Tax Losses, Financing Constraints, and Targeting Corporate Fiscal Incentives

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November 17, 2023

Disclaimer

These slides provide an overview of an in-progress research project with theoretical and empirical components. In this slide deck, we detail our theoretical framework.

We recently received approval to use U.S. tax data to provide descriptive and quasi-experimental evidence supporting the framework, as well as to estimate key parameters in our model.

Introduction

- Governments provide economic incentives to firms by offering tax deductions
- Firms respond to immediate tax incentives that relax financial constraints
  Edgerton 2010, Zwick and Mahon 2017, Saez, Schoefer and Seim 2019, Liu and Mao 2019
- 40-50% of firms do not receive immediate benefits from additional tax deductions because they have tax losses Cooper and Knittel 2006
- Tax losses target economic incentives provided via tax deductions at specific firms

This Paper

What are the economic implications of allowing losses to target tax incentives?

- Use tax data to characterize differences between firms with and without tax losses
- Develop quasi-experimental evidence on how losses, financing constraints and their interaction dictate firm responses to tax changes
- Specify a dynamic investment model with tax incentives, losses, and financing constraints
  - Estimate the model using key moments from the data
  - Counterfactuals exploring impacts and incidence of tax incentives

Contributions to the Literature

- Dynamic incentives of tax losses
  - Provide new description of investment and financing status before and after losses
  - Rich characterization of tax code incentives in dynamic investment model

Auerbach 1986, Mayer 1986, Auerbach and Poterba 1987, Altschuler and Auerbach 1990, Cooper and Knittel 2006, Altschuler et al. 2009, Kaymak and Schott 2019

- Heterogeneous firm responses to stimulus
  - Focus on interaction between financial constraints and tax loss status

Edgerton 2010, Zwick and Mahon 2017, Saez, Schoefer and Seim 2019, Liu and Mao 2019, Jeenas 2019, Ottonello and Winberry 2020, Chen et al. 2021, Chen et al. 2023

Plan For Data Analysis

- Descriptive Statistics
  - Frequency, persistence, and size of tax losses
  - Degree of financial constraints faced by loss and non-loss firms
  - Loss firms likely to face more constraints because costs exceed revenues
- Quasi-Experimental Analysis
  - Estimate impacts of tax changes by tax loss and financial constraint status
  - Bonus depreciation industry exposure design Zwick and Mahon 2017, Curtis et al. 2022
  - DPAD industry exposure design Ohrn 2018, Dobridge et al. 2022

Key Features of the Dynamic Investment Model

- Investment impacted by persistent, unobserved heterogeneity
    - TFP and revenue shocks
    - Convex adjustment costs of investment
- Comprehensive treatment of tax losses (carryforwards)
    - Tax payment if income exceeds deductions
    - Tax deduction *next period* if deductions exceed income
- Costly external financing and exit
    - Firm invests with internal funds left after taxes
    - Endogenously priced debt depending on default probability

Production

Firm revenue given by

$$A^{1-\alpha}K^{\alpha} - \omega(s, K)$$

- TFP A follows AR(1)

$$\log A' = \rho \log A + \varepsilon, \quad \varepsilon \sim \mathcal{N}(0, \sigma^2), \quad \rho \in (0, 1)$$

- Persistent *revenue shock* $\omega(s, K)$

$$\omega(s, K) = \mathbb{1}(s = 1)(f_\omega + h_\omega K),$$

  where s is Bernoulli variable correlated through time

$$\Pr(s' = 1 | s = 1) > \Pr(s' = 1 | s = 0).$$

Investment

- Investment subject to costly adjustment

$$I = K' - (1-\delta)K, \qquad C(I,K) = I + \frac{\gamma}{2}\left(\frac{I^2}{K}\right)$$

- Two sources of investment financing
  - Cash (internal): net revenue after taxes (next slide)
  - Debt (external): priced competitively based on default risk

Taxes

- Allow for depreciation deductions, interest deductions, and loss carryforwards
- **Income net of present deductions** NI

$$NI = A^{1-\alpha}K^{\alpha} - \omega(s,K) - \eta I - (1-\eta)\delta K,$$

η denotes the fraction of investment deducted in the current period Details

- **Past deductions** TD

$$TD' = \max\left\{-(NI - TD), 0\right\} + b'\left(1 - \frac{1}{R_{b',K',\mathcal{S}}}\right)$$

where $R_{b',K',\mathcal{S}}$ denotes interest rate, priced to account for default risk

