The Macroeconomics of Capital Durability

Hui-Jun Chen[1] Min Fang [2] Spyridon Gkikopoulos[3] Chi-Yang (Ben) Tsou [3]

[1]National Tsing Hua University

[2]University of Florida

[3]University of Manchester

Febuary 5, 2025

The 4th Tokyo-Taipei-Seoul Macroeconomics Network Workshop

Introduction

- Capital durability as an essential feature of capital: large variations across assets
  - Depreciation rates vary
    - as low as 1% for new residential structures
    - as high as 31% for computing equipment
- Tax policies allow depreciation-related tax deductions on capital investment
- Q: How do **tax policies** and **financial frictions** jointly shape capital durability decisions?
  - A general equilibrium model with heterogeneous firms with tax policies and financial frictions
  - Empirical evidence on the evolution of investment tax deductions and reforms in bankruptcy laws
  - Policy implications on the mitigation of distortion and the faster recovery from recessions

Motivating Example

Figure: Budget Truck

Figure: Long-haul Truck

- Key trade-off (Rampini, 2019): down payment (today) v.s. continuation value (tomorrow)

The Economic Mechanism

- **General Equilibrium Model**: durability choice + occasionally binding financial constraint
  - Constrained firms favor "cheaper" **non-durable** capital due to lower upfront cost
  - Non-durable capital receives higher tax deductions (higher δ), even more affordable
  - As bonus depreciation increases, **durable** capital gains more deductions and is *less costly*
- **Policy Implications**:
  1. Reducing Financial Frictions (Cross-Section):
     - Durable capital provides greater collateral value
     - Durable capital $\uparrow \Rightarrow$ Frictions $\downarrow \Rightarrow$ Misallocation $\downarrow$
  2. Faster Recovery from Recessions (Time-Series):
     - Bonus depreciation encourages durable investment during downturns
     - Constrained firms rebuild balance sheets, resulting in faster aggregate recovery
- **This paper**: theory and evidence on the endogenous choice of capital durability

Summary of Paper

- Theory
  - A GE model with heterogeneous firms and occasionally binding financial constraints
  - Formalize the intuition for the choice between durable and non-durable capital
  - Quantitatively assess the key economic mechanism
- Empirical Evidence
  - Measure capital durability and document its connection with financial constraint
  - Causal evidence on the announcement of bonus depreciation and reforms in bankruptcy laws
- Policy Implications
  - Mitigates financial frictions and reduces capital misallocation
  - Promotes durable investment during downturns, helping constrained firms recover faster

Related Literature

- **Macroeconomic Models with Financial Frictions**
  - Kiyotaki and Moore (1997), Gertler and Kiyotaki (2010), Jermann and Quadrini (2012), He and Krishnamurthy (2013), Khan and Thomas (2013), Brunnermeier and Sannikov (2014), Elenev, Landvoigt and Van Nieuwerburgh (2021), and Ottonello and Winberry (2020, 2024)

New: theoretically evaluates aggregate implications of durable capital on efficiency and fluctuations

- **Corporate Finance on Collateral Constraints**
  - Albuquerque and Hopenhayn (2004), Almeida and Campello (2007, 2010), Gomes and Schmid (2020), Rampini and Viswanathan (2010, 2013), Falato, Kadyrzhanova, Sim and Steri (2022), Rampini (2019), Lanteri and Rampini (2023)

New: empirically identifies how financial frictions distorts the user cost of durable capital

- **Tax Policy and Corporate Investment**
  - Cummins, Hassett and Hubbard (1996), Goolsbee (1998), Hassett and Hubbard (2002), House and Shapiro (2008), Zwick and Mahon (2017), and Xu and Zwick (2024)

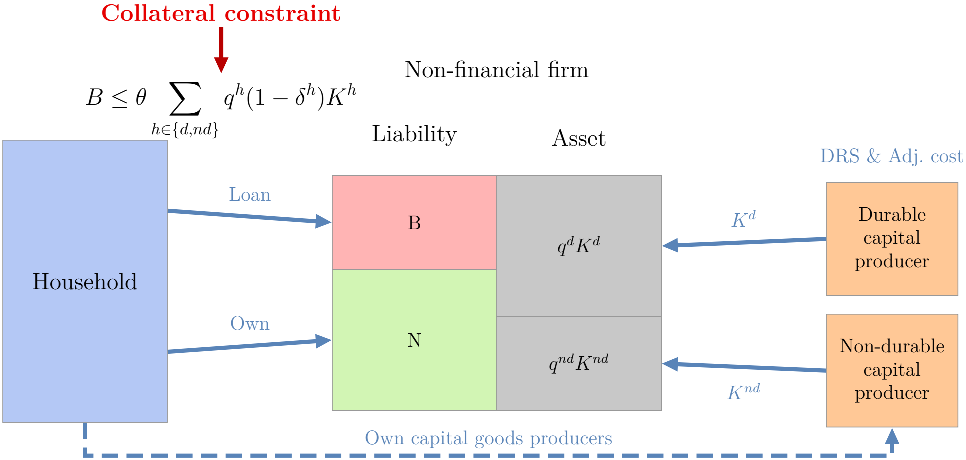
New: empirically and theoretically examine the effects of tax policy through durable capital

