motives

Model Simulations

(a) Cumulative across Models



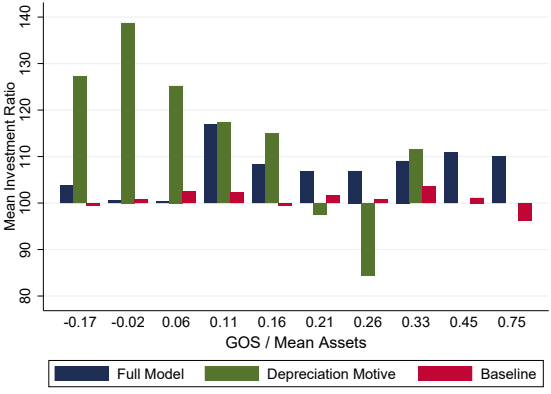
(b) Q1-2 vs. Q3-4 Spikes, Full model



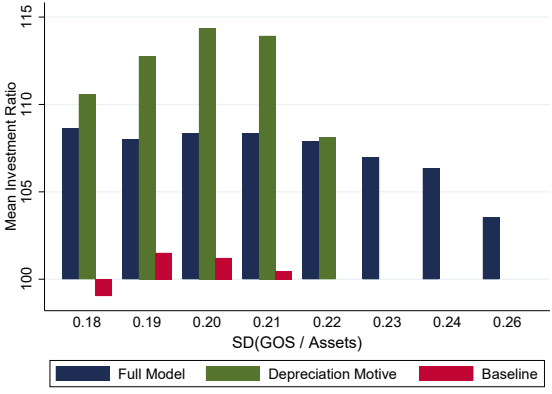
Depreciation versus Option Value Motives