- Taxes paid are a function of taxable income

$$TI = NI - TD, \qquad T(TI) = \max\{0, \tau \cdot TI\}$$

External Financing and Exit

- Positive dividend constraint (no equity financing)
    - Investing more than cash on hand requires costly borrowing
    - Firm can borrow $\frac{b'}{R_{b',K',\mathcal{S}}}$ today and pay b' back tomorrow
- Firm forced to default and exit if b exceeds cash plus fraction of recoverable capital ξ

$$A^{1-\alpha}K^{\alpha} - \omega(s,K) - T(NI,TD) + \xi(1-\delta)K < b$$

- Debt priced competitively based on default risk
    - Risk neutral lender indifferent between a riskless loan with interest rate R and risky loan with an interest rate $R_{b',K',\mathcal{S}}$ Details

Firm Problem

- We define the state space $\mathcal{S} = \{A, s, K, b, TD\}$ and write the firm problem

$$V(\mathcal{S}) = \max_{I,b'} \underbrace{A^{1-\alpha}K^{\alpha} - \omega(s,K) - T(TI) - b - C(I,K)}_{=d} + \frac{b'}{R_{b',K',\mathcal{S}}} + \frac{1}{R}\mathbb{E}_{(A',s')|(A,s)}[\mathbb{1}_{(A',\omega')\notin \text{default}} V(\mathcal{S}')],$$

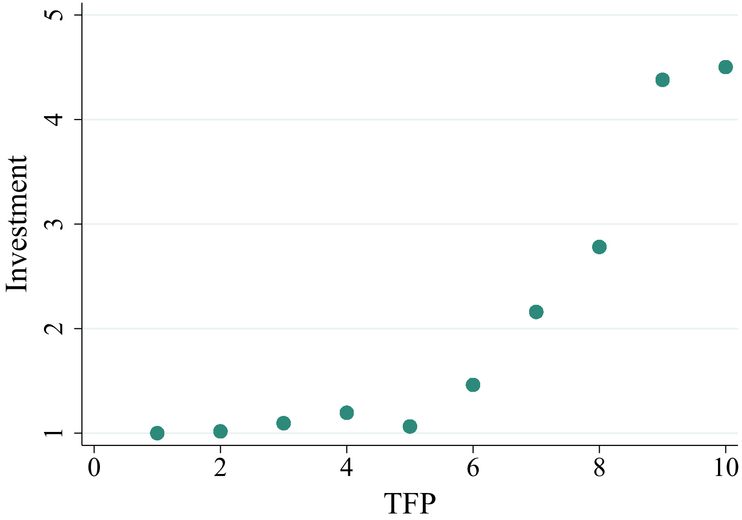
$$\text{s.t.} \quad b' \geq 0, \quad d \geq 0.$$

- Solve by Value Function Iteration Details

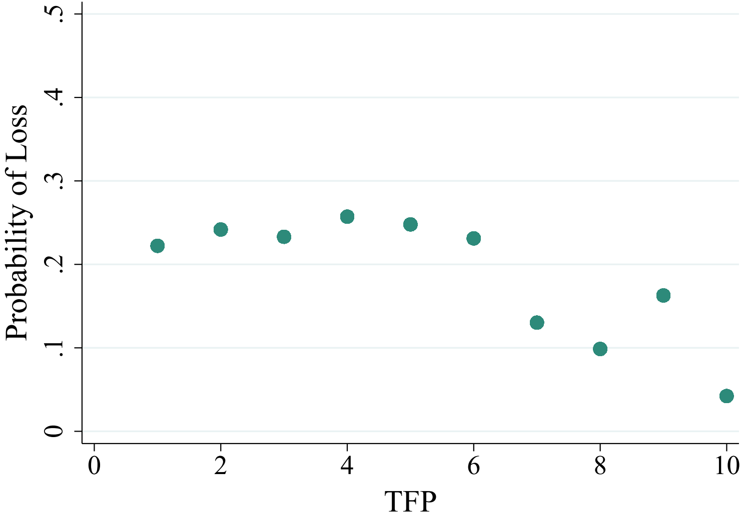
Patterns Produced by The Model

- Calibrate parameters, solve model, simulate panel of firms
- Higher TFP firms:
  - Invest more
  - Are less likely to have a loss
  - Are less likely to default

