Entry Costs and the Macroeconomy[1]

Germán Gutiérrez
NYU

Callum Jones
IMF

Thomas Philippon
NYU, NBER, CEPR

Federal Reserve Board

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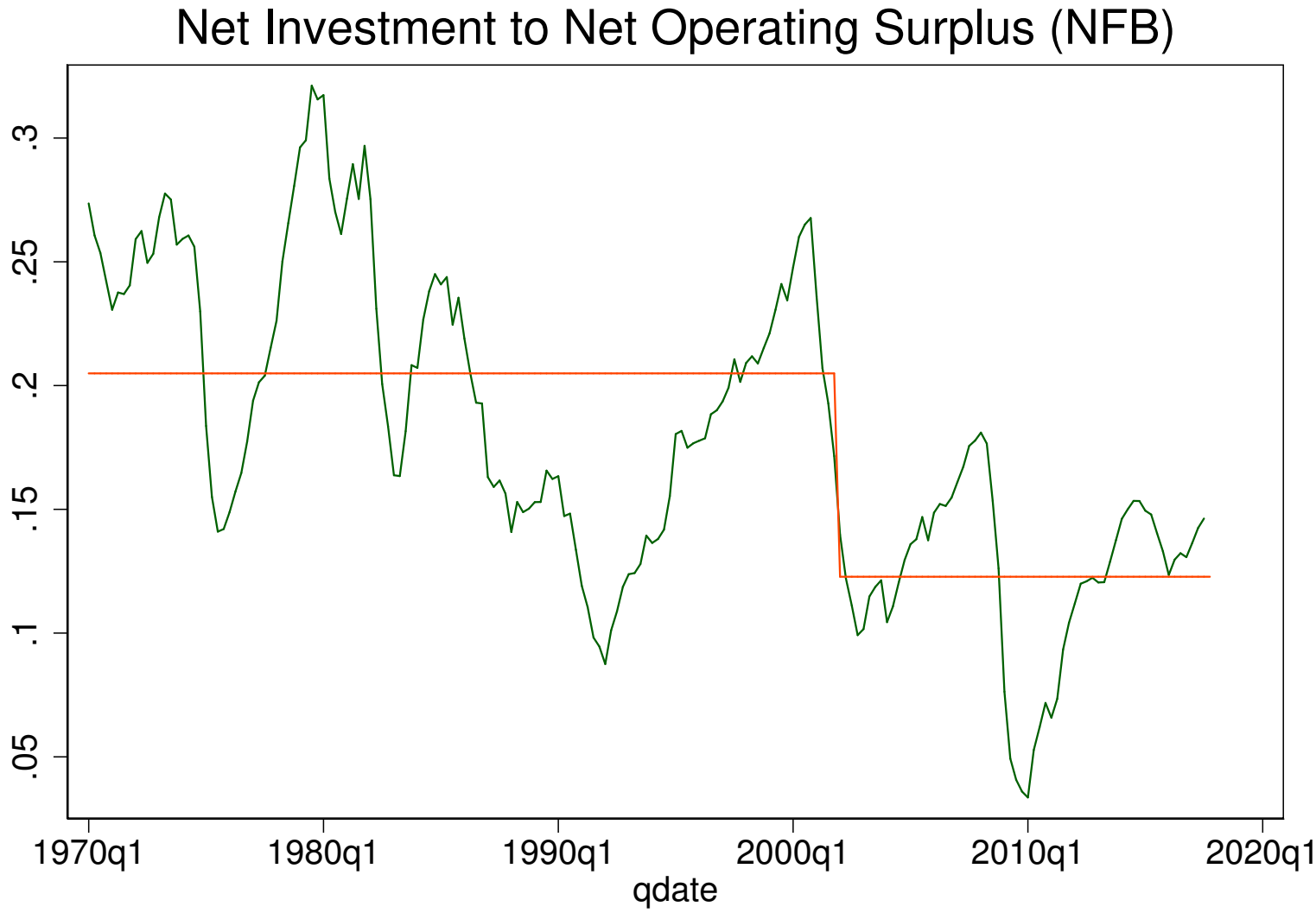
[1]The views expressed herein are those of the authors and should not be attributed to the IMF, its Executive Board, or its management.

