External Financing and the Role of Financial Frictions over the Business Cycle: Measurement and Theory

Ali Shourideh
Wharton

Ariel Zetlin-Jones
CMU - Tepper

November 7, 2014

Introduction

- Question: How important are financial shocks over the business cycle?

- Conventional View: financial shocks limit firms' ability to borrow to finance investment

- **This Paper:**
  - Use data on financial flows to quantitatively evaluate the importance of this view

  - Find financial shocks play sizable role, but face challenges accounting for particularly large recessions

Role of External Funds

- What firms use external funds in the data?
- Not aggregate of nonfinancial firms
  - Funds flow from nonfinancial firms to rest of economy essentially all the time
- Possibility:
  - Some firms use external funds to finance part of investment
  - Other firms generate external funds above own investment needs

External Funds and Heterogeneity

- Finding: Two kinds of heterogeneity in financial flows
- Among publicly held firms (as a fraction of aggregate investment):
  - Total inflows to firms receiving inflows: 22%
  - Total outflows by firms making outflows: 50%
- Among privately held firms (as a fraction of aggregate investment):
  - Total inflows to firms receiving inflows: 82%
  - Total outflows by firms making outflows: 170%
- Suggests reallocation important

This Paper

- Develop quantitative model of financial frictions with heterogeneous firms and idiosyncratic risk
- Model financial frictions as collateral constraints
- Model financial shocks as shocks to collateral constraints
- Use data on financial flows to discipline importance of role of financial markets

Quantitative Results

- Analyze unanticipated shock to collateral constraint in calibrated model
  - Shock calibrated to generate 1 St. Dev. decline in debt-to-assets on impact
  - Half-life of shock is 1 year

- Findings:
  - Output falls by 0.4% on impact
  - Effect on output roughly 2.5 times as persistent as shock
  - Consumption, Investment, Employment move in same direction of output
  - Sectors of economy move together

Related Literature

- Financial frictions and Business Cycles:
  - Bernanke-Gertler (1989), Bernanke-Gertler-Gilchrist (1999)
  - Carlstrom-Fuerst (1993), Kiyotaki-Moore (1997,2008), and many others
  - Jermann-Quadrini (2012), Khan-Thomas (2014), Basetto-Cagetti-DeNardi (2011)
- Modeling financial frictions:
  - Evans-Jovanovic (1989), Buera-Kaboski-Shin (2010), Midrigan-Xu (2014), Moll(2014)
- Measuring External Funds:
  - Rajan-Zingales (1998), Buera-Kaboski-Shin (2010)
- Trade Linkages:
  - Blanchard-Kioytaki(1987), Basu-Fernald (1994), Gabaix(2010), Jones (2011)

Plan of the Talk

- Stylized Facts on Financial Flows
- Dynamic Model of Financial Frictions
- Calibration Results

Evidence on Financial Flows and External Financing

Measuring Financial Flows

- Budget constraint

$$d_{it} + k_{it+1} - (1-\delta)k_{it} \leq p_{it}q_{it} - w_t l_{it} - r_t b_{it} + b_{it+1} - b_{it}$$

- Re-arranging

$$\underbrace{k_{it+1} - (1-\delta)k_{it}}_{X_{it}} - \underbrace{(p_{it}q_{it} - w_t l_{it} - r_t b_{it})}_{AF_{it}} \leq b_{it+1} - b_{it} - d_{it}$$

- $X_{it} - AF_{it}$: Inflow of External Funds

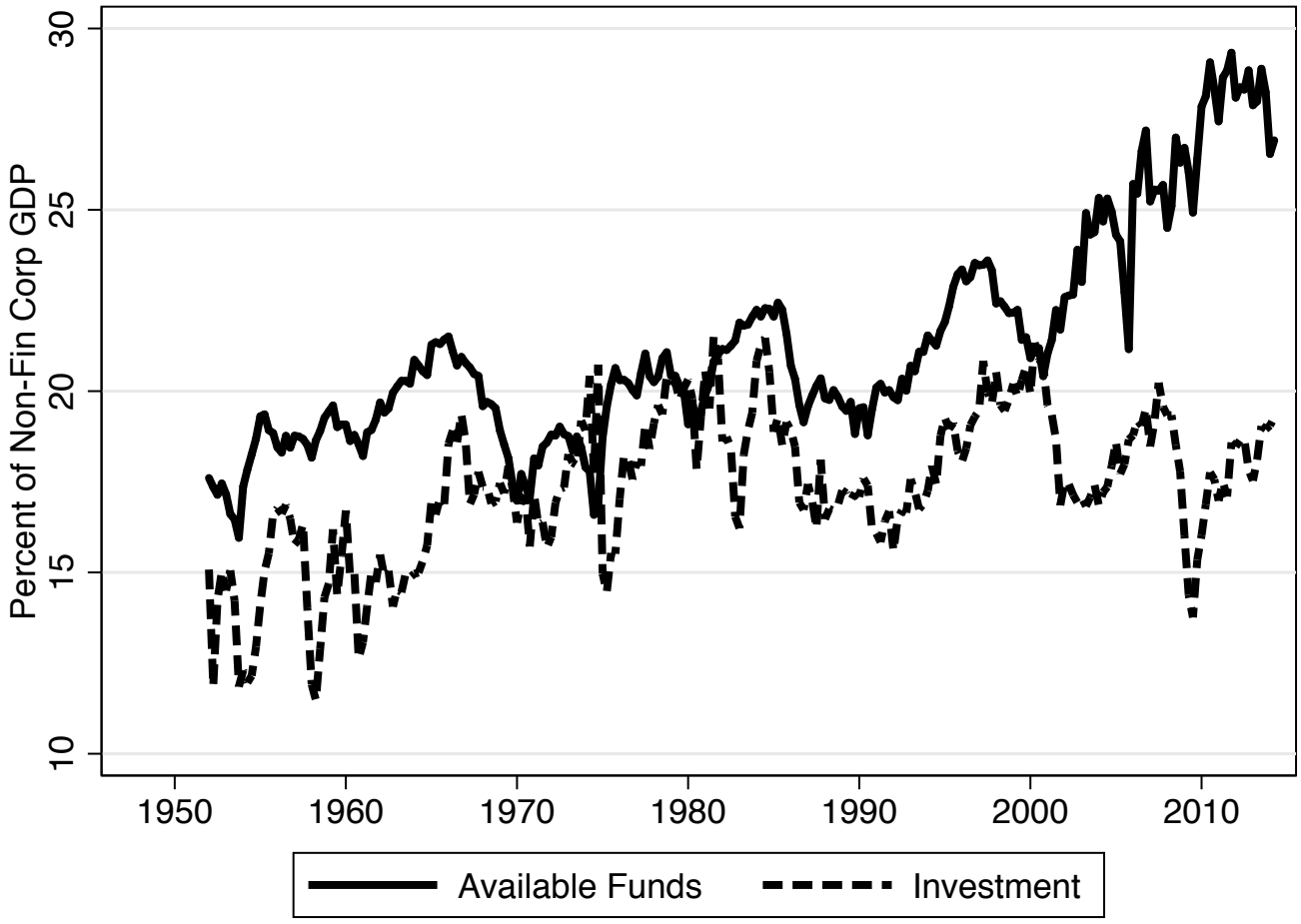
- Use same conceptual measure in aggregate and disaggregated data

Aggregate Financial Flows

- U.S. Flow of Funds, 1952-2010
  - AF_t = After Tax Profits + Depreciation
  - X_t = Capital Expenditures
- Available Funds: average 18% of Non-Financial Corporate GDP
- Investment: average 15% of Non-Financial Corporate GDP

Aggregate Financial Flows

- U.S. Flow of Funds, 1952-2010



- Firms can internally finance investment *all the time*

Firm-Level Financial Flows

- Firm level data sources
  - Publicly traded: Compustat – U.S. (1971-2013), Compustat – U.K. (1992-2013)
  - Privately held: Amadeus – U.K., 2005-2012

- Comparison of Public and private firms in U.K.