Model Simulations

(c) Earnings Mean across Models

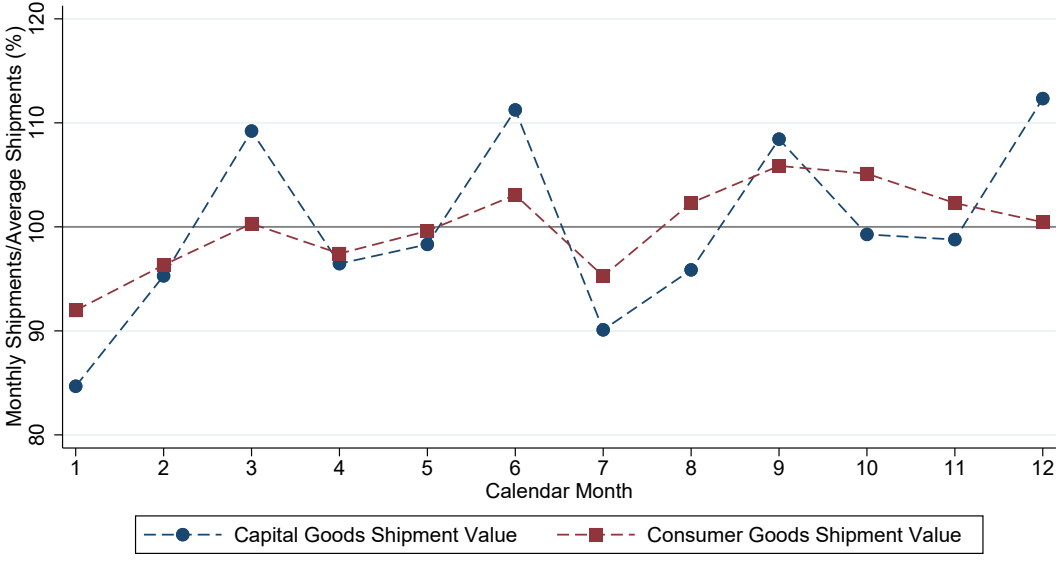


(d) Earnings Volatility across Models

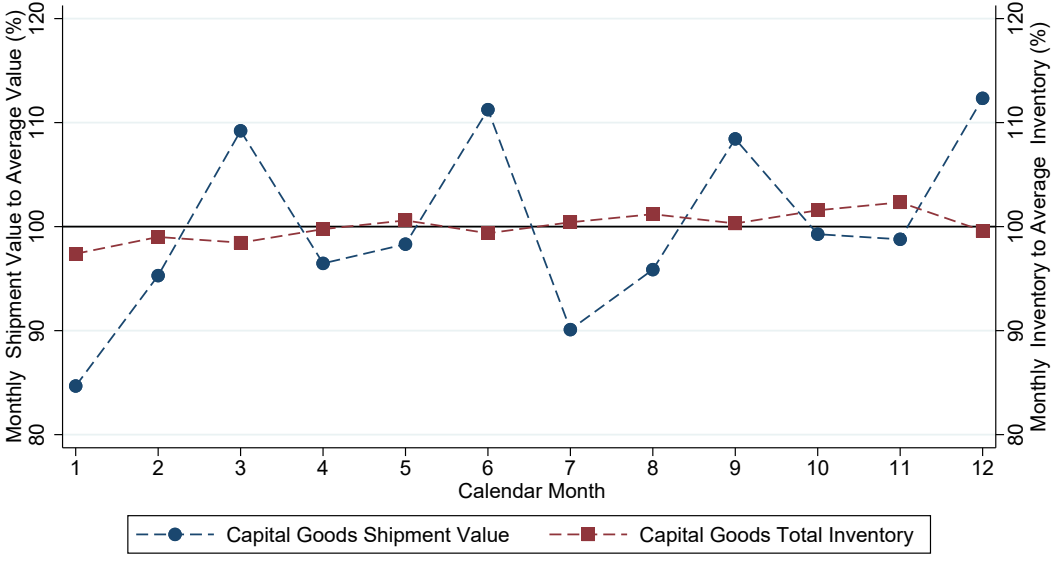


6. Implications of Tax-Minimizing Investment Behavior

Spikes in Capital Goods Shipments (1958-2016)