Fact 1: Investment is Low



Gutiérrez and Philippon '17, and Lee et al '16.

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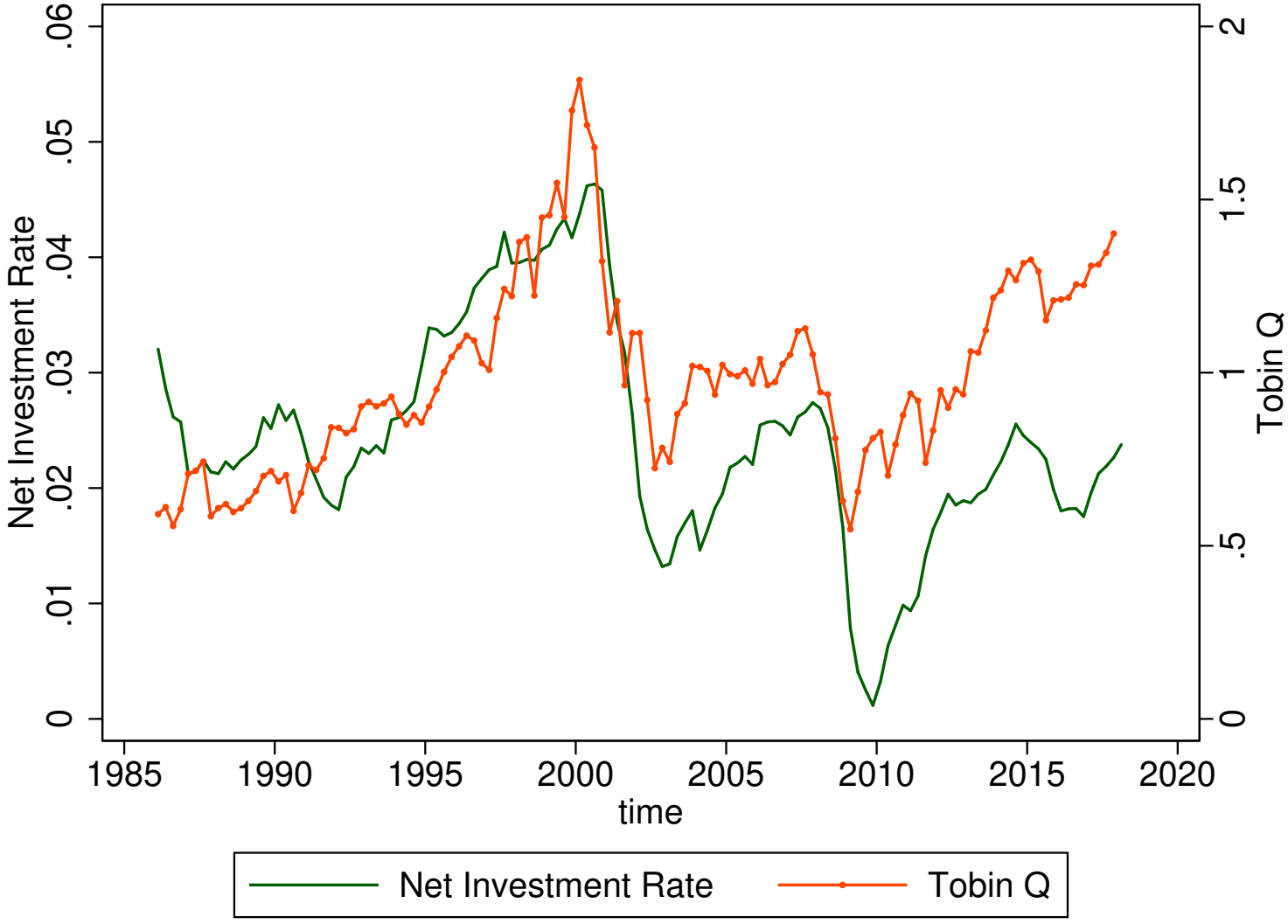