Company Type	Assets	Investment	Sales	I/A	AF/A
	Cross-Sectional Median (Millions or %)				
Private	0.24	0.002	0.38	1.23%	14.99%
Public	115.86	2.66	126.71	3.07%	10.42%

Firm Year Observations: Private $\approx$ 700,000; Public $\approx$ 10,000

- Private firms much smaller
- Private firms comparable investment, profitability

Firm-Level Net Financial Inflows

- In Compustat

$$AF_{it} = \text{Operating Activities Net Cash Flow}$$
$$X_{it} = \text{Capital Exp.} + \text{Acquisitions} - \text{Sale of PPE}$$

- In Amadeus

$$AF_{it} = \text{Income Before Ext. Items} + \text{Depreciation}$$
$$X_{it} = \Delta \text{ Fixed Assets}_{\,t} + \text{Depreciation}$$

- Note, X_{it} not just purchases of new capital goods

- X_{it} has reallocation dimension

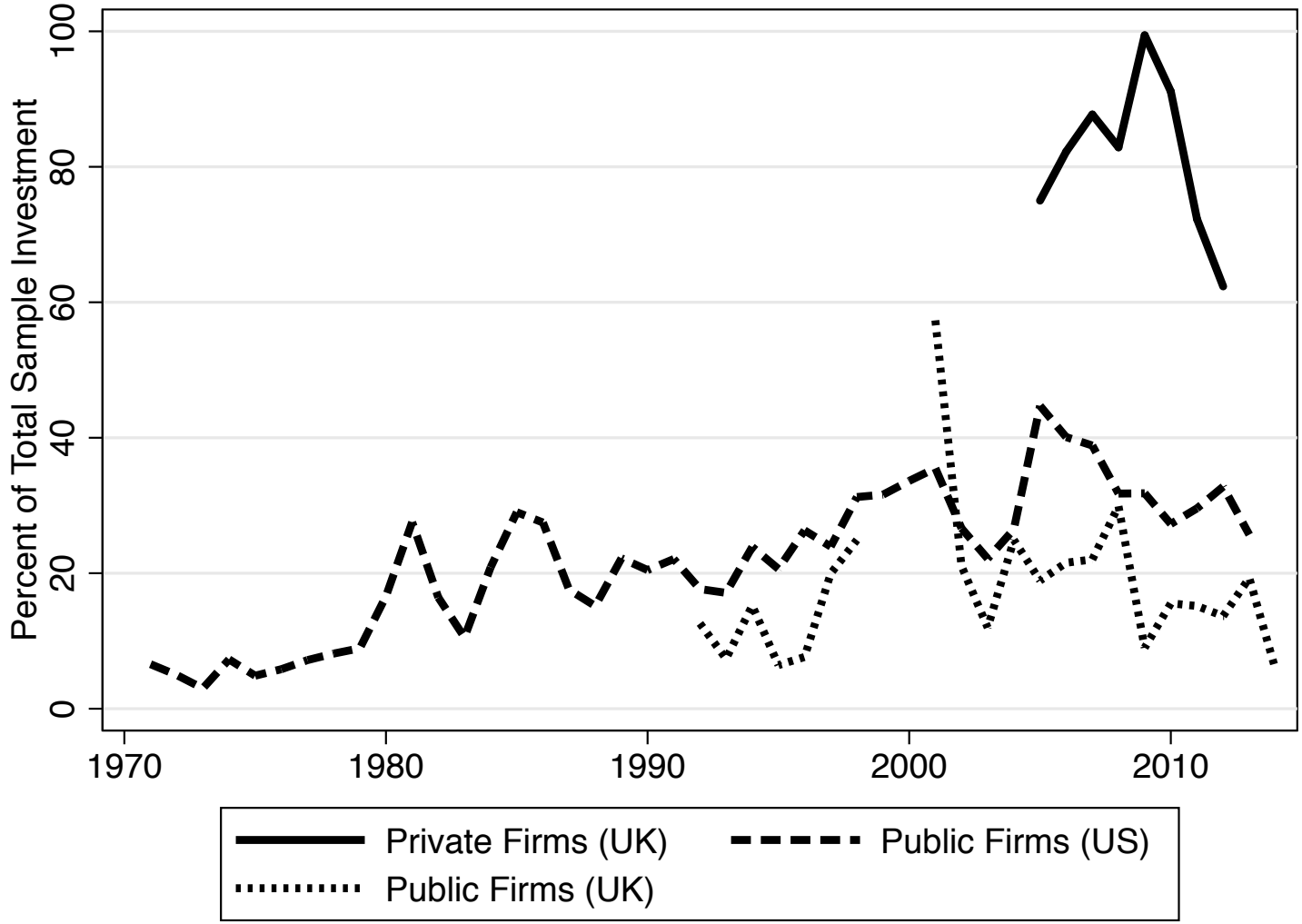
Firm-Level Net Financial Inflows

- Construct measure of inflows:

$$\text{Inflows} = \frac{1}{T}\sum_{t=1}^{T}\frac{\sum_i (X_{it} - AF_{it})\mathbf{1}_{[X_{it} \geq AF_{it}]}}{\sum_i X_{it}}$$

- Public firms, Inflows roughly 20%
- Private firms, Inflows roughly 80%

Heterogeneity in Net Financial Flows



- Private firms use more external funds than public firms

Comparing Public and Private Firms

- Private firms on average smaller
- Private firms more concentrated in services industry
- Is public/private difference only capturing size/industry composition? No.
- Compare use of external funds within industry/size class
  - Focus only on U.K. firms

Within Industry Heterogeneity

	Investment Share		Use of Ext. Fin.	
Industry	Private	Public	Private	Public
Agriculture	0.58%	0.05%	0.39%	0.01%
Construction	-1.32%	0.17%	9.61%	1.10%
Manufacturing	19.53%	34.71%	12.93%	7.28%
Mining	17.68%	2.21%	5.85%	0.84%
Retail Trade	10.31%	18.74%	5.78%	2.00%
Services	30.64%	8.85%	26.89%	2.21%
Transportation	17.39%	35.19%	16.99%	4.26%
Wholesale Trade	5.20%	1.03%	3.20%	0.53%

- Within each broad industry, private firms use more external funds
- Relationships stable over time

Within Size Class Heterogeneity

- Define asset quartiles for public firms in each year
- Use public thresholds to bin private firms

	Investment Share		**External Financing**	
Quartile	Private	Public	Private	Public
Q1	6.03%	0.18%	8.25%	0.44%
Q2	9.83%	1.27%	9.69%	0.93%
Q3	21.55%	5.25%	17.93%	2.19%
Q4	62.59%	93.34%	45.76%	14.55%

- Private firms use more external funds than similarly sized public firms
- Similar with deciles, stable over time

A Dynamic Model of Financial Frictions

Model Ingredients

- Central Ingredient
  - Heterogeneous firms with idiosyncratic risk

- Other ingredients
  - Two types of firms: publicly & privately held

  - Trade Linkages:
    - Differentiated goods, monopolistic competition
    - Input-output structure in production

Environment

- Dynamic economy, $t = 0, 1, 2, \ldots$
- Agents:
  - Representative Worker (owns publicly held firms)
  - Owners of privately held firms
- Firms: continuum, measure 1 of intermediate good producers
  - $i \in [0, s]$ are *privately held*
  - $i \in (s, 1]$ are *publicly held*

Intermediate Good Production

- In period t, firm i uses capital, labor and intermediate input to produce gross output

$$q_{it} = z_{it} \left(k_{it}^{\alpha} l_{it}^{1-\alpha} \right)^{\eta} I_{it}^{1-\eta}$$

- Idiosyncratic productivity shock:

$$\ln z_{it} = \rho_z \ln z_{it-1} + \sigma_z \epsilon, \epsilon \sim N(0,1)$$

- Firms *exogenously* exit at rate ζ

- New firms draw from current distribution of wealth and tfp

Final Good Production and Market Clearing

- Final Good produced competitively according to

$$Q_t = \left[\int_0^1 q_{it}^{1-\frac{1}{\rho}} di \right]^{\frac{\rho}{\rho-1}}$$

- Aggregate goods market clearing

$$C_t^W + \int_0^s d_{it} di + K_{t+1} - (1-\delta) K_t = Q_t - \int_0^1 I_{it} di$$

Preferences

- Owners of Privately Held Firms:

$$E \sum_t (\beta(1-\zeta))^t \ln d_{it}$$

- Representative Worker

$$\sum_t \beta^t \ln \left(C_t - \frac{\psi}{1+\frac{1}{\epsilon}} L_t^{1+\frac{1}{\epsilon}} \right)$$