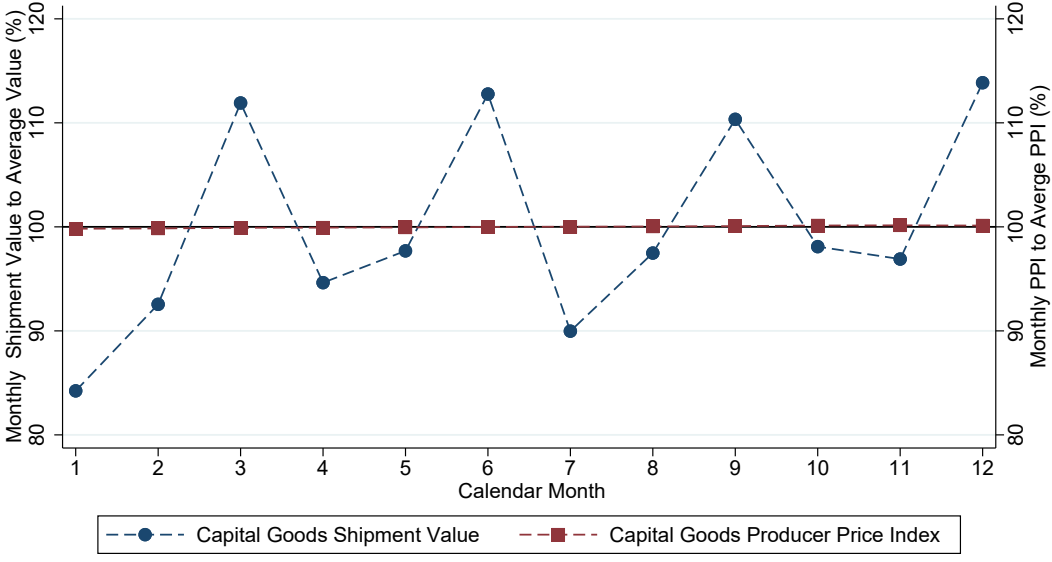


Capital Goods Shipments & Inventories Spikes



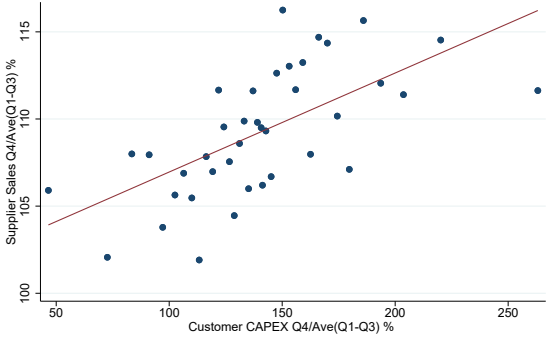
‣ Firm Inventory

Spikes in Capital Goods Shipments and Prices

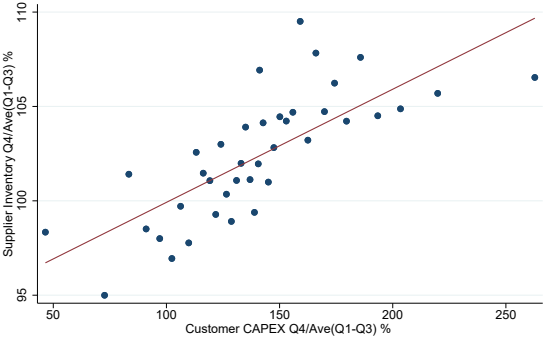


Supplier Q4 Inventory and Sales Spikes

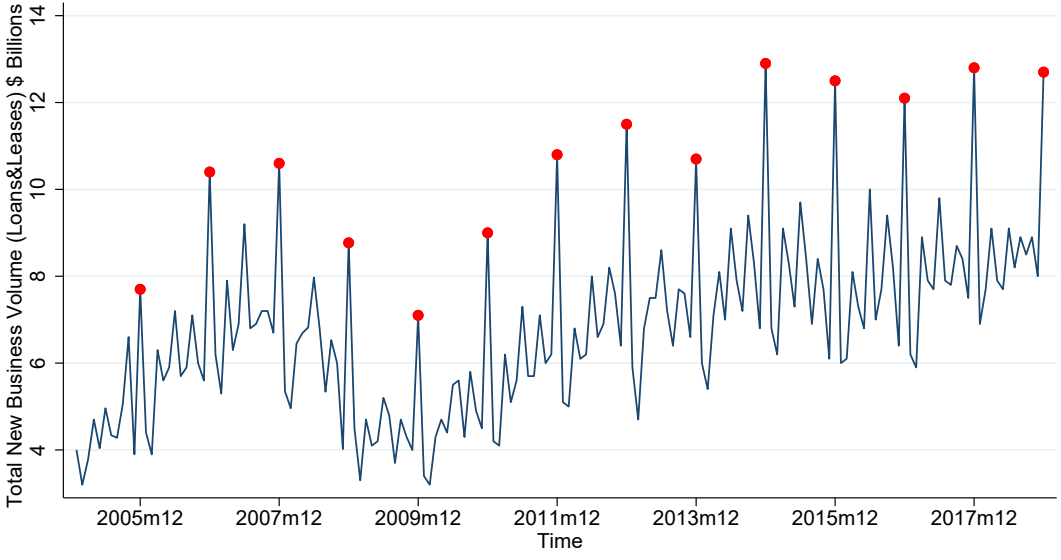
(a) Supplier Q4 Sales Spikes



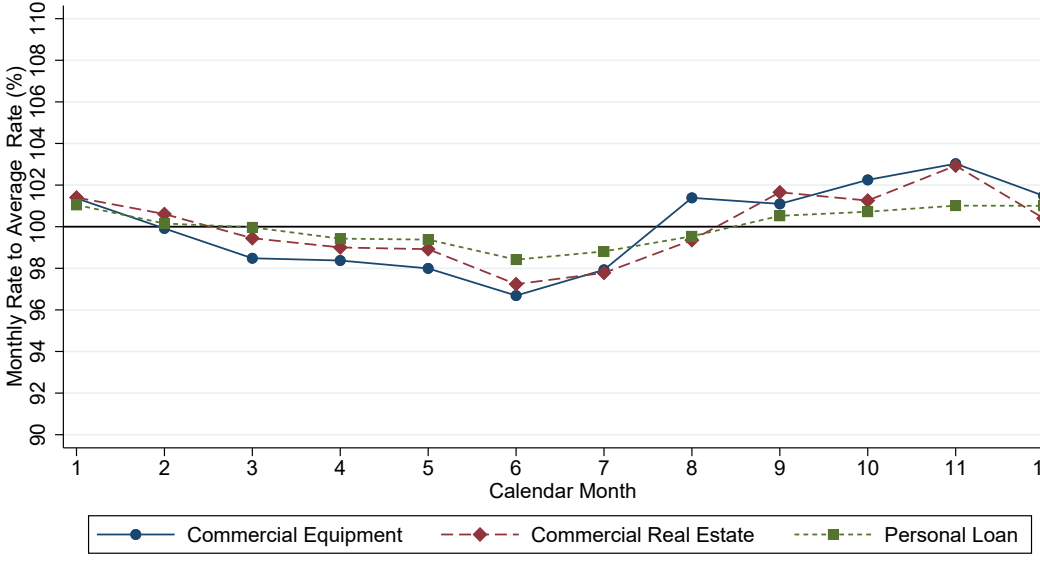
(b) Supplier Q4 Inventory Spikes



Capital Lending Volume



Interest Rate Seasonality



Interactions with Fiscal Stimulus Policy

Implications for design of temporary fiscal stimulus policies:

1. To the extent that stimulus policies do not provide purchase-year benefits, their impact will be mitigated by the tax-minimization motives
   - Policy stimulus usually comes in weak economic times
   - Firms may have insufficient taxable income to benefit immediately from policy or sufficient alternative tax shields (e.g. NOL deductions)
2. Temporary investment incentives may face "crowding out" by impact of similar policies implemented in past
   - During 2001 recession, policymakers introduced temporary bonus depreciation, allowing firms to take additional deductions for eligible investment
   - Firms accumulated large NOL stocks to be used in future years
   - When policy reintroduced during 2008 recession, nearly 50% of firms had sufficient NOLs to zero out taxable income before taking depreciation into account

7. Conclusion

Conclusion

Facts:

1. Large firms retime investment at fiscal year-end
2. This behavior occurs in many countries
3. Tax-minimization partly explains this behavior
4. Amplified when stronger incentive to use investment as a tax shield in response to temporary shocks

Implications:

1. Facts most consistent with model in which firms place extra weight on purchase-year, after-tax costs
2. Tax policy should consider difference between instruments
   - Policies directly targeting investment likely matter more to growing firms than payout or corporate rates
3. Spikes appear to aggregate, but
   - Focus on high-frequency behavior means aggregate conclusions should be drawn with caution
   - Building tax asymmetries into macro models a good next step

Thank You!