Heterogeneous Firm Model

Model Overview

- A GE model with heterogeneous firms and occasionally binding financial frictions
- Collateral constraints as in Kiyotaki and Moore (1997), and Kiyotaki and Gertler (2012)
- New Ingredients:
  - Idiosyncratic productivity shocks/firm entry and exit
  - Choice between durable versus non-durable capital
- Quantitatively plausible firm size distribution and dynamics to study the cross section
- Aggregation result: Ottonello and Winberry (2020, 2024) and Fang, Hsu and Tsou (2025)

Model Overview: Balance Sheets of Firms



Collateral constraint

$$B \leq \theta \sum_{h \in \{d,nd\}} q^h (1 - \delta^h) K^h$$

Model Setup: Corporate Tax and Bonus Depreciation

I. IRS: To encourage investment, corporate tax authority introduce three features:

- **Short useful life for tax purpose:** Tax depreciation rate $2\delta^h >$ capital depreciation rate δ^h
- **Double-Declining Balance in early year:** Firms immediate deduct $2 \times 2\delta^h$ per unit of investment
- **Bonus Depreciation:** extra deduction $(1 - 4\delta^h)\omega_t$ at the rate $\omega_t \in [0, 1]$

$\Rightarrow$ Accumulation of remaining as tax-deductible stock ξ^h_{jt}

$$\xi^h_{jt+1} = \underbrace{(1 - 2\delta^h)\xi^h_{jt}}_{\text{Remaining Stock}} + \underbrace{(1 - 4\delta^h)q^h_t i^h_{jt}}_{\text{Double-Declining}} - \underbrace{(1 - 4\delta^h)\omega_t q^h_t i^h_{jt}}_{\text{Bonus Depreciation}}$$

II. The PV of tax deduction from bonus depreciation per unit:

$$\omega^h_t = \underbrace{4\delta^h + \overbrace{(1 - 4\delta^h)\omega_t}^{\text{Bonus Depreciation}}}_{\text{Deduction today}} + \underbrace{\beta(1 - 4\delta^h - (1 - 4\delta^h)\omega)\left[\text{PV of } \xi^h_{jt}\right]}_{\text{PV of Remaining Deduction}}, \qquad (1)$$

1. **Intensive Margin:** Non-durable is more deductible $\omega^{nd}_t > \omega^d_t$
2. **Extensive Margin:** The deduction for durable capital grows faster as bonus rate rise $\frac{\partial \omega^d_t}{\partial \omega_t} > \frac{\partial \omega^{nd}_t}{\partial \omega_t}$

Model Setup: Firm Optimization

- Firm j's optimization problem (π_d as an exogenous liquidation probability):

$$v(n_{jt}, z_{jt}) = \max_{\{k^d_{jt+1}, k^{nd}_{jt+1}, b_{jt+1}, l_{jt}, d_{jt}\}} d_{jt} + \mathbb{E}_t \left[\Lambda_{t+1} \times \left(\begin{array}{c} \pi_d \; n_{jt+1} \\ +(1-\pi_d) v(n_{jt+1}, z_{jt+1}) \end{array} \right) \right],$$

subject to

$$d_{jt} = n_{jt} - (1-\tau^c \omega^d_t) q^d_t k^d_{jt+1} - (1-\tau^c \omega^{nd}_t) q^{nd}_t k^{nd}_{jt+1} + \frac{b_{jt+1}}{1+r_t} \geq 0,$$

$$n_{jt+1} \equiv (1-\tau^c)(y_{jt+1} - w_{t+1} l_{jt+1}) - b_{jt+1} + (1-\tau^c \omega^d_t) q^d_{t+1} (1-\delta^d) k^d_{jt+1} + (1-\tau^c \omega^{nd}_t) q^{nd}_{t+1} (1-\delta^{nd}) k^{nd}_{jt+1},$$

$$b_{jt+1} \leq \theta_t \left[(1-\delta^d) q^d_t k^d_{jt+1} + (1-\delta^{nd}) q^{nd}_t k^{nd}_{jt+1} \right],$$

- Internal funding constraint: $d_{jt} \geq 0$ and $\lambda_t(n, z)$
- Collateral constraint: $b_{jt+1} \leq \theta_t \left[(1-\delta^d) q^d_t k^d_{jt+1} + (1-\delta^{nd}) q^{nd}_t k^{nd}_{jt+1} \right]$ and $\mu_t(n, z)$

Decision Rules: Euler Equation

- FOC w.r.t. borrowing b':

$$\underbrace{\frac{1+\lambda_t(n,z)}{1+r_t}}_{\text{Marginal Benefit}} = \mu_t(n,z) + \mathbb{E}_t\left\{\Lambda_{t+1} \times \left[\left(\pi_d + (1-\pi_d)\underbrace{(1+\lambda_{t+1}(n',z'))}_{\text{Marginal Cost}}\right)\right]\right\}$$

- FOC w.r.t. type-h capital k^h_{jt+1}:

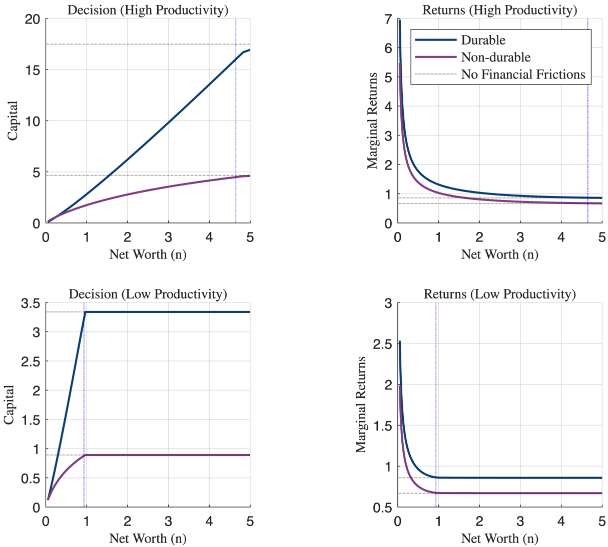
$$\underbrace{[1+\lambda_t(n,z)]\,(1-\tau^c\omega^h_t)q^h_t}_{\text{Marginal Cost}} = \underbrace{\mu_t(n,z)\theta_t(1-\delta^h)q^h_t}_{\text{Relaxation of the Collateral Constraint}}$$

$$+\mathbb{E}_t\left\{\Lambda_{t+1} \times \left[\begin{array}{c}\left(\pi_d + (1-\pi_d)(1+\lambda_{t+1}(n',z'))\right) \\ \times\left(\underbrace{(1-\tau^c)MPK'_h}_{\text{Marginal Product of Capital}} + \underbrace{(1-\tau^c\omega^h_t)q^h_{t+1}(1-\delta^h)}_{\text{Continuation Value}}\right)\end{array}\right]\right\}$$

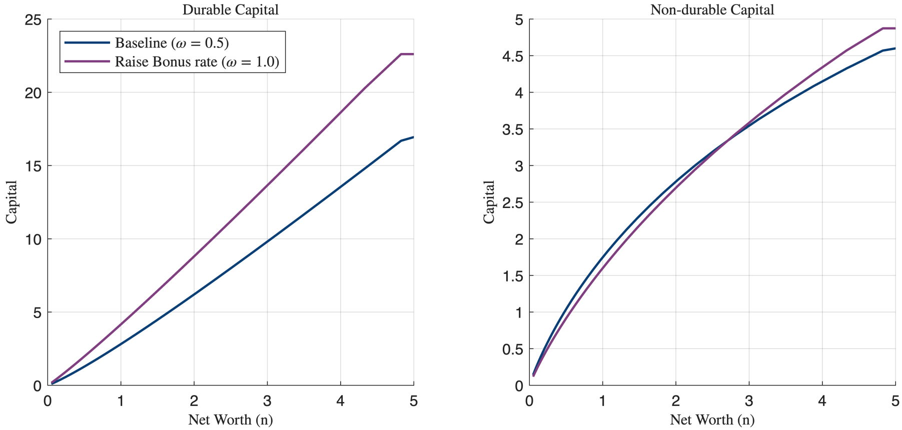
◂ Back

Decision Rules: Investment and Return

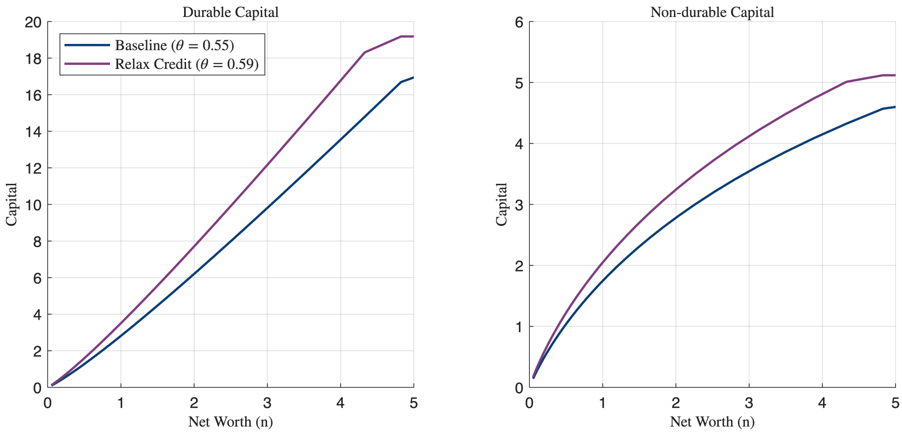
▸ Calibration



Decision Rules: Higher Bonus Depreciation Rate ω



Decision Rules: Higher Collateralizability θ



Empirical Evidence

Empirical Identification Intuition

- From the Euler Equations on k^d and k^{nd}: ▸ Euler
  - Marginal Cost = *Internal Funding Constraint* + Upfront Cost
  - Marginal Benefit = *Relaxation of Collateral Constraint* + Continuation Value
- Bonus Depreciation Policies:
  - When bonus rate ω_t rises, the marginal cost of durable capital drops

  $\Rightarrow$ Firms invest more in durable capital
- Relaxation of Collateralizability:
  - Reform of the bankruptcy law provides more protection to creditors $\Rightarrow$ willing to lend more
  - When financial constraints are relaxed (e.g., due to reforms), the MB of durable capital increases

  $\Rightarrow$ Firms invest more in durable capital, especially for constrained firms!

