Leverage over the Firm Life-Cycle, Firm Growth and Aggregate Fluctuations

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Motivation

- Great deal is known about life-cycle dynamics of U.S. firms
- Far less is known about how these firms finance their growth
  - Literature often focuses on publicly listed companies,
    - 26% of employment and 44% of gross output details
  - Or the youngest (KFS) and smallest (SBCS)
  - We lack an understanding of financing patterns over the firm size and age distribution.

This paper asks:

1. How do firms finance their operations over their life-cycle?
2. Do financing patterns matter for shock responsiveness?
3. What are the implications for aggregate fluctuations?

Contex

- Mixed results regarding which firms respond more to aggregate shocks
  - *Small firms propagate adverse shocks:* Chodorow-Reich, 2014; Farre-Mensa and Ljungquvist, 2016; Gilchrist et. al., 2018
  - *Small and large firms respond similarly*: Moscarini and Chari et. al., 2013; Kudlyak and Sanchez, 2016; Crouzet and Mehrotra, 2017
- Mixed results whether differences in responsiveness arise from financial frictions
  - *High leverage firms respond more:* Giroud and Mueller, 2017; Jeenas, 2018; Kalemli-Ozcan et al., 2018
  - *High leverage firms respond less:* Ottonello and Winberry, 2018
- **Mixed findings may reflect differences in financing of public vs. private, small vs. large, young vs. old firms.**

This Paper

1. Develop **LOCUS** – **L**BD + **O**rbis + **C**ompustat for **US** firms

2. Explore determinants of firm leverage focusing on life-cycle characteristics (age and size).

3. Exploit credit tightening during Great Recession to analyze response of firm leverage and growth.

4. Assess relationship between firm leverage during Great Recession and sectoral employment and revenue growth.

Preview of Results

- **Heterogeneity in leverage by firm size and age**
  - Large and young firms are more leveraged
  - During crisis: Large private firms become more constrained
- **Heterogeneity affects response to shocks and firm growth**
  - Leverage and firm growth are positively correlated
  - During crisis: High leverage firms grow less due to deleveraging
- **Sector growth dynamics linked to firm leverage**
  - Leverage and sector growth are positively correlated
  - During crisis: High leverage sectors grow less due to de-leveraging

Data & Addressing Selection

Our Data Sources

- **Longitudinal Business Database**: U.S. Census Bureau data derived from the Business Register
  - Establishment and firm-level information on employment, payroll, industry, revenue (firm-level) and location.

- **Financial Data**: balance sheet and income statement data
  - Compustat (S&P): publicly-traded firms
  - Orbis (Moody's): privately-held firms (not representative but we address selection by matching with the LBD)

- **LOCUS**: match rate between financial data and LBD is around 80%. Over 70% of matches are based on EIN. details

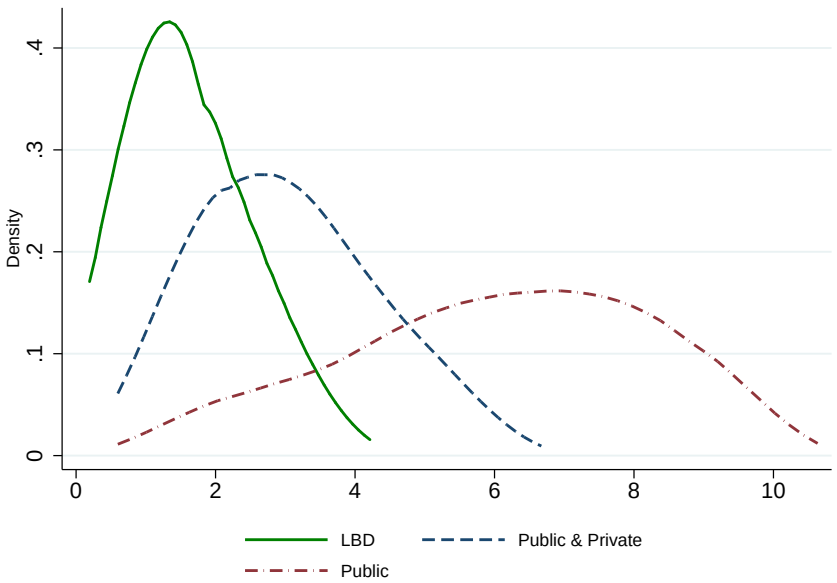
LOCUS Coverage

Average (2005-2011)	*Orbis (%)*	*Compustat (%)*	*LOCUS (%)*
Employment	9	21	31
Payroll	10	25	35
Revenue	11	27	38

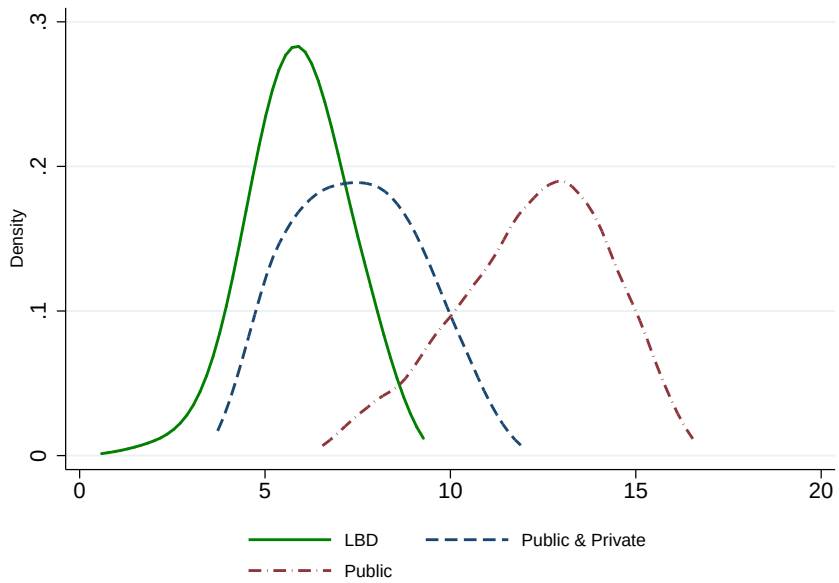
- Final sample contains 198,000 firms (97% are private).
- Accounts for 31% of emp, 35% of payroll and 38% of revenue
- Privately-held firms account for 1/3 of the emp, payroll and revenue in LOCUS.