  - SDF: M_t

Producer's Problem

- Maximize utility of owners subject to
- Budget Constraint:

$$d_{it} + a_{it+1} \leq$$
$$p_{it} z_{it} \left(k_{it}^{\alpha} l_{it}^{1-\alpha} \right)^{\eta} I_{it}^{1-\eta} - w_t l_{it} - I_{it} - (r_t + \delta) k_{it} + (1 + r_t) a_{it}$$

- Collateral Constraint ($\lambda \geq 1$):

$$k_{it} \leq \lambda a_{it}$$

- Inverse demand function for monopolistically competitive output

Worker's Problem

- Workers own publicly held firms
- Workers maximize discounted lifetime utility

$$\sum_t \beta^t \ln\left(C_t - \frac{\psi}{1+\frac{1}{\epsilon}} L_t^{1+\frac{1}{\epsilon}}\right)$$

- Subject to sequence of budget constraints

$$C_t^W + A_{t+1}^W \leq w_t L_t + (1+r_t) A_t^W + \int_s^1 d_{it} di$$

- Implies objective of publicly held firm:

$$E \sum_t M_t d_{it}$$

Equilibrium Definition

- Market Clearing:

$$K_t \equiv \int_0^1 k_{it} di = A_t^W + \int_0^1 a_{it} di$$

$$L_t = \int_0^1 l_{it} di$$

$$C_t^W + \int_0^s d_{it} di + K_{t+1} - (1-\delta) K_t = Q_t - \int_0^1 I_{it} di$$

Equilibrium Definition (Recursive)

- A stationary equilibrium consists of
  - $(d_L(a,z), a'_L(a,z), k'_L(a,z), l_L(a,z), I_L(a,z))$
  - $(d_U(a,z), a'_U(a,z), k'_U(a,z), l_U(a,z), I_U(a,z))$
  - $C^W, L, A^{w'}$
  - $G_U(a,z), G_L(a,z)$

  satisfying
  - Optimality, market clearing
  - G_j is stationary:

$$G_j^* = \int_{a,z} H_j((a,z), A \times Z) G_j^*(a, dz)$$

where

$$H_j((a,z), A \times Z) = \int_Z \mathbf{I}_{\{a'_j(a,z) \in A\}} \psi(z) dz$$

with $j = U, L$.

Discussion on Publicly Held Firms

Publicly Held Firms Do Not Face Binding Constraints

Proposition

Suppose z is bounded above. Then, in a stationary equilibrium, the collateral constraint does not bind for any publicly held firm.

- If $d_{it} > 0$ then constraint does not bind along any future outcome path
- $\exists \bar{a}$ such that for $a > \bar{a}$ the firm is unconstrained for all future histories
- As long as constraint binds with positive probability, $a' > a + \epsilon$ for some small $\epsilon > 0$

- Implies publicly held firms do not require much external funds for investment, as in data

Calibration and Results

Calibration Overview

- Model period is 1 year
- Critical parameters for calibration:
  - Process for idiosyncratic risk (ρ_z, σ_z)
  - Collateral constraint (λ)
- All else equal, these parameters determine "bindingness" of the collateral constraint
- Use financial data (use of external funds, dispersion in leverage, aggregate indebtedness) to discipline model parameters
- Remaining parameters standard or perform sensitivity

Calibrated Parameters and Moments

Parameter	Value	Moment	Model	Data
Calibrated Parameters				
Collateral Constraint (λ)	6.98	External Financing	0.82	0.82
Persistence of Idio. TFP (ρ_z)	0.95	Debt-to-Total Assets	0.49	0.49
Std. of Idio. TFP (σ_z)	0.33	Dispersion in Net Debt-to-Assets	0.54	0.54
Disutility of labor (ψ)	0.41	Aggregate Hours	0.3	0.3
Share of private firms (s)	0.41	Private Firms Share of Gross Output	0.4	0.4
Share of Intermediate Inputs (η)	0.43	Intermediate Input Share	0.43	0.43
Fixed Parameters				
Discount Rate (β)	0.96			
Labor Supply Elasticity (ε)	2.6			
Elasticity of Substitution (ρ)	4			
Capital Share (α)	0.3			
Depreciation Rate (δ)	0.07			
Exit Risk of Private Firms (ζ)	0.10			

- λ implies firms can collateralize up to 86% of capital
- 28% of private firms face binding collateral constraint

How Does the Model Do?

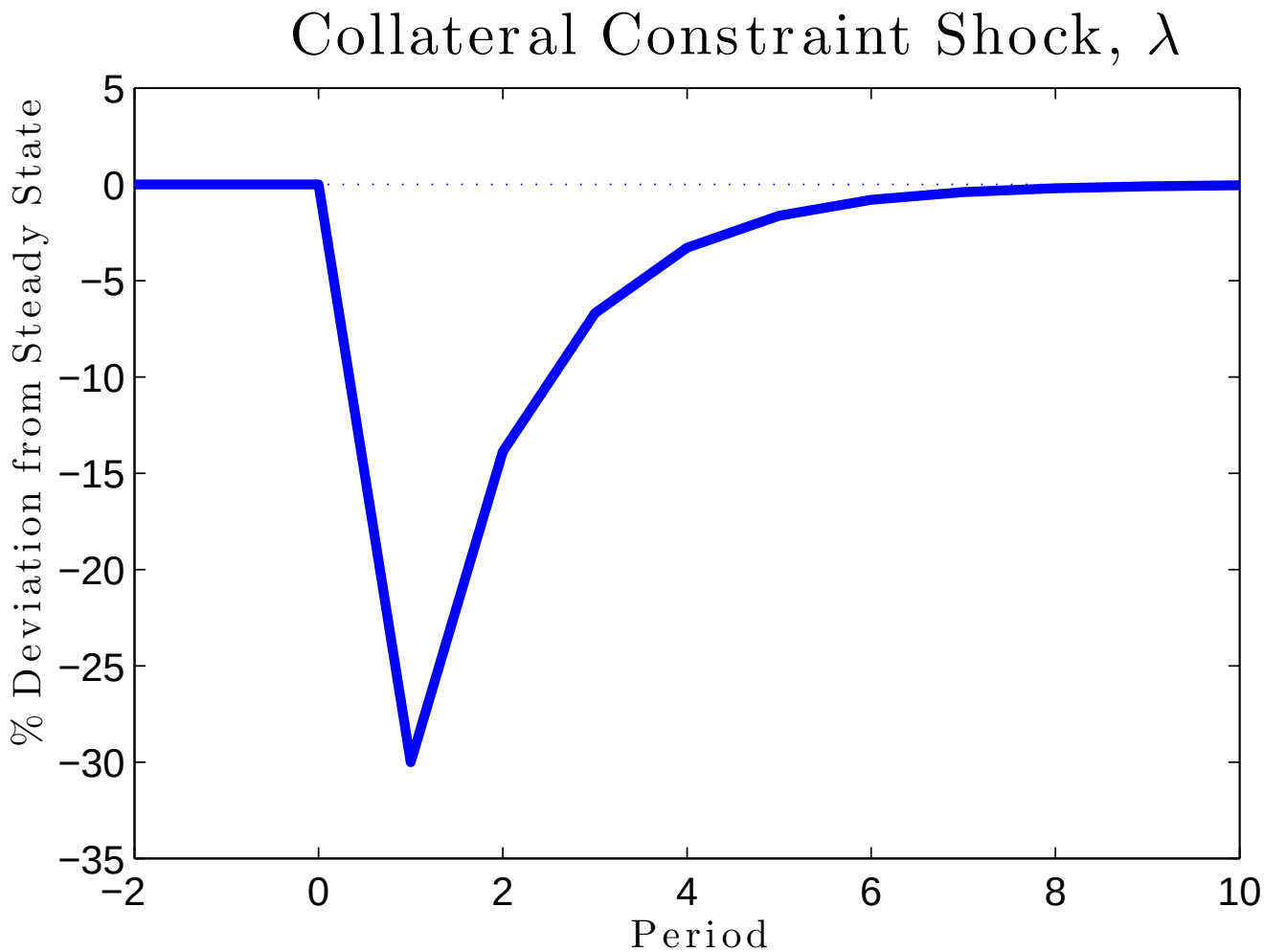
Idiosyncratic Risk

- How much idiosyncratic risk do firms face?
- Analyze employment growth in model and data
- Measure cross-sectional dispersion in employment growth
  - In Model: ≈ 0.47
  - In Data (for privately held firms): 0.42 (Davis et al. 2007)
- Matching financial flows does not induce "too much" firm level volatility