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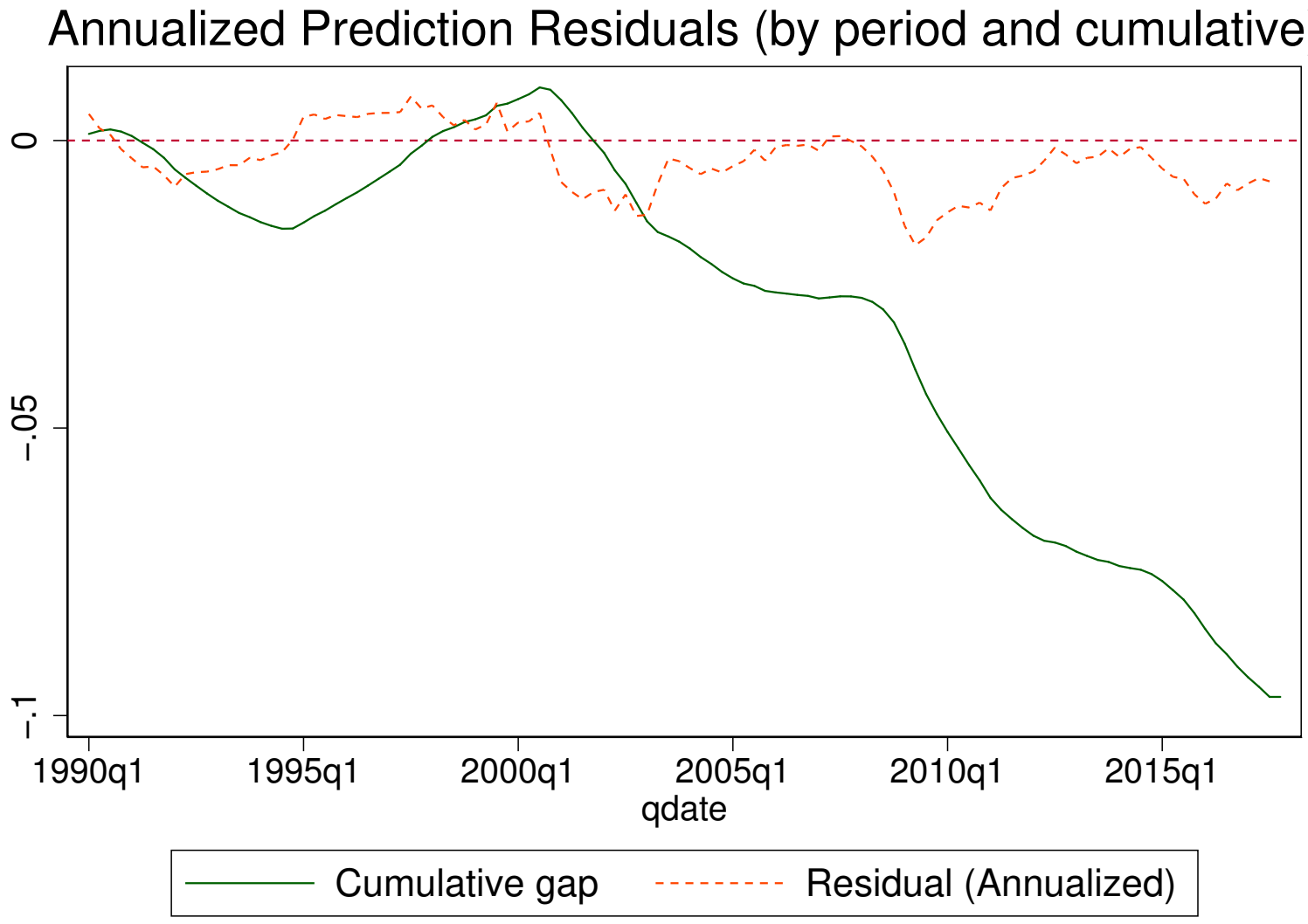
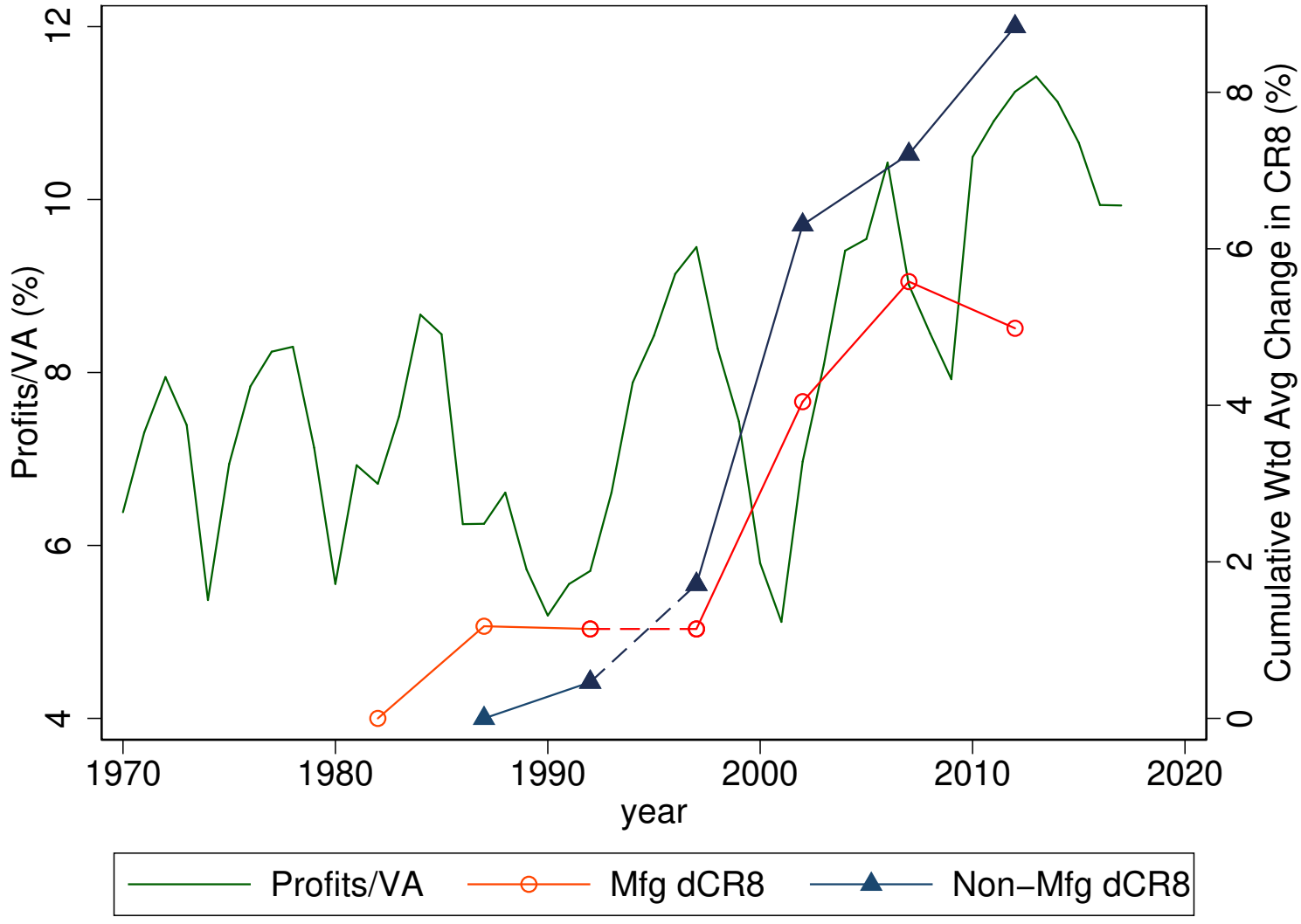