Employment and Revenue Distributions

Employment



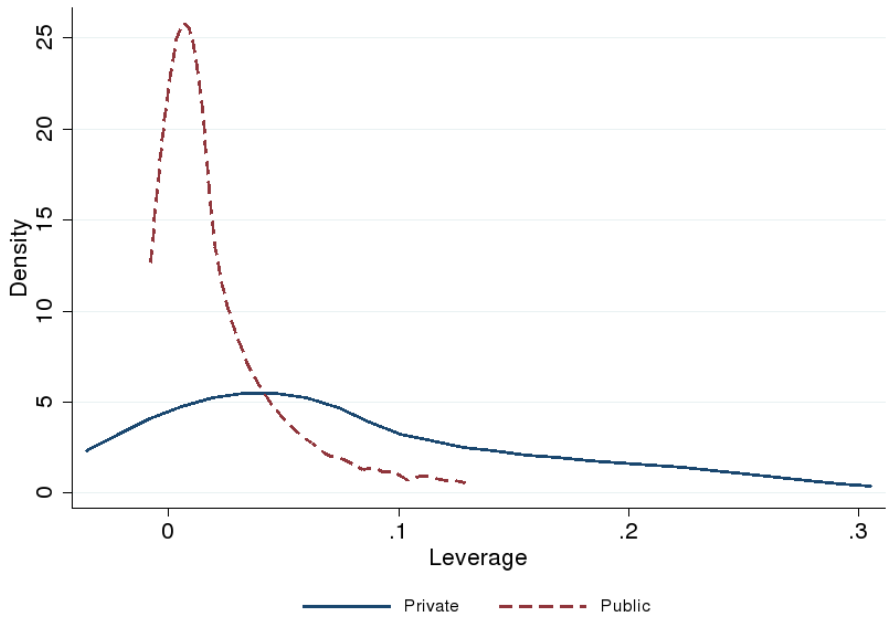
Revenue



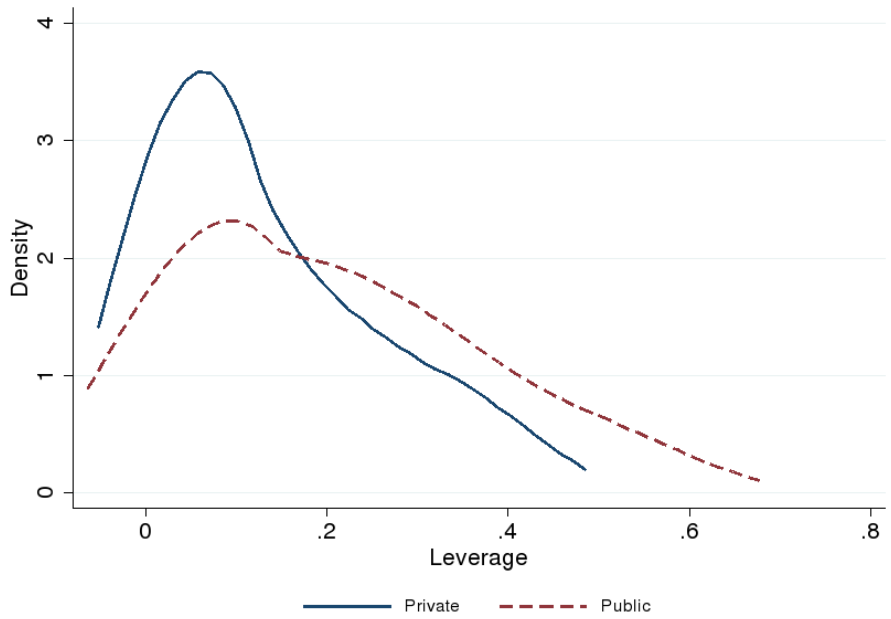
- **Avg. employment**: 20 in LBD, 6,200 in CS, 170 in Orbis
- **Avg. revenue**: $ 4.6M in LBD, $ 2180M in CS, $ 33.8M in Orbis

Leverage Distributions

Short-term



Long-term



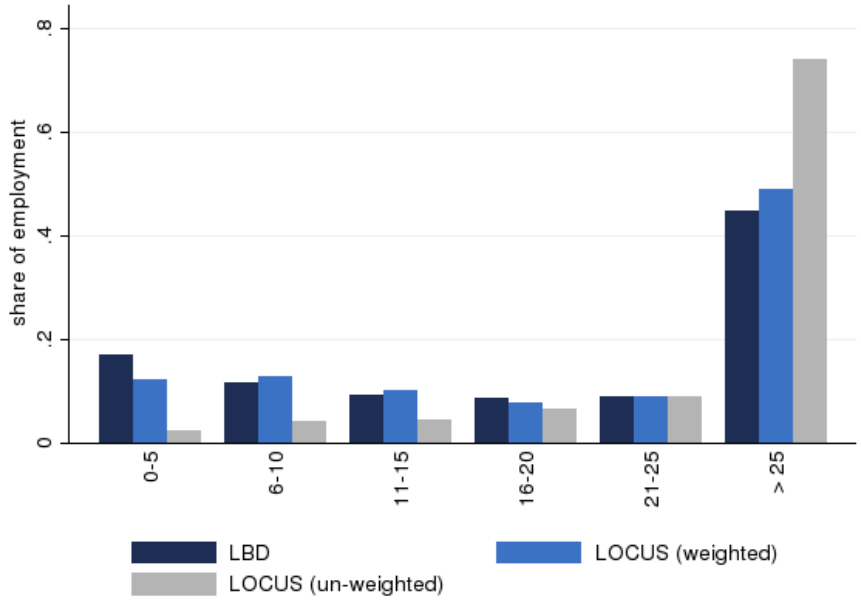
- Conditional on having positive debt, public firms have higher long-term and lower short-term leverage than private firms.