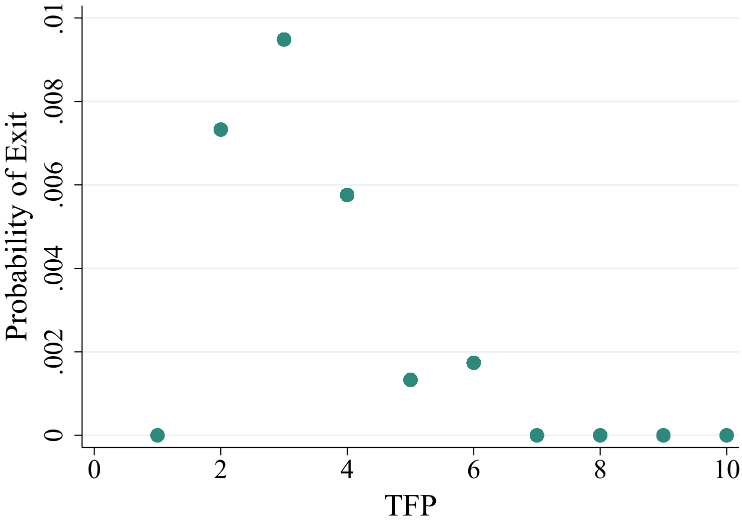
Higher TFP Firms Invest More



Higher TFP Firms Have Fewer Losses



Higher TFP Firms Exit Less Frequently



Estimating Model Parameters

- Production $A^{1-\alpha}K^{\alpha}$ with TFP A following $\log(A') = \rho \log(A) + \varepsilon'$
  - Estimate α, ρ from relationship between revenues and capital using system GMM Details
- Loss shock $\omega(s, K) = \mathbb{1}(s = 1)(f_\omega + h_\omega K)$
  - Estimate transition probabilities directly in data
  - Estimate f_ω, h_ω using SMM, target persistence and frequency of loss moments Details
- Convex adjustment costs $C(I, K) = K' - (1 - \delta)K + \frac{\gamma}{2}\frac{(K'-(1-\delta)K)^2}{K}$ and capital recovery fraction during default ξ
  - Estimate γ, ξ using SMM, target investment, exit, and leverage moments Details

What Does the Model Accomodate?

- Policy experiments in a system with losses and fully specified financing constraints
  - Tax rate, accelerated depreciation, interest deductions, cash transfers
- Different loss systems
  - Carryforwards, tax symmetry, loss limitations or “hybrid” models

Policy Experiment Using Simple Calibrated Model

Proof of concept for counterfactuals to be run with estimated parameters

- Simulate panel of 10,000 firms with
  - No investment incentive (Baseline)
  - Additional depreciation for tax purposes
  - Unconditional cash transfer to all firms
  - Corporate tax rate cut
- Compare firm panel outcomes
  - Total investment
  - Dollars of investment and output per dollar of tax expenditure (MVPF)

Policy Experiment Using Simple Calibrated Model

	Baseline	Additional Depr	Cash Transfer	Tax Cut
Panel A: Levels				
MVPF	–	3.9415	0.4542	2.1281
Exit (cumul.)	0.0754	0.0727	0.0657	0.0645
Panel B: Relative to Baseline				
Tax revenue	1.0	0.901	0.9161	0.7873
Capital	1.0	1.046	0.9995	1.049
Output	1.0	1.0322	1.0031	1.0374
Top 5%	1.0	0.993	1.0021	1.002
Bottom 5%	1.0	0.9726	0.9595	0.9642
Exit (cumul.)	1.0	0.9642	0.8714	0.8554

Appendix

Depreciation deductions

- Assume capital depreciates geometrically at rate δ
- Allow for a fraction η of investment to be deducted immediately
- Varying η changes generosity of accelerated depreciation
- If capital is sold, firm must pay back deductions claimed for "undepreciated" capital
- Can be accommodated without additional states other than TD

	1	2	3	4	5
Investment in t	100	0	0	0	0
Capital in t (for production)	0	100	80	64	51.2
Capital in t (for tax purposes)	0	50	40	32	25.6
Depreciation deduction in t	50	10	8	6.4	5.1

Table: Example with $\eta = 50\%, \delta = 20\%$

Back

Debt Pricing

Defining a state $\mathcal{S} = (A, s, K, b, TD)$ and the set of states where the firm exits as Ω,

$$\Omega(b', R_{b',K',\mathcal{S}}, \mathcal{S}) = \{(A', K') \text{ s.t. } A'K'^{\alpha} - \omega(s', K') - T(NI', TD') + \xi(1-\delta)K' < b'\},$$