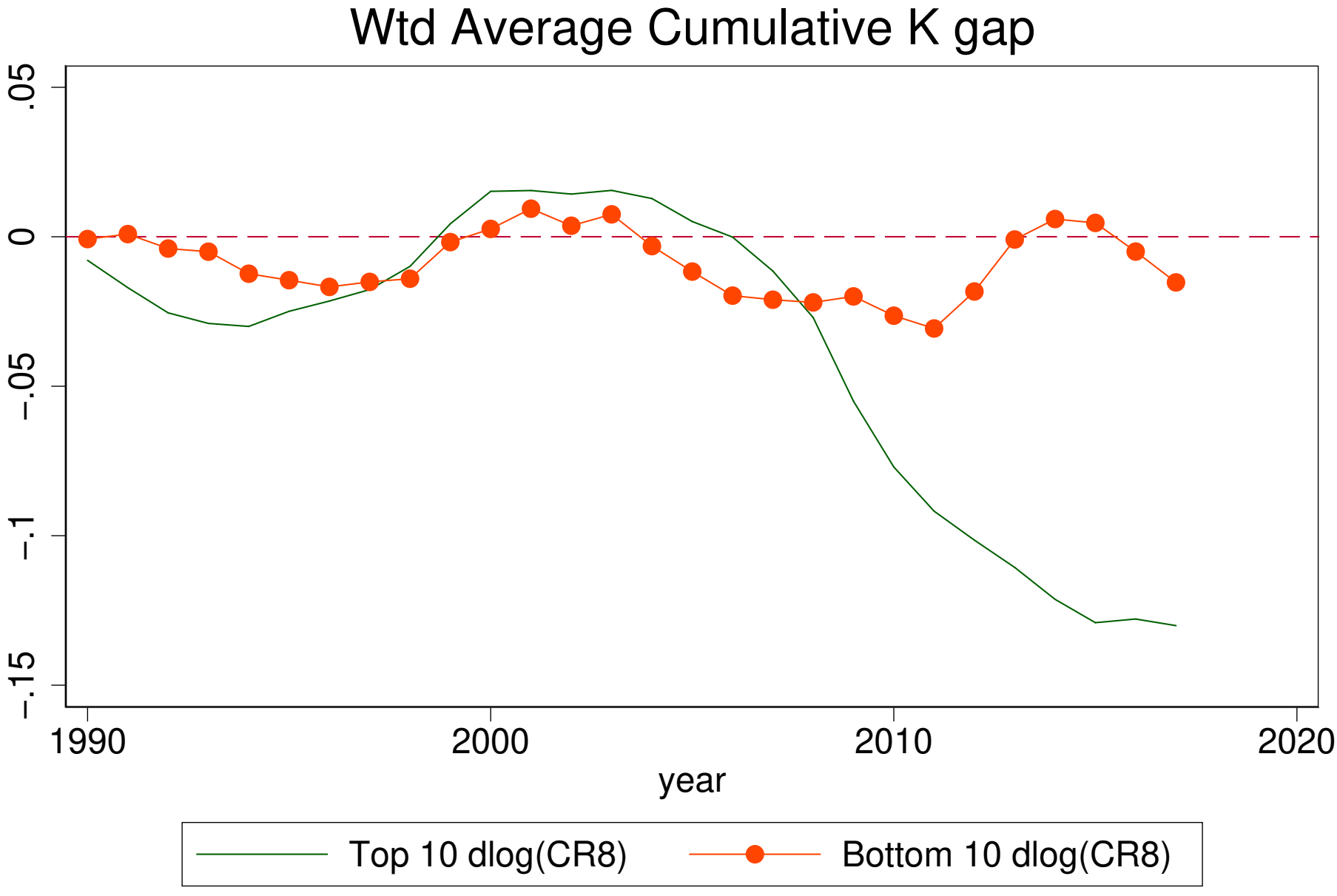