Main Quantitative Experiment: Effect of Shocks to λ

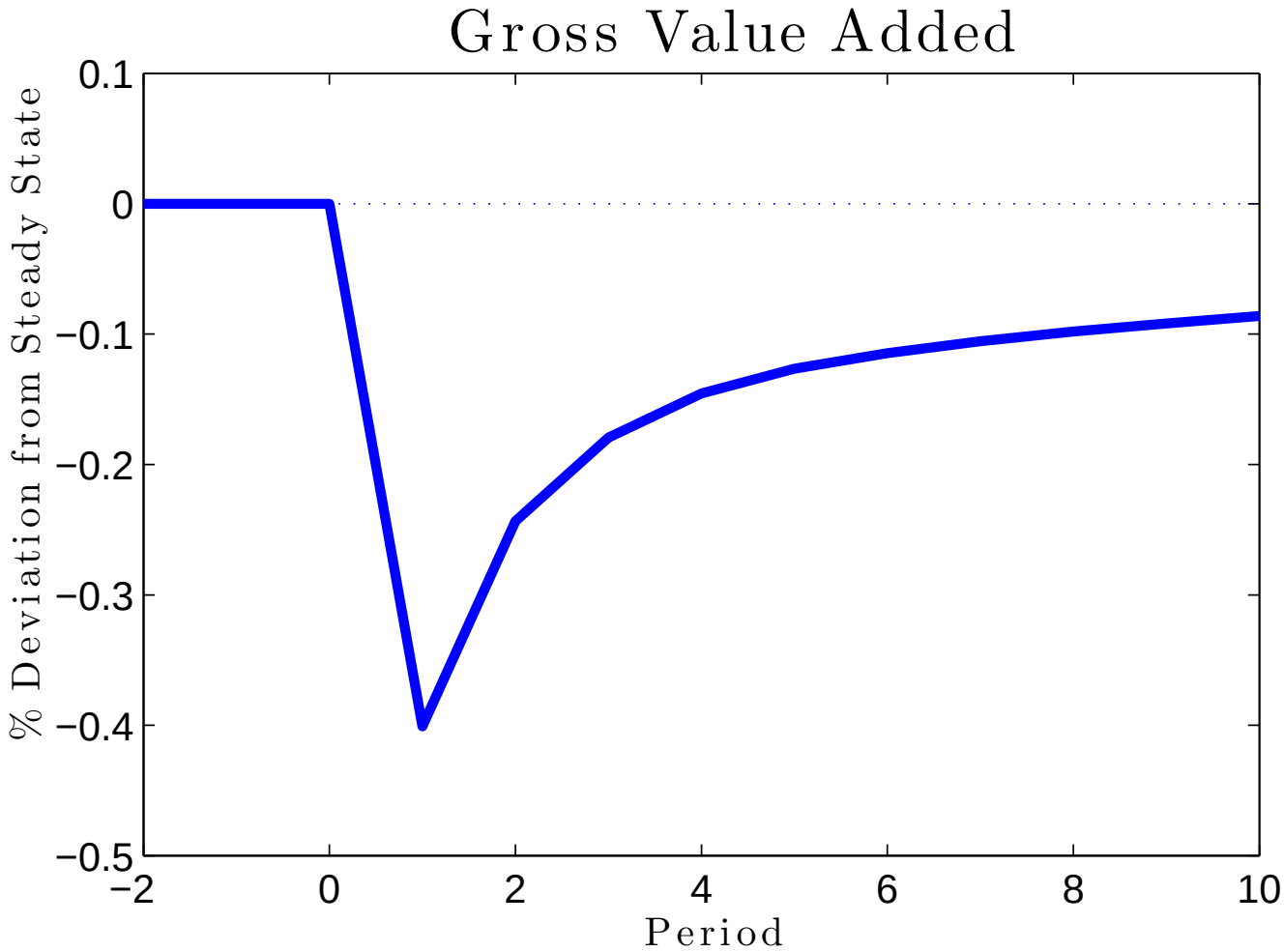
Impulse Response Exercise

- Feed in Impulse to λ to get 1 S.D. shock to aggregate Debt-to-Assets (Half-life = 1 Year)



Impulse Response Exercise

- GDP falls 0.4%, half-life roughly 2.5 years



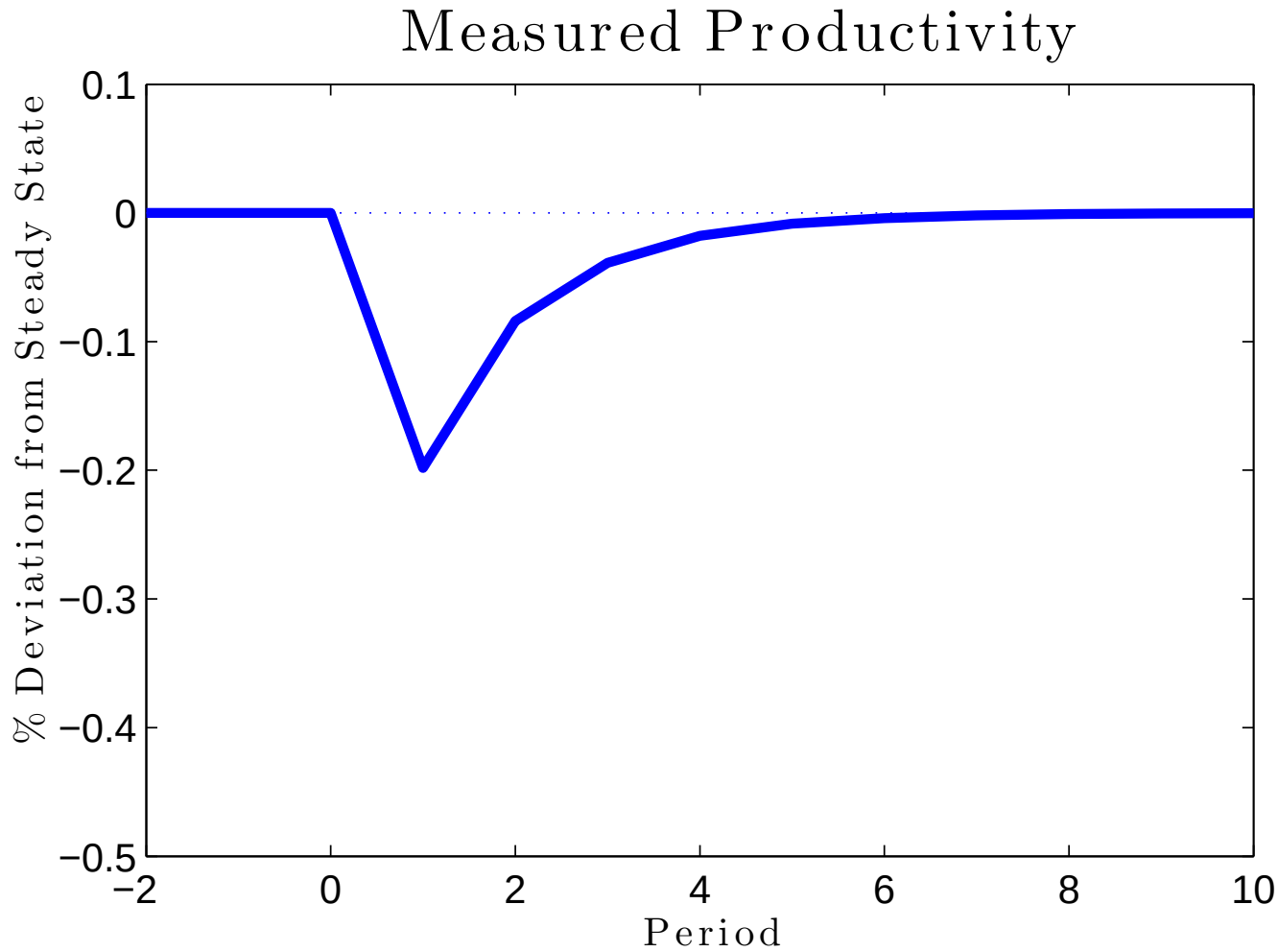
Comparable in size to TFP shock, endogenous persistence