Sample and Measures

- Sample: Compustat from 1993 to 2012, excluding those
  - In financial and utilities sectors (SIC = 6000-6999 and 4000-4999)
  - Not incorporated or located in the US
  - With missing values for key and control variables
- Outcome Variable:
  - Capital durability = weighted average service life of capital assets
    - Jia, Li, and Tsou (2025) ▸ Durability
- Exogenous Variations:
  - The evolution of bonus depreciation over time ▸ Bunus Depreciation
  - Anti-recharacterization laws (ARL) $\Rightarrow$ reforms in bankruptcy laws in 90s and early 2000s
- Financial Constraint Proxies:
  - Size, including net worth, capital, employee: Ottonello and Winberry (2025)
  - Dividend payment dummy: Farre-Mensa and Ljungqvist (2016)
  - Size-Age index: Hadlock and Pierce (2010)

Difference-in-Differences Specification: Bonus Depreciation

- For firm j in industry i at year t

$$o_{jit} = b_1 \times \text{BONUS}_{jit} + b_2 \times \text{BONUS}_{jit} \times \overline{\text{FC}}_j + c \times X_{jt} + \text{FEs} + \varepsilon_{jit}$$

  - o_{jit}: the logarithm of capital durability for firm j in industry i and year t
  - $\text{BONUS}_{it} = \omega_{it} - \omega_{i0}$
    1. IRS/BEA provides the PV of type-h's bonus depreciation ω_t^h
    2. $\omega_{it} = \sum_h a_{it}^h \omega_{it}^h$: aggregation of bonus depreciation in industry i
    3. ω_{i0}: the PV pre-2001
  - $\overline{\text{FC}}_j$: financial constraint proxies, including size, DIV, and SA
  - X_{jt}: other firm characteristics, including net worth, B/M, I/K, ROA, and leverage
  - FEs: firm and time fixed effects

Results on Bonus Depreciation

	(1)	(2)	(3)	(4)	(5)	(6)
BONUS	0.026^{***}	0.033^{***}	0.045^{***}	0.034^{***}	0.081^{***}	0.029^{***}
[t]	[2.688]	[3.224]	[4.390]	[3.210]	[6.544]	[2.755]
BONUS × $\overline{\text{Net Worth}}$		-0.004^{*}				
[t]		[-1.781]				
BONUS × $\overline{\text{Capital}}$			-0.002^{**}			
[t]			[-2.150]			
BONUS × $\overline{\text{Employee}}$				-0.003^{**}		
[t]				[-2.405]		
BONUS × $\overline{\text{SA}}$					0.013^{***}	
[t]					[5.165]	
BONUS × $\overline{\text{Non-DIV}}$						0.008^{**}
[t]						[2.087]
Observations	52,469	48,062	48,062	47,736	48,062	48,062
R-squared	0.880	0.872	0.872	0.873	0.873	0.872
Controls	No	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	Industry	Industry	Industry	Industry	Industry	Industry

Parallel Trend Assumptions on Bonus Depreciation to Capital Durability

Figure: **Capital Durability Surrounding Bonus Depreciation Policies**

Difference-in-Differences Specification: ARLs

- For firm j incorporated in State s at year t

$$o_{jst} = b_1 \times \text{Law}_{jst} + b_2 \times \text{Law}_{jst} \times \overline{\text{FC}}_j + c \times X_{jt} + \text{FEs} + \varepsilon_{jst}$$

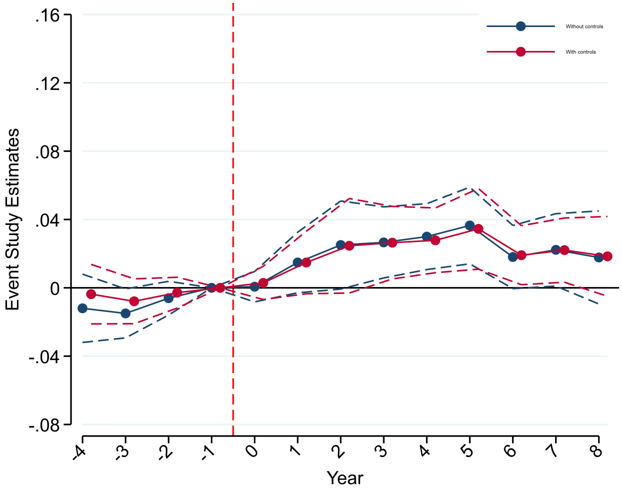
  - o_{jst}: the logarithm of capital durability for firm j in state s and year t
  - Law_{st}: enacted state dummy for anti-recharacterization laws
    - incorporated in TA, LA, AL, or DE, and the fiscal year is after the passing of the laws in these states
  - $\overline{\text{FC}}_j$: financial constraint proxies, including size, DIV, and SA
  - X_{jt}: other firm characteristics, including net worth, B/M, I/K, ROA, and leverage
  - FEs: firm and time fixed effects