Fact 2: Concentration & Profits Have Increased



Decker et al '14, Gomme et al '11, Furman '15.

Fact 3: Investment Gap Only in Concentrating Industries



Interpretating the Evidence

- Interpretation remains controversial:
  - Endogeneity of profits/entry/concentration/investment
  - Need a model to interpret the evidence
  - Macro models so far focus on effect of (assumed) higher markups
- We use a fully specified model with competing drivers of facts
  - Use the data to derive entry cost series and study their importance
  - Provide direct empirical evidence of what these entry costs are

Our Approach and Findings

- Develop a model with monopolistic competition and firm entry
  - Entry decision based on expected profits
- Estimate model on industry/aggregate data, 1989-2015, to get:
  - Shocks and relationship between entry, competition, investment
  - Identified entry costs correlate with regulation/M&A
- Use the model to study aggregate implications, 1989 to 2015
  - Find about 10% of entry driven by shocks to demand beliefs
  - An increase in aggregate firm entry costs from 2003
  - Absent this increase, C_t & K_t would be 7.5% higher

Model

Overview

- Continuum of industries indexed by j
- Goods- and capital-producing firms with quadratic capital adj costs
- Firm entry into goods-producing industries
- Industry-level beliefs about demand before 2000
- Nominal rigidities and monetary policy subject to the ZLB
- Estimate the model on industry and aggregate data

Capital Producers

- Representative firm in industry j accumulates capital K_j to

$$\max_{I_{j,t}} \; V_{j,t} = \sum_{i=0}^{\infty} \Lambda_{t,t+i} \text{Div}_{j,t+i}$$

where

$$\text{Div}_{j,t} = R^k_{j,t} K_{j,t} - I_{j,t} - \frac{\phi_k}{2} K_{j,t} \left(\frac{I_{j,t}}{K_{j,t}} - \delta \right)^2$$

and investment is

$$I_{j,t} = K_{j,t+1} - (1 - \delta) K_{j,t}$$

- Solution: Q-theory, Details

$$\frac{I_{j,t}}{K_{j,t}} - \delta = \frac{1}{\phi_k} (Q_{j,t} - 1)$$

where $Q_{j,t}$ is market value of the firm / capital replacement cost

Goods Producers

- Industry output aggregated by a perfectly competitive firm

$$Y_t = \left(\int_0^1 (D_{j,t} Y_{j,t})^{\frac{\sigma-1}{\sigma}} \, \mathrm{d}j \right)^{\frac{\sigma}{\sigma-1}}$$

- Industry demand is

$$Y_{j,t} = D_{j,t} \left(\frac{P_{j,t}}{P_t} \right)^{-\sigma} Y_t$$

  where $D_{j,t}$ is an industry demand shock

$$\log D_{j,t} = (1 - \rho_d) \log D_j + \rho_d \log D_{j,t-1} + \sigma_d \varepsilon_{j,t}^d$$

- D_j is steady-state demand

Goods Producers

- Industries are made up of firms i
- Firm output $y_{i,j,t}$ aggregated into an industry output

$$Y_{j,t} = \left(\int_0^{N_{j,t-1}} y_{i,j,t}^{\frac{\epsilon_j - 1}{\epsilon_j}} \, \mathrm{d}i \right)^{\frac{\epsilon_j}{\epsilon_j - 1}}$$

where $N_{j,t-1}$ is the number of firms in industry j at time t

- Firm i chooses $k_{i,j,t}$, $\ell_{i,j,t}$ and $p_{i,j,t}$ to

$$\max_{k_{i,j,t}, \ell_{i,j,t}, p_{i,j,t}} p_{i,j,t} y_{i,j,t} - W_t \ell_{i,j,t} - R_{j,t}^k k_{i,j,t}$$

subject to industry demand, and the production function

$$y_{i,j,t} = k_{i,j,t}^{\alpha} \ell_{i,j,t}^{1-\alpha}$$

Goods-Producers Entry

- The number of existing firms $N_{j,t}$ evolves by

$$N_{j,t+1} = (1 - \delta^n) N_{j,t} + n_{j,t}$$

- Firms pay entry input $\kappa_{j,t}$ at price $p^e_{j,t}$ to become active in $t+1$

$$p^e_{j,t} = (\kappa_{j,t} n_{j,t})^{\phi^n}$$

- Let $V^e_{j,t}$ be the value of a firm in industry j. Firms enter until

$$(1 - \delta^n)\, \mathbb{E}_t \Lambda_{t+1} V^e_{j,t+1} = p^e_{j,t} \kappa_{j,t}$$