Selection into Reporting Financials

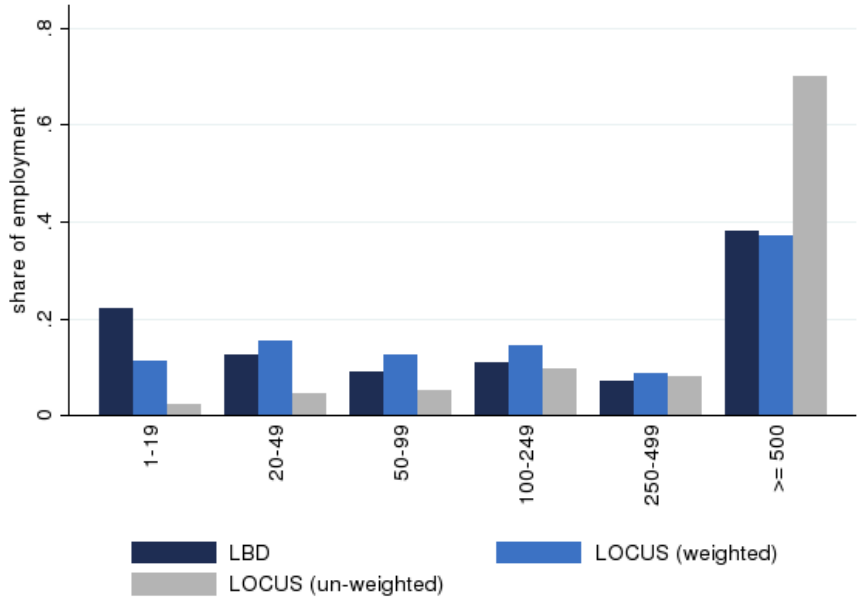
- Only listed firms required to report financials in the US.
- **What factors affect privately-held firm reporting of financials?**
  1. Older, larger, and more complex firms: lower costs of reporting.
  2. Growing firms wishing to expand their access to finance may be required (or have incentive) to report.
  3. Industries differ in the degree to which firms rely on external finance, which may influence reporting.
  4. Regulatory requirements may vary across states and legal forms.
- **Addressing selection**: predicted values from logistic regression used to reweight data (propensity scores). details

Addressing Selection: Age & Employment

Age



Employment



- Observable differences between reporting and non-reporting privately-held firms reduced. additional

Leverage over the Life-cycle

Regression Framework: Financing and Life-cycle

$$LEV_{it} = \alpha + (\omega_s \times \lambda_t) + \beta_1 \log(EMP_{it}) + \beta_2 AGE_{it} + \beta_3 COLLAT_{it} + \beta_4 PROFIT_{it} + \beta_5 PROD_{it} + \epsilon_{it}$$

- Leverage (LEV_{it}) defined three ways:
  - Financial Debt/Total assets (FD/TA_{it})
  - Short-term Liabilities/Total Assets (STL/TA_{it})
  - Long-term Liabilities/Total Assets (LTL/TA_{it})
- Age (AGE_{it}) and employment ($\log(\text{EMP}_{it})$) from LBD
- COLLAT_{it}: tangible fixed assets over total assets
- PROFIT_{it}: net income over total assets
- PROD_{it}: labor revenue productivity
- $(\omega_s \times \lambda_t)$: industry-year fixed effects stats