We have a probability of default

$$\mathbb{P}_{\text{def}}(b' | R_{b',K',\mathcal{S}}, \mathcal{S}) = \sum_{(A',\omega')\in\Omega} \pi\Big((A', \omega')|(A, \omega)\Big),$$

And an expected value recovered by the lender

$$SV(b' | R_{b',K',\mathcal{S}}, \mathcal{S}) = \sum_{(A',\omega')\in\Omega} \pi\Big((A', \omega')|(A, \omega)\Big) \max\{A'K'^{\alpha} - \omega(s', K') - T(NI', TD') + \xi(1-\delta)K', 0\}.$$

Implying an interest rate that solves the no-arbitrage condition (a fixed point)

$$\frac{b'}{R_{b',K',\mathcal{S}}} = \frac{b'(1 - \mathbb{P}_{\text{def}}(b' | R_{b',K',\mathcal{S}}, \mathcal{S}))}{R} + \frac{SV(b' | R_{b',K',\mathcal{S}}, \mathcal{S})}{R},$$

External Financing

Solving Model

- For a grid of $\mathcal{S} = \{A, s, K, b, TD\}$, solve for the debt price $R_{b',K',\mathcal{S}}$ of any investment decision I from no-arbitrage condition Details

$$\frac{b'}{R_{b',K',\mathcal{S}}} = \frac{b'(1 - \mathbb{P}_{\mathsf{def}}(b'|R_{b',K',\mathcal{S}}, \mathcal{S}))}{R} + \frac{SV(b'|R_{b',K',\mathcal{S}}, \mathcal{S})}{R}.$$

- Solve for firms' policies and value functions by parallelized Value Function Iteration

Firm Problem

System GMM Estimation

- Exploit relationship between revenues and capital in the data

$$Y = A_{it}^{1-\alpha} K_{it}^{\alpha}, \quad A_{it} = \phi_t + \kappa_i + \varepsilon_{it}, \quad \varepsilon_{it} = \rho_\varepsilon \varepsilon_{it-1} + e_{it} \sim \mathcal{N}(0, \sigma_\varepsilon)$$
$$r_{it} = \rho_\varepsilon r_{it-1} + \theta k_{it} - \rho_\varepsilon \theta k_{it-1} + \phi_t^* + \kappa_i^* + m_{it} - \rho_\varepsilon m_{it-1} + (1-\theta) e_{it}$$
$$\Delta r_{it} = \rho_\varepsilon \Delta r_{it-1} + \theta \Delta k_{it} - \rho_\varepsilon \theta \Delta k_{it-1} + \Delta \phi_t^* + \Delta m_{it} - \rho_\varepsilon \Delta m_{it-1} + (1-\theta) \Delta e_{it}$$

- System GMM to estimate α, ρ_ε using level and first difference equations Blundell and Bond 2000

$$\mathbb{E}[z_{i,t-s}^D (\Delta m_{it} - \rho_\varepsilon \Delta m_{it-1} + (1-\theta) \Delta e_{it})] = 0$$
$$\mathbb{E}[z_{i,t-s}^L ((1-\theta)(1-\rho_\varepsilon)\kappa_i + m_{it} - \rho_\varepsilon m_{it-1} + (1-\theta) e_{it})] = 0$$

where $z_{i,t-s}^L = [\Delta r_{it-s}, \Delta k_{it-s}]$ with $s \geq 2$ and $[z_{i,t-s}^D = [r_{it-s}, k_{it-s}]$ with $s \geq 3$

Estimation

SMM Estimation

- Use SMM to estimate parameters consistent with important moments in the data

$$\max_{\Theta}[\hat{m} - m(\Theta)]' W [\hat{m} - m(\Theta)]$$

- **Parameters:** $\Theta = \{f_\omega, s_\omega, \gamma, \xi\}$
- **Moments:** Size and persistence of losses, investment rate, exit rate, leverage
- **Quasi-Experimental Moments:** Can target quasi-experimental estimates of impacts of bonus depreciation Edgerton 2010, Zwick and Mahon 2017 and DPAD Ohrn 2018 during estimation, or reproduce policy experiments with estimated model to assess external validity

Estimation