Deconstructing the Fall in Output

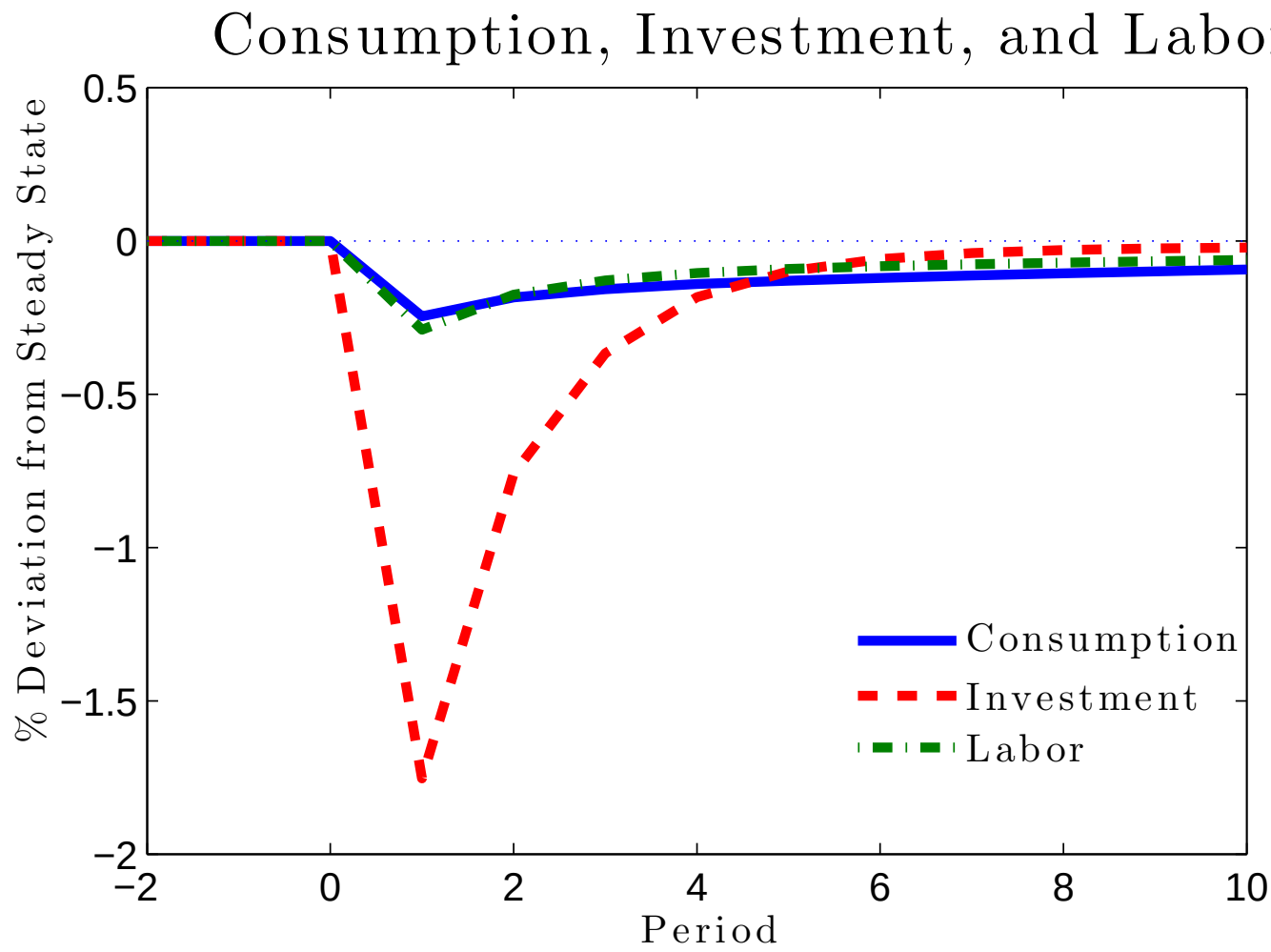
- Constrained firms cannot rent as much capital as without shock
  - firms with positive TFP shocks now or recently
- Unconstrained firms rent more capital than without the shock
  - firms with negative TFP shocks now or recently
  - publicly held firms
- Implies capital not reallocated to "right" firms

Explaining the Fall in Output

- Misallocation implies loss in average measured tfp



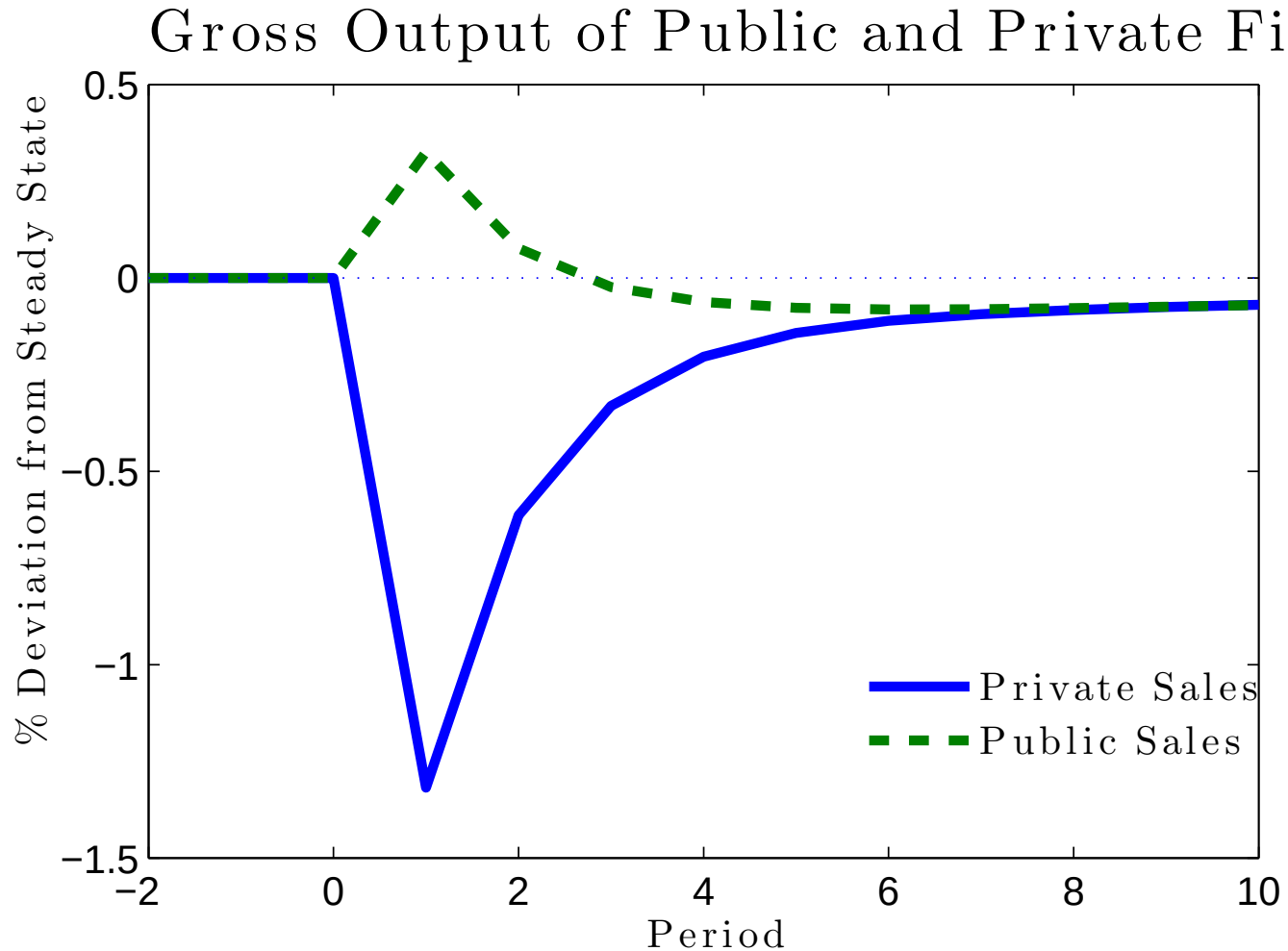
Co-Movement



- Co-movement in aggregate outcomes
- Fall in investment and mis-allocation imply persistent effects

Response of Public and Private Firms

- Sales diverge on impact, both correlated after 1 year



The Effects of Trade Linkages

- Differentiated Goods, monopolistic competition, input-output

- Consider effect of adverse financial shock on unconstrained firms:
  - Reduces labor, capital, and intermediate input demand of constrained firms