- Entry input costs are stochastic

$$\log \kappa_{j,t} = (1 - \rho_\kappa) \log \kappa + (1 - \rho_\kappa) \log \kappa_{j,t-1} + \sigma_\kappa \varepsilon^\kappa_{j,t}$$

Industry Dynamics: Prices (Under Flexible)

- Individual firm sets

$$p_{i,j,t} = \mu_j \mathrm{MC}_{j,t}$$

  where $\mu_j = \frac{\epsilon_j}{\epsilon_j - 1}$

- Industry price is

$$P_{j,t} = \left(\int_0^{N_{j,t-1}} p_{i,j,t}^{1-\epsilon_j} \mathrm{d}i \right)^{\frac{1}{1-\epsilon_j}} = \frac{\mu_j \mathrm{MC}_{j,t}}{N_{j,t-1}^{\frac{1}{\epsilon_j - 1}}}$$

- $\Rightarrow$ More entry - lower price

Industry Dynamics: Output/Investment

- All firms face the same factor prices so industry supply is

$$Y_{j,t} = N_{j,t-1}^{\frac{\epsilon_j}{\epsilon_j - 1}} y_{i,j,t}$$

- Industry demand is

$$Y_{j,t} = D_{j,t} P_{j,t}^{-\sigma}$$

- Equate supply and demand and substitute in $P_{j,t}$,

$$y_{i,j,t} = \frac{(\mu_j \mathrm{MC}_{j,t})^{-\sigma} D_{j,t}}{N_{j,t-1}^{\frac{\epsilon_j - \sigma}{\epsilon_j - 1}}}$$

- $\Rightarrow$ More entry - lower individual firm output

Households and Monetary Policy

- Households choose C_t, ℓ_t and savings to

$$\max \ \mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\gamma}}{1-\gamma} - \frac{\ell_t^{1+\psi}}{1+\psi} \right)$$

  subject to the budget constraint:

$$S_t + P_t C_t \leq \tilde{R}_t S_{t-1} + W_t \ell_t$$

- Add sticky prices and wages, and monetary policy:

$$r_t = \max \left[0, \ \phi_i r_{t-1} + \phi_p \pi_t^p + \phi_y (y_t - y_t^F) + \phi_g \left(\frac{Y_t / Y_{t-1}}{Y_t^F / Y_{t-1}^F} \right) \right]$$

- r_t subject to the ZLB

Shocks

- Industry and aggregate shocks:
  - Entry-cost
  - Productivity
  - Inflation equations (Phillips curves)
  - Valuation of corporate assets
- Industry-specific shocks:
  - Industry demand
  - Regime shift in industry demand beliefs, between 1995 and 2000
- Aggregate-specific shocks:
  - Household discount factor
  - Monetary policy

Regime Shift in Demand Beliefs Before 2000

- Noisy entry: entry uncorrelated with future demand. Evidence:
  - Doms (2004): high dotcom growth rates
  - Hogendorn (2011): excess entry into Telecom sector
  - Substantial inflows into VC funds focused on dotcom

- We capture this as variations in beliefs about D_j, where

$$\log D_{j,t} = (1 - \rho_d) \log D_j + \rho_d \log D_{j,t-1} + \sigma_d \varepsilon^d_{j,t}$$

  - Before 1995 and after 2000, $D_j = 1$ for all industries
  - Between 1995 and 2000, D_j is a free parameter

Estimation

Estimation Approach and Data

- Bayesian/likelihood approach
- Data:
  - Industry: annual data, 1989 to 2015, for 43 industries on
    - Q Details
    - Concentration Ratio Details
    - Nominal Output, Capital, Prices Details
  - Aggregate: quarterly data, 1989Q1 to 2015Q1, on
    - Fed Funds rate / Inflation / Expected ZLB Durations
    - Consumption / Investment / Employment
    - Concentration Ratio Details

Estimated Parameters

- Calibrated Parameters
  - Elasticity ϵ_j calibrated to $\frac{NOS_j}{Y_j}$ Distribution Other Parameters
- Estimated Parameters:
  - Industry:
    - Shock processes, AR(1)
    - Expected demand regimes D_j
    - ϕ^n and σ
  - Aggregate:
    - Shock processes, AR(1)
    - Taylor Rule parameters
- Three main challenges:
  - (i) ZLB, (ii) demand expectations, (iii) industry data $\times$ 43