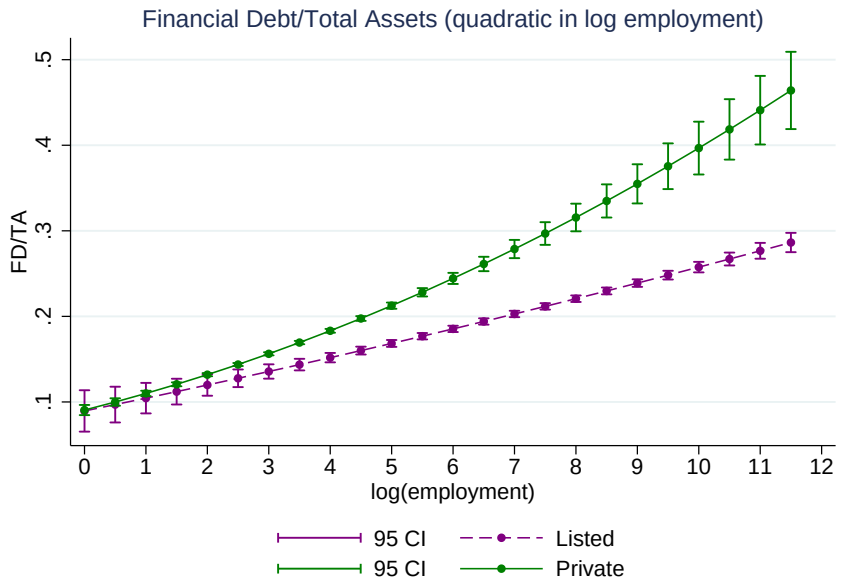
Benchmark: Cross-sectional

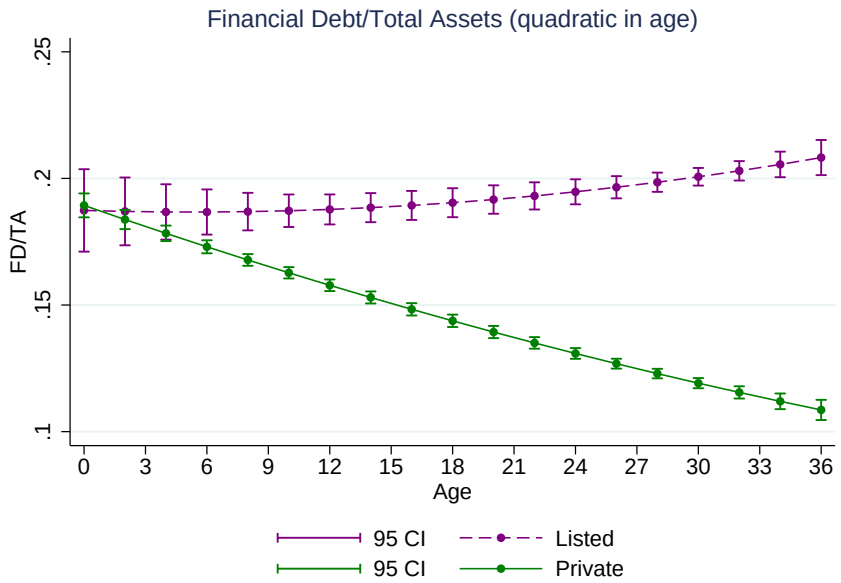
$$LEV_{it} = \alpha + (\omega_s \times \lambda_t) + \beta_1 \log(EMP_{it}) + \beta_2 AGE_{it} + \beta_3 COLLAT_{it} + \beta_4 PROFIT_{it} + \beta_5 PROD_{it} + \epsilon_{it}$$

	(FD/TA$_{it}$)		(STL/TA$_{it}$)		(LTL/TA$_{it}$)	
	Listed	Private	Listed	Private	Listed	Private
log(EMP$_{it}$)	0.0178***	0.0281***	-0.0014***	0.0117***	0.0195***	0.0167***
	(0.0008)	(0.0007)	(0.0003)	(0.0003)	(0.0007)	(0.0006)
AGE$_{it}$	0.0007***	-0.0024***	0.0001	-0.0004***	0.0006***	-0.0019***
	(0.0002)	(0.0001)	(0.0001)	(0.0000)	(0.0002)	(0.0001)
Full controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Wgts (logit)	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	20,000	320,000	20,000	320,000	20,000	320,000
R2	0.2299	0.1525	0.1164	0.0882	0.2275	0.1523

- Large and young private firms are more leveraged.

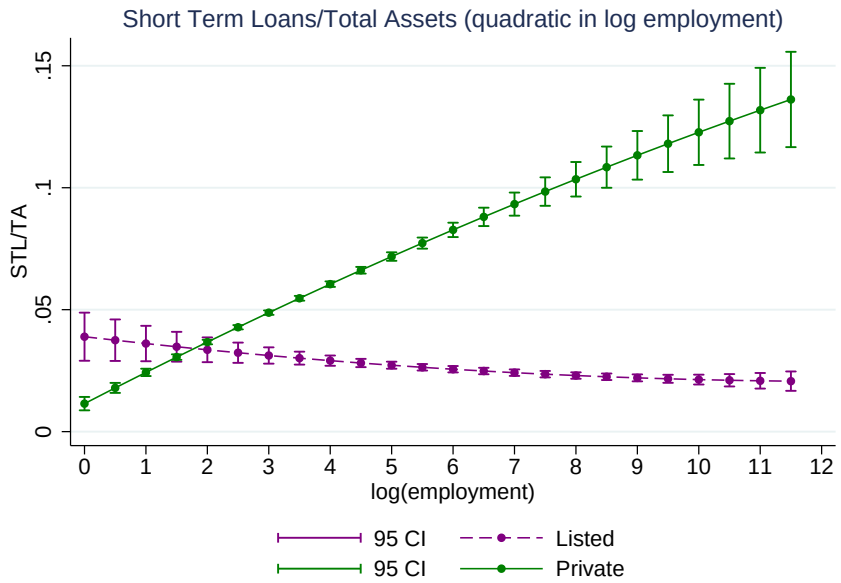
Benchmark: Financial Leverage, Size, and Age

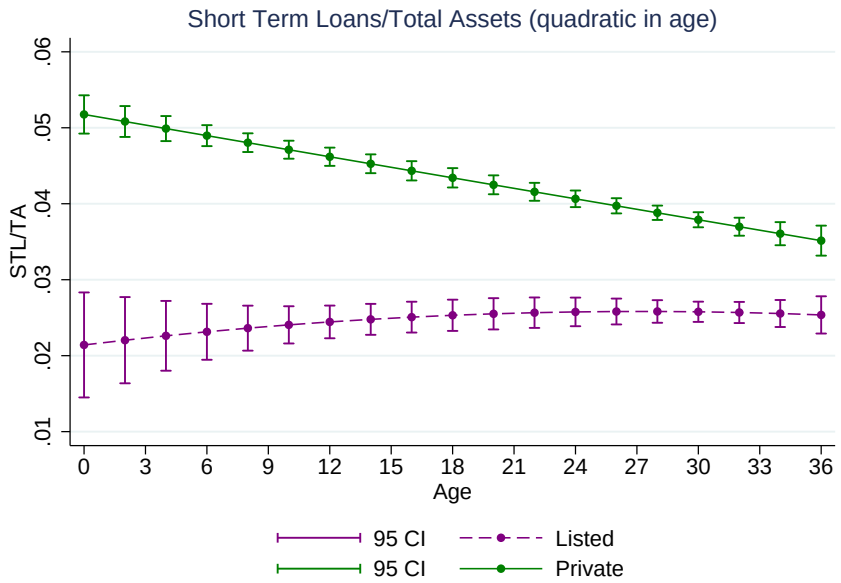




- Size strongly positively and age strongly negatively related to long-term leverage only among private firms.