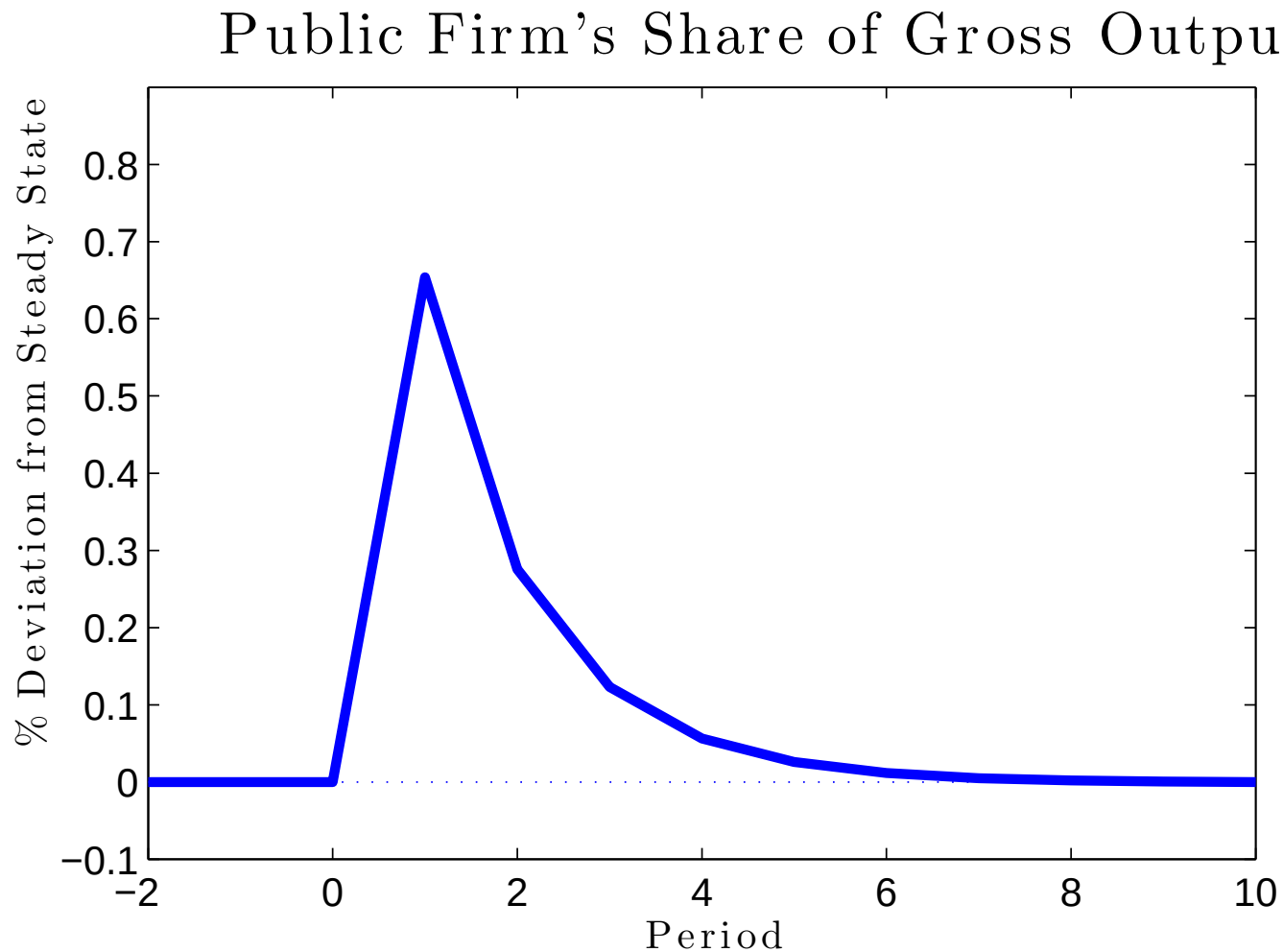
    $\Rightarrow$ wage and capital rental rate fall, tending to raise output of unconstrained firms

    $\Rightarrow$ Monopolistic competition + input-output structure implies demand for goods produced by unconstrained firms fall

- Elasticity of substitution & labor supply important determinants

Share of Output by Publicly Held Firms

- Share of Output rises then returns to 0

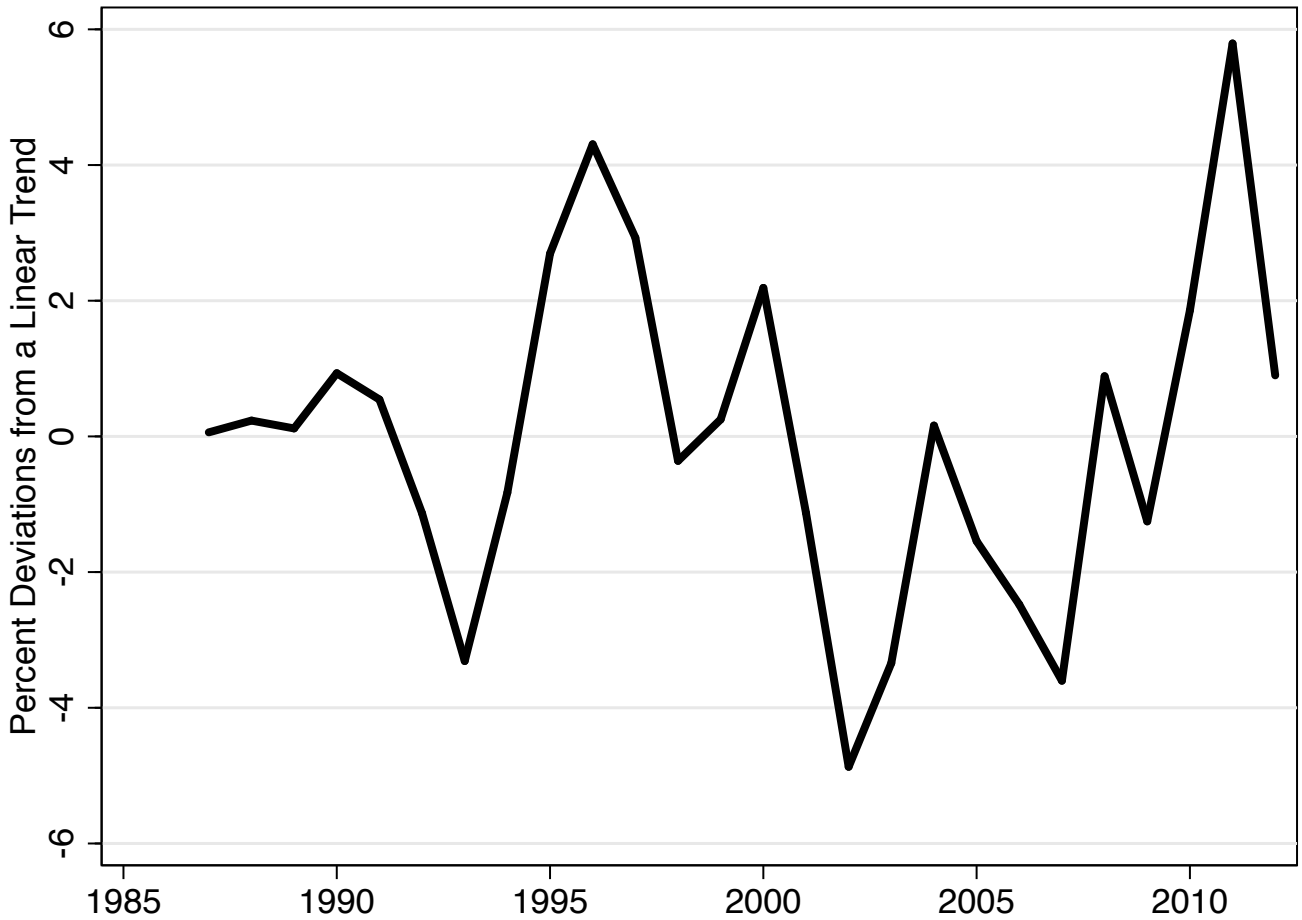


Compustat Share of Gross Output

- Implications for how Publicly held and privately held are affected by financial shocks
- How do these firms vary over the cycle?
- Construct gross output of non-financial publicly held firms as aggregate of Compustat
- Analyze Compustat share of Total non-financial gross output in U.S.