Results on ARLs

	(1)	(2)	(3)	(4)	(5)	(6)
Law	0.018^{**}	0.028^{***}	0.062^{***}	0.029^{***}	0.180^{***}	0.018^{*}
[t]	[2.039]	[3.061]	[6.899]	[3.142]	[17.523]	[2.005]
Law × $\overline{\text{Net Worth}}$		-0.018^{***}				
[t]		[-30.670]				
Law × $\overline{\text{Capital}}$			-0.009^{***}			
[t]			[-51.814]			
Law × $\overline{\text{Employee}}$				-0.012^{***}		
[t]				[-31.250]		
Law × $\overline{\text{SA}}$					0.049^{***}	
[t]					[60.643]	
Law × $\overline{\text{Non-DIV}}$						0.015^{***}
[t]						[8.280]
Observations	52,469	48,062	48,062	47,736	48,062	48,062
R-squared	0.880	0.872	0.872	0.873	0.873	0.872
Controls	No	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	State	State	State	State	State	State

Parallel Trend Assumptions on ARLs to Capital Durability

Figure: **Capital Durability Surrounding Anti-recharacterization Laws**



Robustness Checks

- Exogeneity of Policy Shock
  - **Event Study:** Dynamic treatment effects and pre-trend tests
  - **Placebo Tests:** Assigning treatment to neighboring states
  - **Alternative Specifications:** State-by-year fixed effects, clustered errors, excluding outliers
  - **Balance Checks:** Pre-treatment covariate balance between treated and control groups
- Alternative Measures and Samples
  - **Financial Constraint Proxies:** SA, WW, text-based measures
  - **Sample Splits:** by industry, constraint level
  - **Compositional Change Tests**
- Robust DID Estimation
  - Correcting for bias in staggered adoption designs using recent econometric methods

Policy Implications

Mitigation of Financial Frictions: Cross-Section

Figure: Average Durability across Bonus Rate

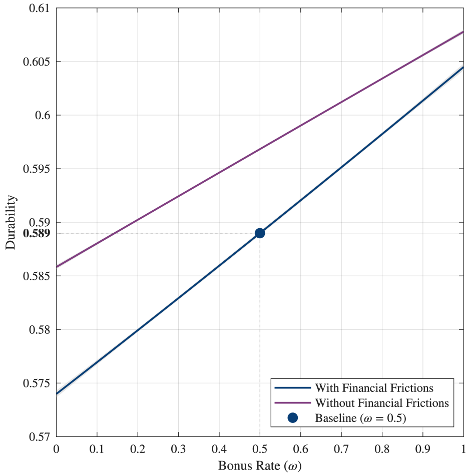
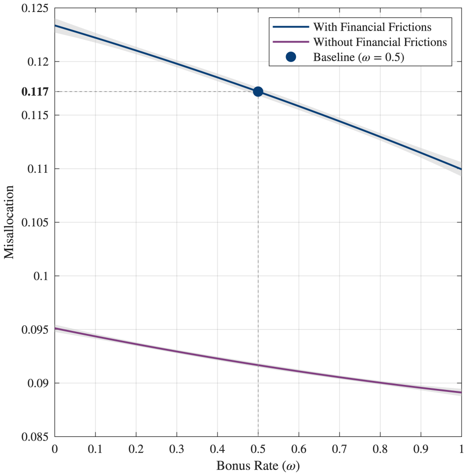
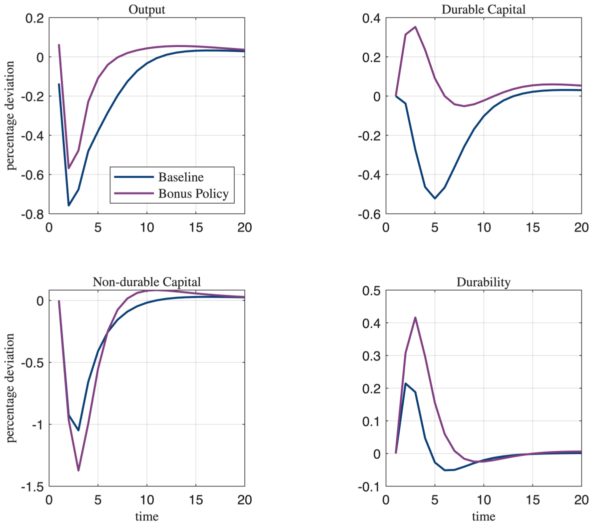


Figure: Capital Misallocation across Bonus Rate



Mitigation of Financial Frictions: Time-Series



Conclusion

- Mechanism: Financial frictions inhibit firms from investing in durable capital
  - Bonus depreciation lowers the effective cost of durable capital ⇒ increase in durable investment
- Empirical Evidence:
  - Difference-in-differences on changes in bonus depreciation and bankruptcy laws
  - Increase in durable capital
  - Financially constrained firms respond more strongly
- Policy Implications:
  - Bonus depreciation mitigates financial frictions and reduces capital misallocation
  - Encourages durable investment during downturns, accelerating recovery