Benchmark: Short-term Leverage, Size, and Age





- Size strongly positively and age strongly negatively related to short-term leverage only among private firms.

Benchmark: Panel

$$LEV_{it} = \alpha_i + (\omega_s \times \lambda_t) + \beta_1 \log(EMP_{it-1}) + + \beta_2 COLLAT_{it-1} + \beta_3 PROFIT_{it-1} + \beta_4 PROD_{it-1} + \epsilon_{it}$$

	(Listed) STL/TA_{it}	(Private) STL/TA_{it}
$\log(EMP_{it-1})$	0.0024	**0.0066****
	(0.0024)	**(0.0033)**
$COLLAT_{it-1}$	0.0097	-0.0019
	(0.0156)	(0.0101)
$PROFIT_{it-1}$	-0.0230***	-0.0001
	(0.0056)	(0.0034)
$PROD_{it-1}$	-0.0005	0.0017
	(0.0014)	(0.0026)
Industry-Year FE	Yes	Yes
Firm FE	Yes	Yes
Wgts (logit)	Yes	Yes
Obs.	10,000	19,000
R2	0.5542	0.7271

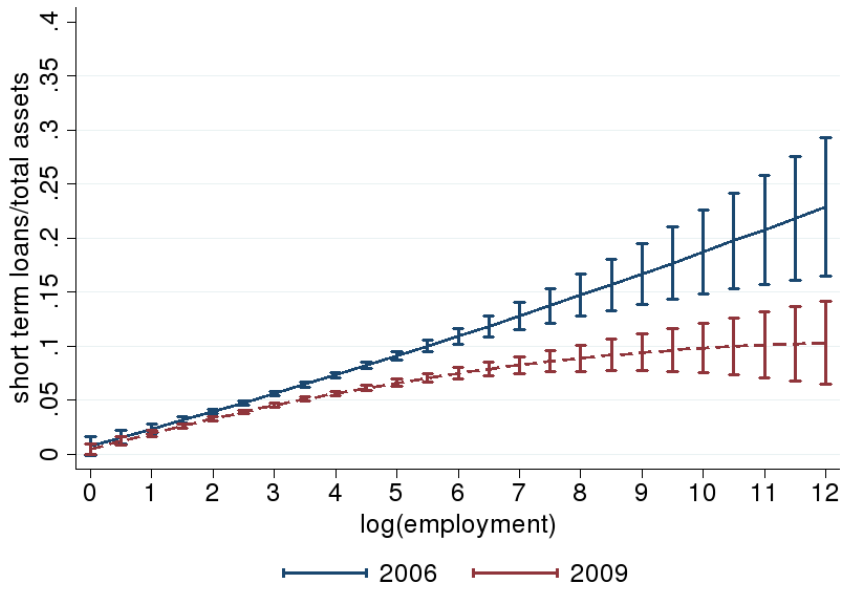
- Positive relationship between size and leverage observed within firms over time.

Firm Responsiveness to Shocks

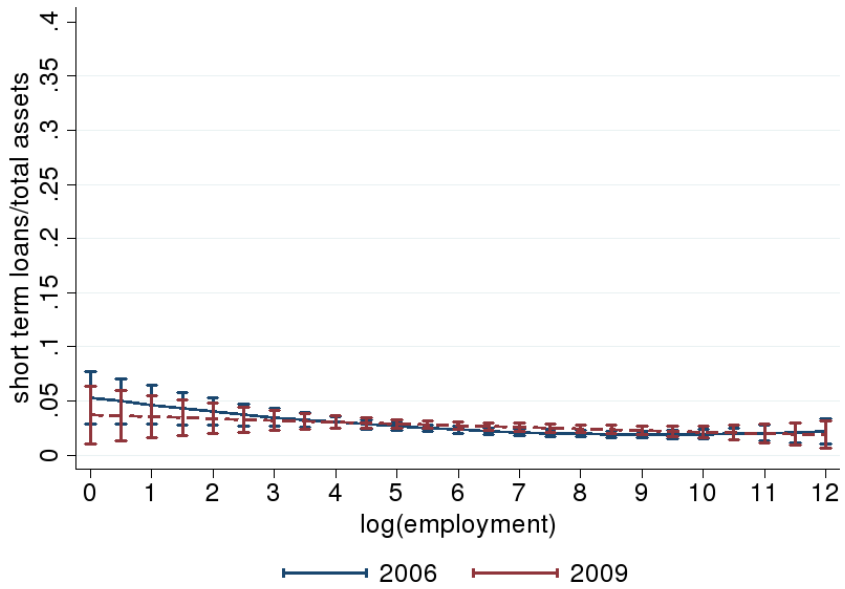
Great Recession & Leverage: Cross-sectional

$$LEV_i = \alpha + \omega_s + \beta_1 \log(SIZE_i) + \beta_2 \log(SIZE_i)^2 + \Gamma Z_{it} + \epsilon_i$$

Private Firms



Public Firms



- Private firms appear "constrained" during recession, but not public ones.

Great Recession & Leverage: Panel

$$STL/TA_{it} = \alpha_i + (\omega_s \times \lambda_t) + (\phi_c \times \lambda_t) + \beta_1 \log(EMP_{it-1}) + \beta_2(\log(EMP_{it-1}) \times CRISIS_t) + \beta_3(\log(EMP_{it-1}) \times POST_t) + \Gamma Z_{it} + \epsilon_{it}$$

	Private	Public
$\log(EMP)_{it-1}$	**0.010*** **	0.002
	(0.002)	(0.003)
$\log(EMP)_{it-1} \times CRISIS_t$	**-0.006*** **	-0.001
	(0.001)	(0.001)
$\log(EMP)_{it-1} \times POST_t$	**-0.010*** **	-0.001
	(0.001)	(0.001)
Wgts (logit)	Y	Y
Full Controls	Y	Y
County-Year FE	Y	Y
Industry-Year FE	Y	Y
Firm FE	Y	Y
Obs.	99,000	13,000
R2	0.7319	0.6545

- Evidence of private firms deleveraging, but not public ones.