Compustat Share of Gross Output

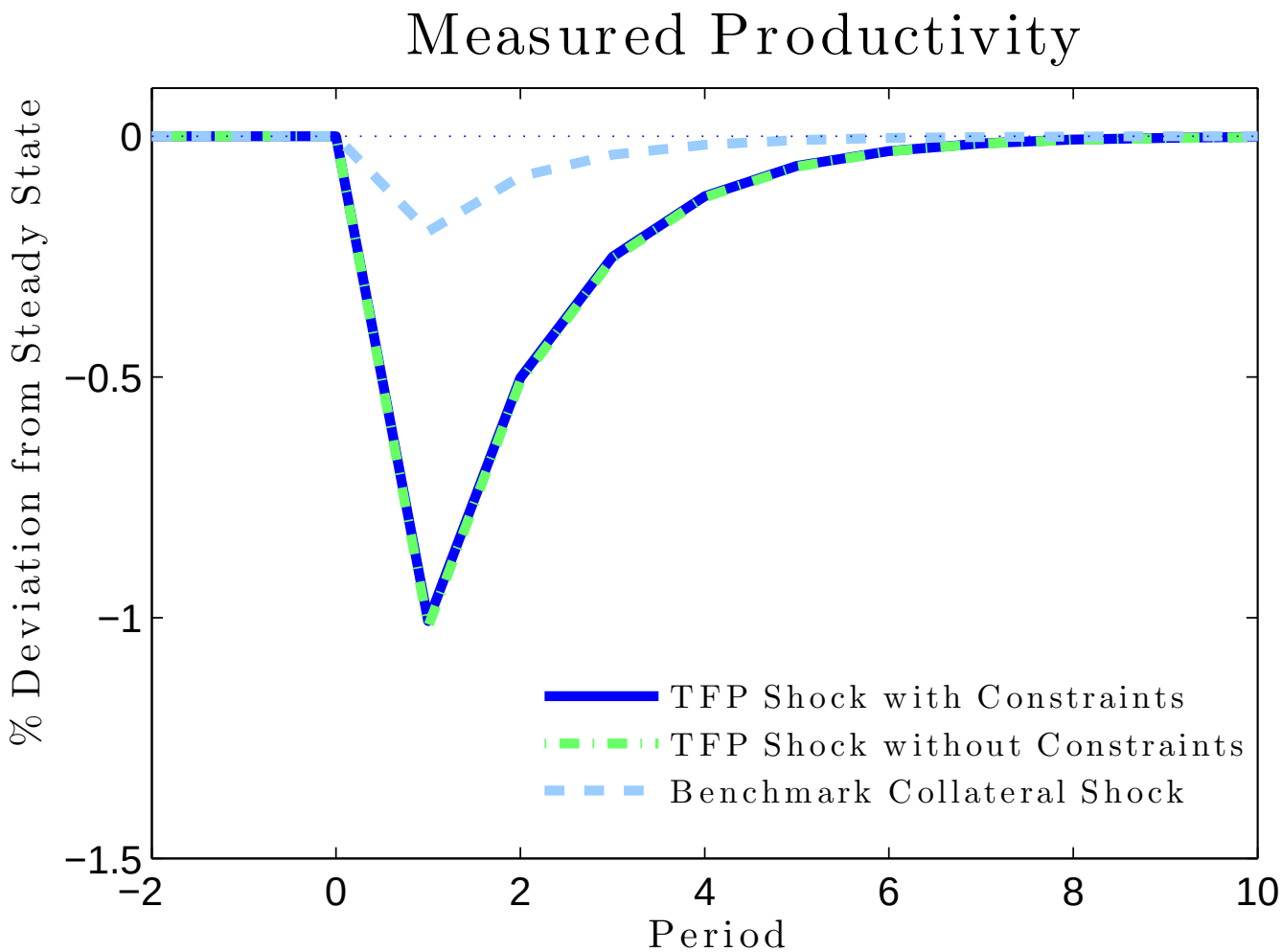
- Percentage Deviations from a linear trend



Effects of Shocks to Aggregate TFP

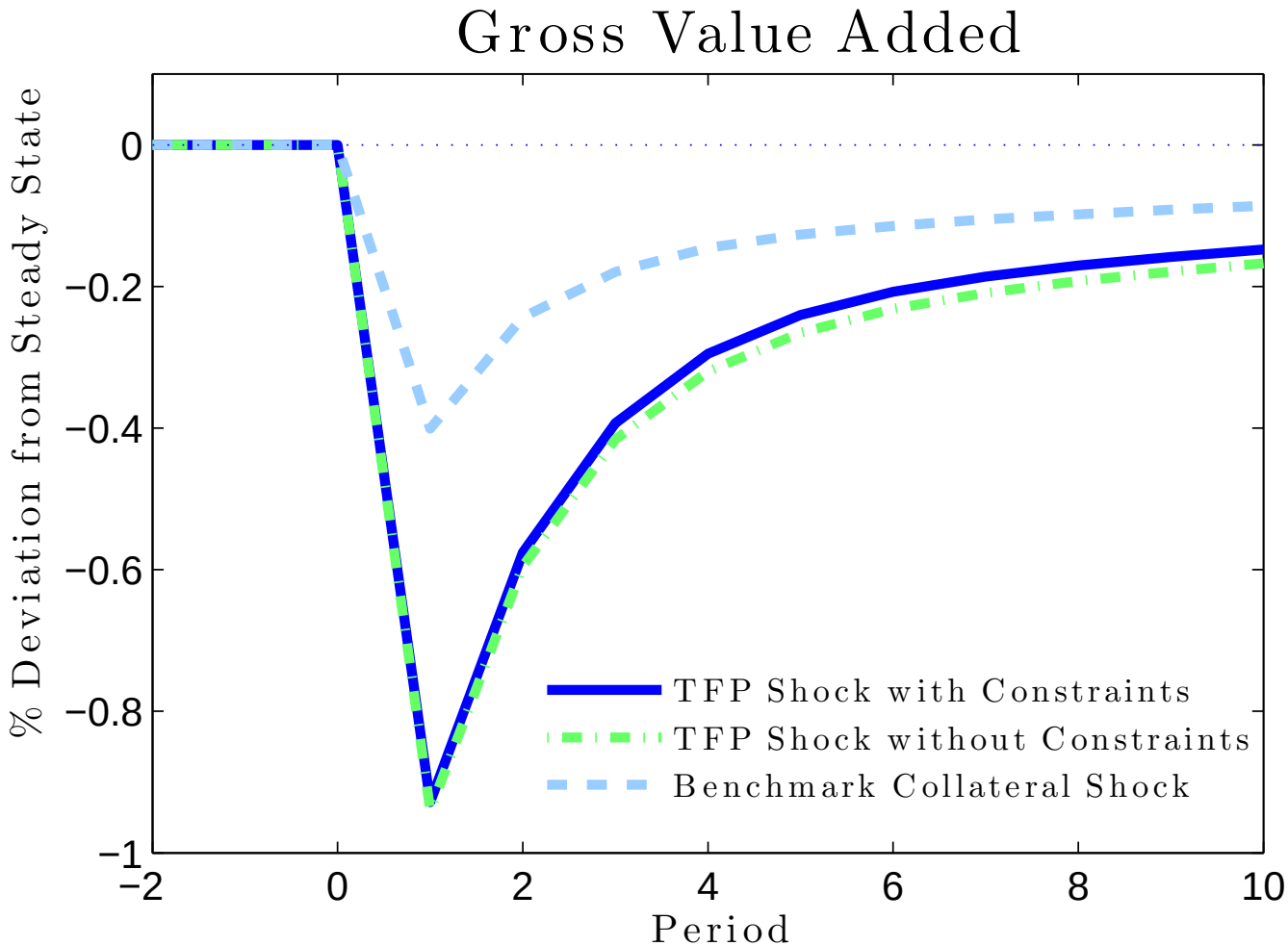
Impulse Response Exercise

- Path for measured TFP (with and without Collateral Constraint)