The End

Appendix

Data Appendix

Measurement of Asset Durability

1. Industry-level (*i*) physical capital (K) durability

$$Durability_i^K = \sum_{h=1}^{71} \overline{w}_{h,i} \times Durability\ Score_h$$

   - $Durability\ Score_h$: service life of type-h capital, equal to $1/\delta_h$
   - $\overline{w}_{h,i}$: industry *i*'s type-*h* capital over its total capital stock

2. Firm-level (*j*) physical capital (K) durability

$$Durability_j^K = \sum_{s=1}^{n_j} \widetilde{w}_{j,s} \times Durability_s^K$$

   - $\widetilde{w}_{j,s}$: firm *j*'s sales in segment (industry) *i* ▸ Example

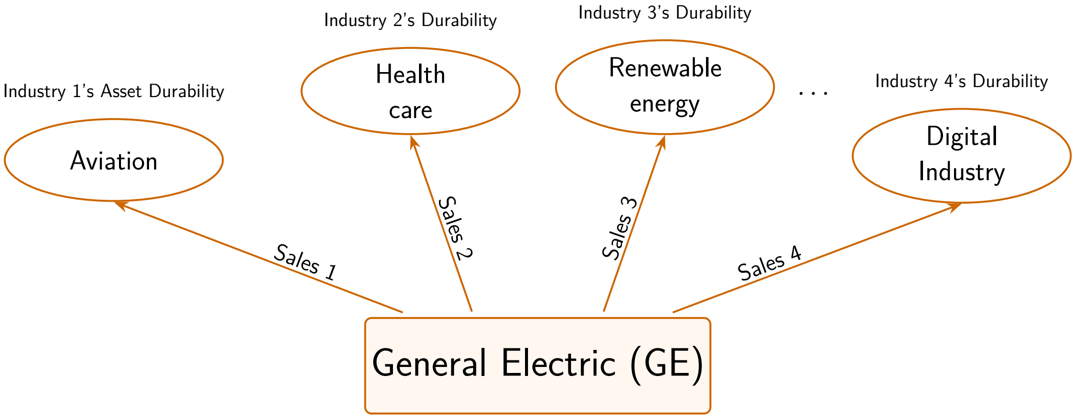
3. Firm-level (*j*) overall asset durability across tangible capital (K_j) and non-tangible capital (H_j) is

$$Durability_j = Durability_j^K \times \frac{K_j}{K_j + H_j} + Durability_i^H \times \frac{H_j}{K_j + H_j}$$

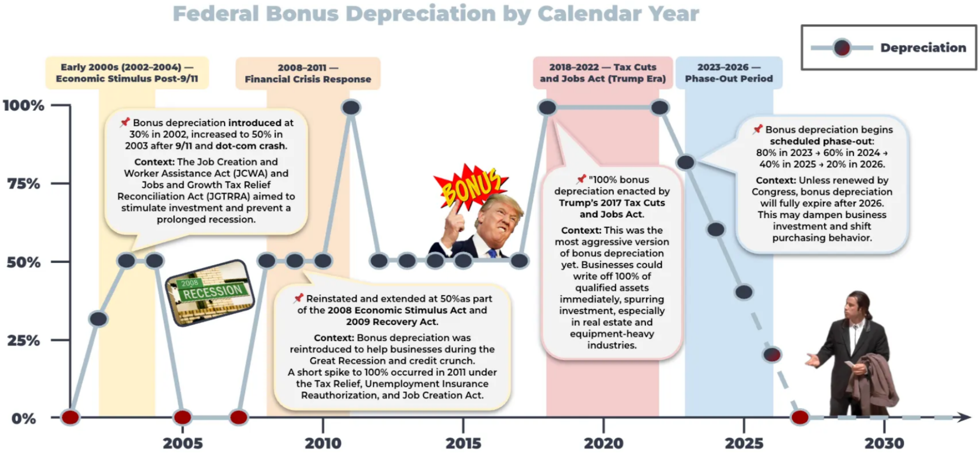
◂ Back

Measurement of Capital Durability: An Illustrative Example

◂ Back



Bonus Depreciation Timeline



📌 Bonus depreciation **introduced** at 30% in 2002, increased to 50% in 2003 after **9/11** and **dot-com crash**.

Context: The Job Creation and Worker Assistance Act (JCWA) and Jobs and Growth Tax Relief Reconciliation Act (JGTRRA) aimed to stimulate investment and prevent a prolonged recession.

📌 Reinstated and extended at 50%as part of the **2008 Economic Stimulus Act** and **2009 Recovery Act**.

Context: Bonus depreciation was reintroduced to help businesses during the Great Recession and credit crunch. A short spike to 100% occurred in 2011 under the Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act.

📌 "100% bonus depreciation enacted by **Trump's 2017 Tax Cuts and Jobs Act**.

Context: This was the most aggressive version of bonus depreciation yet. Businesses could write off 100% of qualified assets immediately, spurring investment, especially in real estate and equipment-heavy industries.

📌 Bonus depreciation begins **scheduled phase-out**: 80% in 2023 → 60% in 2024 → 40% in 2025 → 20% in 2026.