Great Recession & Growth: Panel

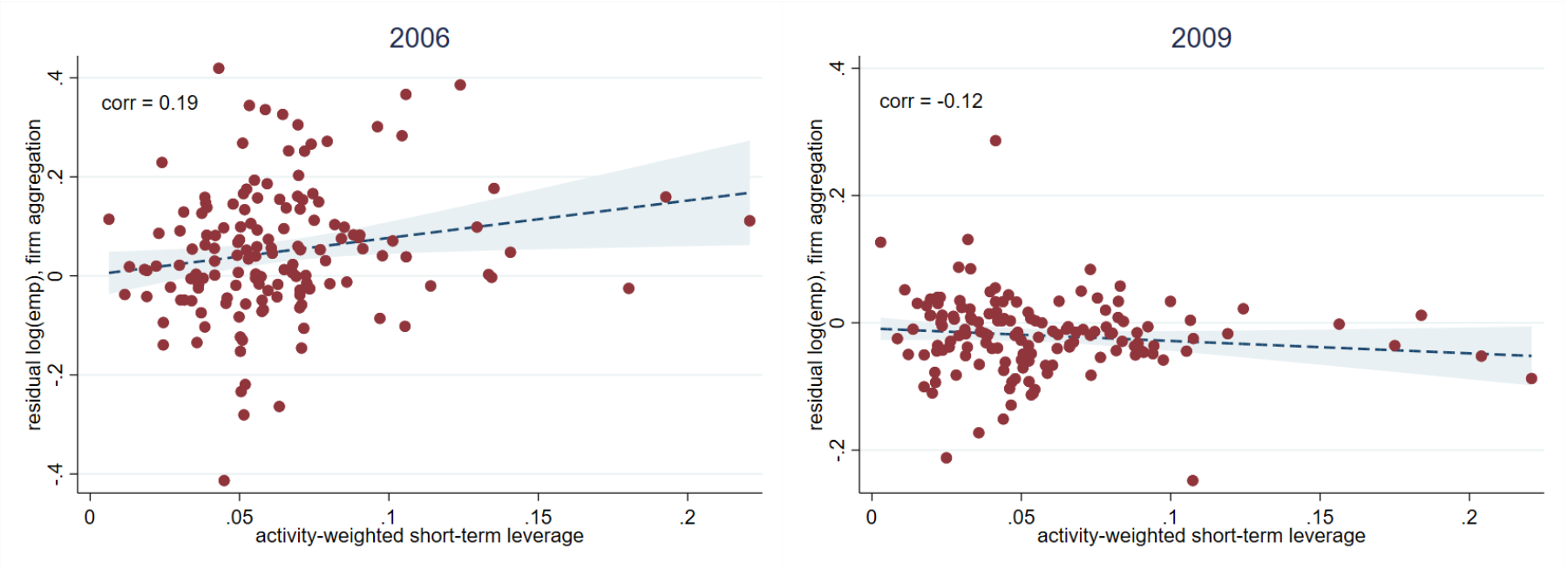
$$FG_{it} = \alpha_i + (\omega_s \times \lambda_t) + (\phi_c \times \lambda_t) + + \beta_1 STLEV_{it-1} + \beta_2 (STLEV_{it-1} \times CRISIS_t) + \beta_3 (STLEV_{it-1} \times POST_t) + \Gamma Z_{it-1} + \epsilon_{it}$$

	$\log(EMP)_{it}$		$\log(REV)_{it}$	
	private	public	private	public
$STLEV_{it-1}$	**0.062***	-0.07	**0.10****	-0.12
	(0.03)	(0.12)	**(0.04)**	(0.19)
$STLEV_{it-1} \times CRISIS_t$	**-0.08****	-0.01	-0.068	-0.10
	(0.04)	(0.17)	(0.07)	(0.26)
$STLEV_{it-1} \times POST_t$	-0.001	-0.250	0.10	-0.25
	(0.04)	(0.18)	(0.07)	(0.28)
Wgts (logit)	Y	Y	Y	Y
Full Controls	Y	Y	Y	Y
County-Year FE	Y	Y	Y	Y
Industry-Year FE	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y
Obs.	99,000	13,000	99,000	13,000
R2	0.9738	0.9903	0.9591	0.9801

- Private firm leverage and employment growth are positively related in normal times, but this is mitigated during the crisis.

Sectoral Growth and Leverage

Great Recession & Growth: Sector-level



- Short-term leverage positively correlated with growth pre-crisis and negatively post-crisis.