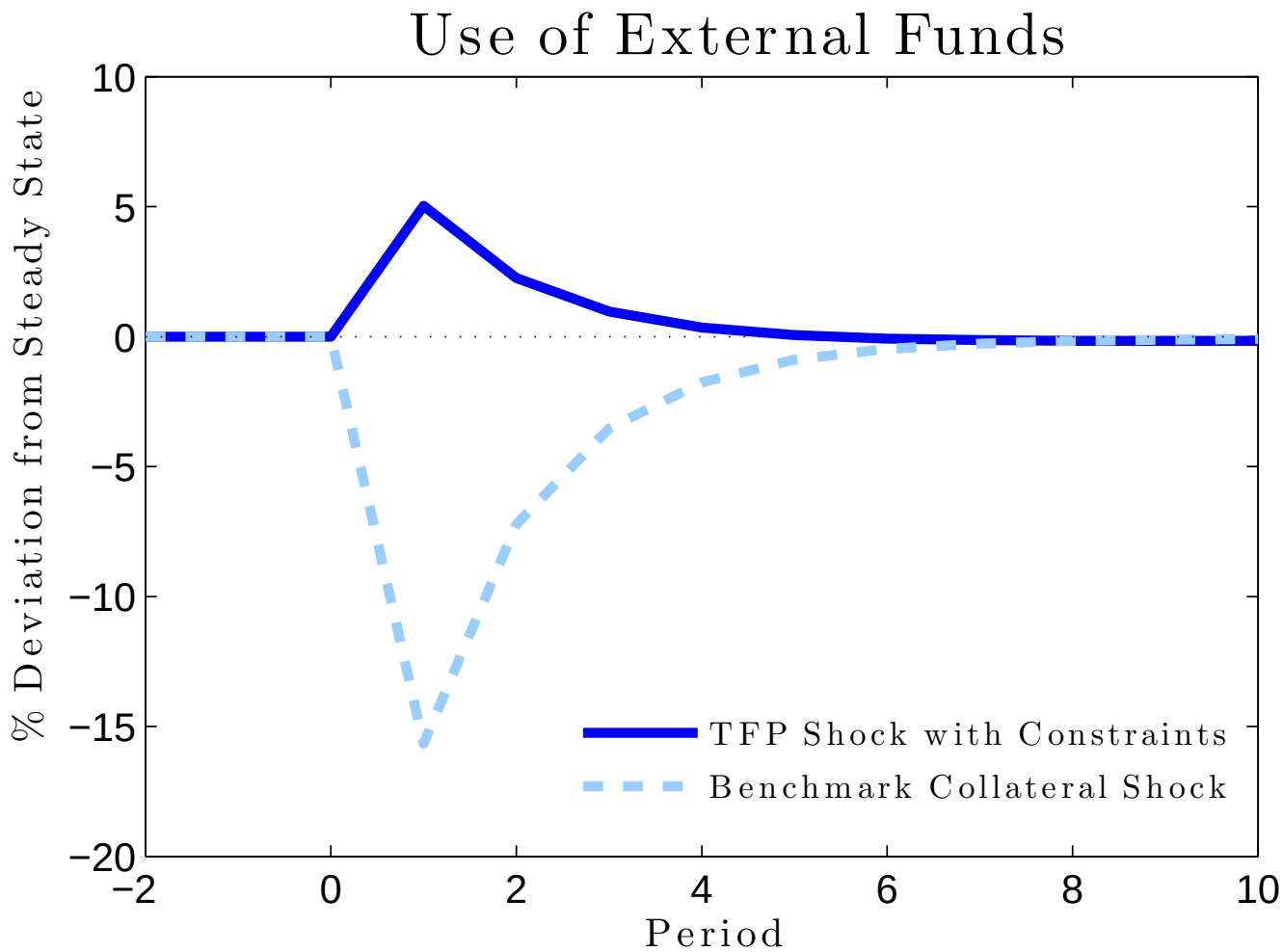
Impulse Response Exercise

- GDP with and without constraint falls by .9%



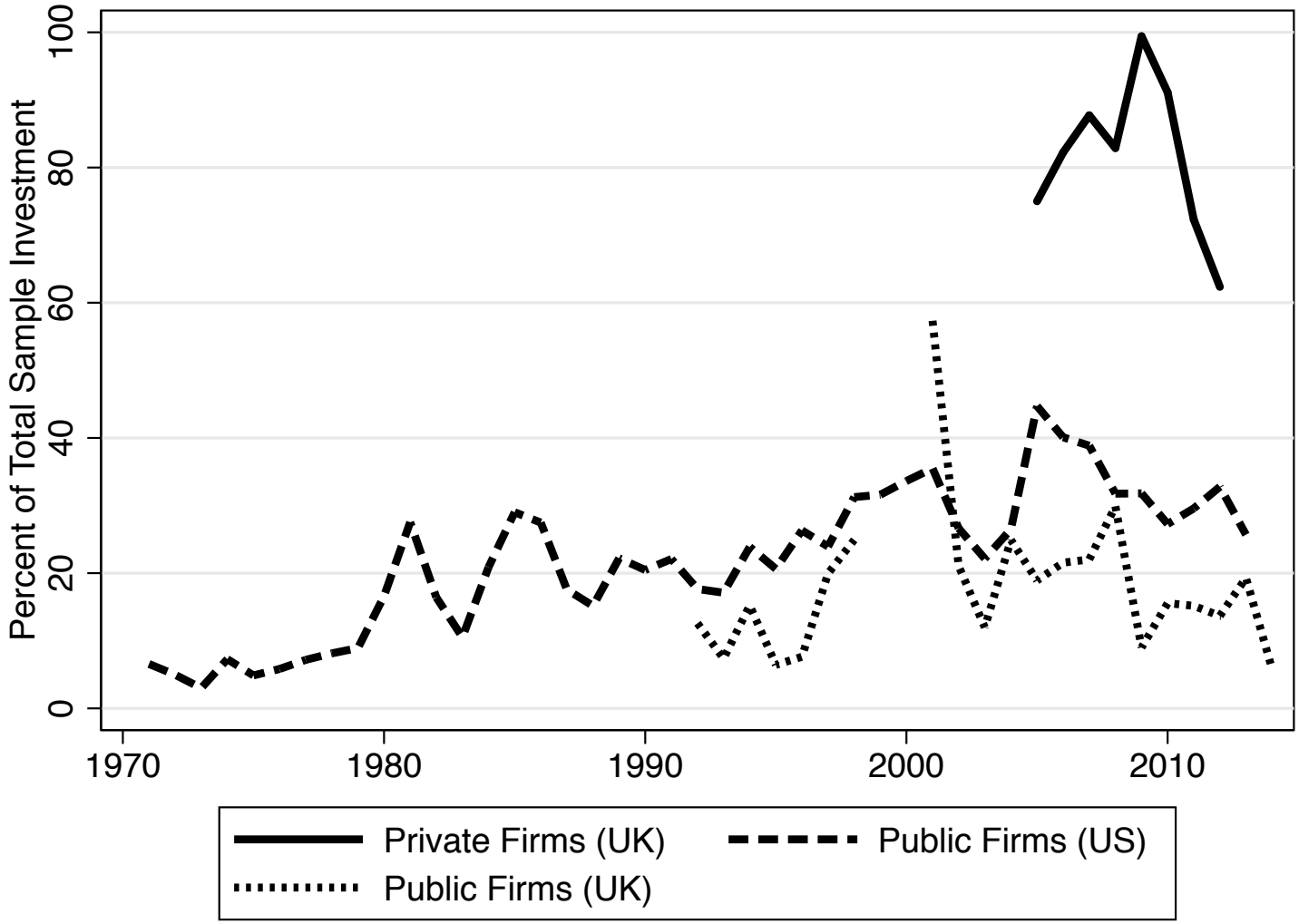
Implications for Financial Flows

- Shock has opposite effect on external funds from financial shock



Implications for Financial Flows

- Decline in external funds since crisis period, especially among private firms



Sensitivity Analysis

Sensitivity Analysis

- **Larger Shocks:**
  - If financial shock generates 2008 decline in commercial lending, GDP falls by 2%

- **Exit Risk of Private Firms:**
  - If $\zeta = 0.05$ (not 0.10), financial shock induces 0.1% decline in GDP
  - Re-calibrating implies larger effect

Sensitivity Analysis

- **Trade Linkages (elasticity of substitution):**
  - If $\rho = 10$, financial shock induces 0.4% decline in GDP
  - No co-movement between public and private firms

- **Share of Private Firms:**
  - Only private firms, financial shock induces 4.5% decline in GDP
  - Highlights importance of understanding response of unconstrained firms

Conclusion

- Evaluated importance of financial markets in channeling funds to firms with profitable investment opportunities
- Documented heterogeneity in firms' use of external funds
- Developed quantitative model of financial frictions consistent with observed firm heterogeneity
- Found financial shocks have sizable effects
- Found financial shocks face challenges in accounting for particularly large recessions when confronted with patterns of external financing