Context: Unless renewed by Congress, bonus depreciation will fully expire after 2026. This may dampen business investment and shift purchasing behavior.

Sample

Model Appendix

Capital Producer

- Type-*h* capital producer buys I_t^h final goods to produce with DRS tech. and adjustment cost,

$$\max_{I_t^h} \; q_t^h \, \Psi\left(\frac{I_t^h}{K_t^h}\right) K_t^h - I_t^h,$$

- The DRS technology with adjustment cost is defined as

$$\Psi\left(\frac{I}{K}\right) = \frac{\left(\frac{\delta^{nd}}{\delta^h}\right)^{-\frac{1}{\psi}} \hat{I}^{\frac{1}{\psi}}}{1-\frac{1}{\psi}} \left(\frac{I}{K}\right)^{1-\frac{1}{\psi}} - \frac{\hat{I}}{\psi - 1},$$

  where $\hat{I}$ is the long-run equilibrium investment rate, and ψ governs the curvature of the aggregate capital adjustment cost function according to Bernanke, Gertler and Gilchrist (1999).

- FOC pins down the price of type-*h* capital:

$$q_t^h = \frac{1}{\Psi'\left(\frac{I_t^h}{K_t^h}\right)} = \left(\frac{\delta^{nd}}{\delta^h}\right)^{\frac{1}{\psi}} \left(\frac{I_t^h/K_t^h}{\hat{I}}\right)^{\frac{1}{\psi}} \Rightarrow q^{h*} = \left(\frac{\delta^{nd}}{\delta^h}\right)^{\frac{1}{\psi}}$$

Calibration Strategies

- **Externally assign** a subset of macro parameters from literature/data
    - Kauffman Firm Survey → entrants leverage
    - BDS → firm exit rate
    - Edgerton (2011) → CES parameter
    - BEA data on structure-equipment ratio → average share of durable capital
- **Internally calibrate** the rest to match aggregate and investment rate moments
    - capital share → capital-output ratio
    - credit parameter → debt-capital ratio
    - depreciation rate → investment-capital ratio and investment rate distribution
    - disutility of labor → one-third of labor
    - Persistence and boundary of Pareto productivity shock → Firm size distribution in BDS

◂ Back

Baseline Model Calibration

Symbols	Descriptions	Values	Sources
Fixed Parameters			
β	Discount factor	0.96	Annual Frequency
π_d	Exogenous exit rate	0.09	BDS data
ν	Labor parameter	0.60	Labor share
θ_0	Entrant leverage	0.41	Kauffman Firm Survey
η	average share of durable capital	0.54	BEA data
κ	CES parameter	5.00	Edgerton (2011)
τ^c	Corporate tax rate	0.35	Pre-TCJA tax rate
ω	Bonus depreciation rate	0.50	Mostly adopted since 2001
Fitted Parameters			
Aggregates			
α	Capital share	0.27	Capital-Output ratio
θ	Collateral constraint	0.55	Debt-Asset ratio
ψ	Disutility of labor	2.15	Working hour
Durability			
δ^d	Durable capital depreciation rate	0.04	Investment rate dist.
δ^{nd}	Non-durable capital depreciation rate	0.09	Investment-Cap. ratio
Idiosyncratic Productivity Shocks			
ρ_z	Probability of retaining z	0.93	Firm size distribution
$\underline{z}$	Lower bound of z	0.44	Firm size distribution
$\bar{z}$	Upper bound of z	1.05	Firm size distribution
a	Pareto shape parameter	3.15	Firm size distribution

Model Fit

Moments	**Data**	**Model**
Output and Finance		
Working hours	0.33	0.33
Investment-Capital ratio	0.068	0.069
Capital-Output ratio	2.3	2.3
Debt-Asset ratio	0.34	0.337
Investment rate distribution		
Standard deviation of investment rate distribution	0.337	0.383
Serial correlation of investment rate distribution	0.058	0.067
Lumpy investment	0.186	0.161
Firm size distribution		
1 to 4 employee	0.55060	0.53156
5 to 19 employee	0.33420	0.35279
20 to 99 employee	0.09640	0.07554
100 to 499 employee	0.01530	0.01514
500 to 2499 employee	0.00260	0.00873
2500+ employee	0.00090	0.01624

References I

Albuquerque, Rui and Hugo A. Hopenhayn (2004) “Optimal Lending Contracts and Firm Dynamics,” *Review of Economic Studies*, 71 (2), 285 – 315, 10.1111/0034-6527.00285.

Almeida, Heitor and Murillo Campello (2007) “Financial Constraints, Asset Tangibility, and Corporate Investment,” *Review of Financial Studies*, 20 (5), 1429 – 1460, 10.1093/rfs/hhm019.

——— (2010) “Financing Frictions and the Substitution between Internal and External Funds,” *Journal of Financial and Quantitative Analysis*, 45 (3), 589 – 622, 10.1017/s0022109010000177.

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist (1999) “The Financial Accelerator in a Quantitative Business Cycle Framework,” in Taylor, John B. and Michael Woodford eds. *Handbook of Macroeconomics*, 1, Chap. 21, 1341–1393, Amsterdam: Elsevier.