Great Recession & Growth: Sector-level (cont'd)

$$\log(SG_{st}) = \alpha_s + \lambda_t + \beta_1 STLEV_{st-1} + \beta_2 (STLEV_{st-1} \times CRISIS_t) + \beta_3 (STLEV_{st-1} \times POST_t) + \epsilon_{st}$$

	(1) log emp (est)	(2) log emp (firm)	(3) log rev (firm)
$STLEV_{st-1}$	**0.71****	**0.69***	**1.7****
	(0.35)	**(0.40)**	**(0.73)**
$STLEV_{st-1} \times CRISIS_t$	**-0.73*****	**-0.82*****	**-2.1*****
	(0.26)	**(0.26)**	**(0.62)**
$STLEV_{st-1} \times POST_t$	**-0.93*****	**-1.07*****	-0.55
	(0.34)	**(0.40)**	(0.82)
Industry FE	Y	Y	Y
Year FE	Y	Y	Y
Obs	1029	1029	1029
R2	0.9919	0.9892	0.9752

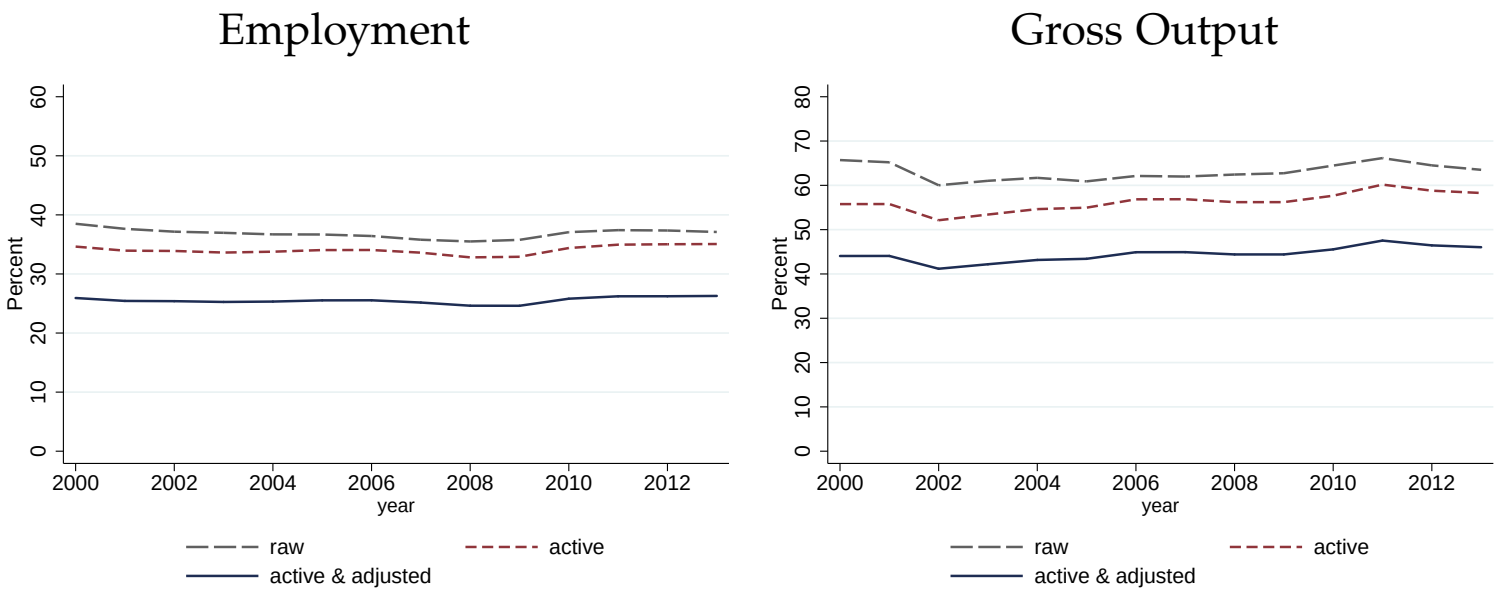
- Leverage and sector growth are positively related in normal times, negatively during and after the crisis.

Summary & Implicaitons

1. Life-cycle characteristics (age and size) matter for private firm leverage.
2. Small private firms always financially constrained and large private firms deleverage during financial crisis.
   - Focusing on listed firms understates firm responsiveness to financial crises.
3. Positive relationship between leverage and firm/sector growth attenuated during the Great Recession.
4. **Firm leverage-growth dynamics consistent with predictions of credit boom-bust cycles**: as long as focus on relevant firms.

Thank You

Compustat Contribution to Economic Activity



- Actively traded firms account for 26% of employment (BDS) and 44% of gross output (BEA)
  - Results similar if exclude FIRE (25% and 46%)
- Important to account for foreign activity and active trading.

Evaluate Match

- **Match rates**:

	Orbis-LBD	Compustat-LBD
Unique entities	70%	79%
Entity-year obs.	78%	84%
Sample revenue	84%	89%

- **Match pass statistics**:

	Orbis-LBD	Compustat-LBD
EIN	76%	75%
Name & full address	18%	6%

return procedure

Merging LBD, Orbis, and Compustat for U.S. Firms

1. Merge Compustat and Orbis separately to the LBD in each year between 2005 and 2012, similar to McCue and Jarmin (2005).
   - Match on EIN only
   - Subsequent matches made using name and location (street, city, state and zip code) information that has been standardized across data sets
   - Follow an iterative nine-step probabilistic matching procedure to generate sample of matches based on name/location information.
   - Validate and clean matches using Jaro-Winkler distance measure, using SWELL (developed by Kutzbach and his team).
2. Combine the annual cleaned matches to generate a separate panel for Compustat-LBD and Orbis-LBD data.
3. Merge the Compustat-LBD and Orbis-LBD data to create final LBD-Orbis-Compustat data for U.S. firms (LOCUS). return details

Merging Orbis, Compustat and LBD: Additional Details

- **Iterations**: Repeat for years 2002 through 2012.
  1. EIN
  2. name, street address, city, state (only for Compustat)
  3. name, city, state, zip code
  4. name, city, zip code
  5. name, state, zip code
  6. name, zip code
  7. name, city
  8. name, state
  9. name (we end up excluding all matches made only on name)

Merging LBD, Orbis, and Compustat: Additional Details

- **Clean matches**: For each entity in Compustat/Orbis, create a match to a firm using the following steps
  1. Drop matches made only on name, and those with low Jaro-Winkler (JW) name scores if the match was made based on name and just one location variable.
  2. Generate composite match score variables based on JW for name and city, indicator of whether state, zip code and industry (4-digit, 2-digit and 1-digit) match.
  3. Keep the highest score.
  4. If duplicates remain, give preference to those with the closest name match and those associated with headquarters.
  5. Drop remaining duplicates