Brunnermeier, Markus K. and Yuliy Sannikov (2014) “A Macroeconomic Model with a Financial Sector,” *American Economic Review*, 104 (2), 379 – 421, 10.1257/aer.104.2.379.

Cummins, Jason G., Kevin A. Hassett, and R.Glenn Hubbard (1996) “Tax reforms and investment: A cross-country comparison,” *Journal of Public Economics*, 62 (1), 237–273, https://doi.org/10.1016/0047-2727(96)01580-0, Proceedings of the Trans-Atlantic Public Economic Seminar on Market Failures and Public Policy.

Edgerton, Jesse (2011) “The effects of taxation on business investment: New evidence from used equipment,” *Federal Reserve Board of Governors, Mimeo, January*.

References II

Elenev, Vadim, Tim Landvoigt, and Stijn Van Nieuwerburgh (2021) “A Macroeconomic Model With Financially Constrained Producers and Intermediaries,” *Econometrica*, 89 (3), 1361 – 1418, 10.3982/ecta16438.

Falato, Antonio, Dalida Kadyrzhanova, Jae Sim, and Roberto Steri (2022) “Rising Intangible Capital, Shrinking Debt Capacity, and the U.S. Corporate Savings Glut,” *The Journal of Finance*, 77 (5), 2799 – 2852, 10.1111/jofi.13174.

Fang, Min, Po-Hsuan Hsu, and Chi-Yang Tsou (2025) “Financial Frictions and Pollution Abatement Over the Life Cycle of Firms,” *SSRN Electronic Journal*, 10.2139/ssrn.4390975.

Gertler, Mark and Nobuhiro Kiyotaki (2010) *Financial Intermediation and Credit Policy in Business Cycle Analysis*, 547 – 599: Elsevier, 10.1016/b978-0-444-53238-1.00011-9.

Gomes, João F. and Lukas Schmid (2020) “Equilibrium Asset Pricing with Leverage and Default,” *The Journal of Finance*, 76 (2), 977 – 1018, 10.1111/jofi.12987.

Goolsbee, A. (1998) “Investment Tax Incentives, Prices, and the Supply of Capital Goods,” *The Quarterly Journal of Economics*, 113 (1), 121 – 148, 10.1162/003355398555540.

Hassett, Kevin A. and Robert Glenn Hubbard (2002) “Tax Policy and Business Investment,” *Handbook of Public Economics*, 3, 1293–1343, `https://api.semanticscholar.org/CorpusID:154185585`.

He, Zhiguo and Arvind Krishnamurthy (2013) “Intermediary Asset Pricing,” *American Economic Review*, 103 (2), 732 – 770, 10.1257/aer.103.2.732.

References III

House, Christopher L and Matthew D Shapiro (2008) "Temporary Investment Tax Incentives: Theory with Evidence from Bonus Depreciation," *American Economic Review*, 98 (3), 737 – 768, 10.1257/aer.98.3.737.

Jermann, Urban and Vincenzo Quadrini (2012) "Macroeconomic Effects of Financial Shocks," *American Economic Review*, 102 (1), 238–271, 10.1257/aer.102.1.238.

Khan, Aubhik and Julia K. Thomas (2013) "Credit Shocks and Aggregate Fluctuations in an Economy with Production Heterogeneity," *Journal of Political Economy*, 121 (6), 1055–1107, 10.1086/674142.

Kiyotaki, Nobuhiro and John Moore (1997) "Credit Cycles," *Journal of Political Economy*, 105 (2), 211 – 248, 10.1086/262072.

Lanteri, Andrea and Adriano A. Rampini (2023) "Constrained-Efficient Capital Reallocation," *American Economic Review*, 113 (2), 354 – 395, 10.1257/aer.20210902.

Ottonello, Pablo and Thomas Winberry (2020) "Financial Heterogeneity and the Investment Channel of Monetary Policy," *Econometrica*, 88 (6), 2473 – 2502, 10.3982/ecta15949.

——— (2024) "Capital, Ideas, and the Costs of Financial Frictions," *SSRN Electronic Journal*, 10.2139/ssrn.4816720.

Rampini, Adriano A. (2019) "Financing Durable Assets," *American Economic Review*, 109 (2), 664 – 701, 10.1257/aer.20170995.

Rampini, Adriano A. and S. Viswanathan (2010) "Collateral, Risk Management, and the Distribution of Debt Capacity," *The Journal of Finance*, 65 (6), 2293 – 2322, 10.1111/j.1540-6261.2010.01616.x.

References IV

——— (2013) “Collateral and capital structure,” *Journal of Financial Economics*, 109 (2), 466 – 492, 10.1016/j.jfineco.2013.03.002.

Xu, Qiping and Eric Zwick (2024) “Tax Policy and Abnormal Investment Behavior,” *The Review of Financial Studies*, 37 (10), 2971 – 3023, 10.1093/rfs/hhae040.

Zwick, Eric and James Mahon (2017) “Tax Policy and Heterogeneous Investment Behavior,” *American Economic Review*, 107 (1), 217 – 248, 10.1257/aer.20140855.