Merging: Additional Details

- **Create panel**: stack the cleaned annual Compustat/Orbis matched data and create a panel using the following steps
  1. *Match to single firm*: impute LBD firm identifier if failed to generate a match in certain years.
  2. *Match to multiple firms*: keep the firm(s) that match based on the strictest criteria and that have the highest overall match score.
  3. *Validation of imputations*: consider the above imputations valid only if firm age and/or employment is observed in the year the imputation was made.
  4. *Remaining matches to multiple firms*: drop cases where Compustat/Orbis entity matches to more than three firms.

return

Addressing Selection

- Similar to Haltiwanger, Jarmin, Kulick and Miranda (2016), the three models we run are:
  1. **Employment continuers:**

$$R_{it} = \alpha + \gamma_1 log(emp_i) + \gamma_2 age_i + \gamma_3 D16_i + \gamma_4 EG_i + ind + mu + lfo + \varepsilon_i$$

  2. **Employment births:**

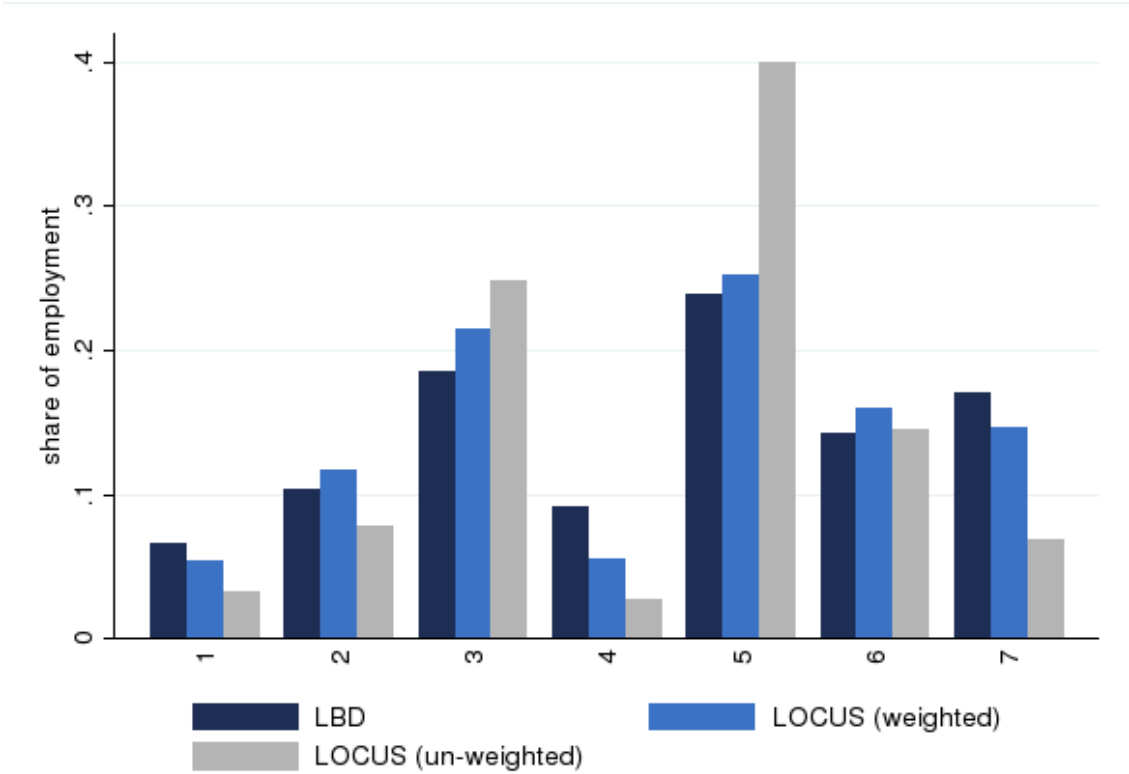
$$R_{it} = \alpha + \beta_1 ln(emp_i) + ind + mu + lfo + \varepsilon_i$$

  3. **Deaths**

$$R_{it} = \alpha + \delta_1 log(emp_i) + \delta_2 age_i + \delta_3 D16_i + ind + mu + lfo + \varepsilon_i$$

return

Addressing Selection: Employment growth



- Decrease in the observable differences between reporting and non-reporting privately-held firms. return

Addressing Selection: MU status and legal form

Multi-unit status: Orbis (weighted) & LBD

	LOCUS (unweighted)	LOCUS (weighted)	LBD
Single-unit	20.73%	46.09%	53.93%
Multi-unit	79.27%	53.91%	46.07%

Legal form: Orbis (weighted) & LBD

	LOCUS (unweighted)	LOCUS (weighted)	LBD
Corp.	42.29%	46.22%	47.31
Soleprop. & Partner.	12.41%	43.71%	36.47
Other	45.3%	10.08%	16.22

- Observable differences in multi-unit status and legal form are also minimized. return

Summary Statistics

	Private		Public	
	mean	stdev	mean	stdev
employment	100		6,200	
age	11		24	
log(employment)	1.8	1.6	6.3	2.4
log(age)	1.9	1.2	3.0	0.7
collateral	0.17	0.24	0.24	0.23
profitability	0.13	0.40	0.22	0.34
total leverage	0.46	0.38	0.56	0.36
financial leverage	0.16	0.24	0.21	0.24
short-term leverage	0.04	0.11	0.03	0.08
long-term leverage	0.12	0.22	0.18	0.21
equity/total assets	0.48	0.38	0.44	0.36

- The weighted mean and standard error are reported separately for private and public firms. return