Challenge 1: Solution Method for ZLB

- The ZLB implies a time-varying representation for our model

$$\mathbf{A}_t x_t = \mathbf{B}_t x_{t-1} + \mathbf{D}_t \mathbb{E}_t x_{t+1} + \mathbf{F}_t \epsilon_t$$

- This gives rise to a time-varying VAR solution

$$x_t = \mathbf{Q}_t x_{t-1} + \mathbf{G}_t \epsilon_t$$

- Expected ZLB durations pin down $\mathbf{Q}_t$ and $\mathbf{G}_t$
  - Guerreri and Iacoviello '15.

- We use survey data on durations from NYFed ZLB Durations

Challenge 2: Demand Regime Shifts

- Suppose the regime which is driving the observables is:

$$\mathbf{A}x_t = \mathbf{B}x_{t-1} + \mathbf{D}\mathbb{E}_t x_{t+1} + \mathbf{F}\epsilon_t$$

  - For example, steady-state demand in industry j, D_j, is low

- But agents believe that a $*$ regime is true:

$$\mathbf{A}^* x_t = \mathbf{C}^* + \mathbf{B}^* x_{t-1} + \mathbf{D}^* \mathbb{E}_t x_{t+1} + \mathbf{E}^* \epsilon_t.$$

  - For example, steady-state demand in industry j, D_j, is high

- We seek a solution of the form

$$x_t = \tilde{\mathbf{Q}} x_{t-1} + \tilde{\mathbf{G}} \epsilon_t$$

Challenge 2: Demand Regime Shifts

- To find the solution, expectations must satisfy

$$\mathbb{E}_t x_{t+1} = \mathbf{Q}^* x_t$$

- Substitute this into $\mathbf{A}x_t = \mathbf{B}x_{t-1} + \mathbf{D}\mathbb{E}_t x_{t+1} + \mathbf{F}\epsilon_t$ to get:

$$\tilde{\mathbf{Q}} = [\mathbf{A} - \mathbf{D}\mathbf{Q}^*]^{-1}\,\mathbf{B}$$

$$\tilde{\mathbf{G}} = [\mathbf{A} - \mathbf{D}\mathbf{Q}^*]^{-1}\,\mathbf{F}$$

- With $x_t = \tilde{\mathbf{Q}}x_{t-1} + \tilde{\mathbf{G}}\epsilon_t$, we can form the state-space

- So beliefs about demand map to $\tilde{\mathbf{Q}}$ and $\tilde{\mathbf{G}}$ and the likelihood

Challenge 3: Using Industry Data

- We want to use industry-level data in identification
- Problem: Infeasible
  - 43 industries, 10+ state variables each, aggregate shocks, ZLB
- Recall our model is

$$x_t = \left[x_t^1,\ x_t^2, \ldots\right]' = \mathbf{Q}_t x_{t-1} + \mathbf{G}_t \epsilon_t$$

- Solution: Write the industry j level variables as

$$x_t^j = \underbrace{\mathbf{Q} x_{t-1}^j + \mathbf{G}\epsilon_t^j}_{\text{industry-level component}} + \underbrace{\mathbf{Q}_t^a x_{t-1}^* + \mathbf{G}_t^a \epsilon_t^*}_{\text{aggregate component}}$$

Challenge 3: Using Industry Data

- Industry j level variables are

$$x_t^j = \underbrace{\mathbf{Q}x_{t-1}^j + \mathbf{G}\epsilon_t^j}_{\text{industry-level component}} + \underbrace{\mathbf{Q}_t^a x_{t-1}^* + \mathbf{G}_t^a \epsilon_t^*}_{\text{aggregate component}}$$

- Express industry-level data relative to average $\bar{x}_t = \int x_t^j \mathrm{d}j$

- Assuming average shock $\int \epsilon_t^j \mathrm{d}j = 0$, then

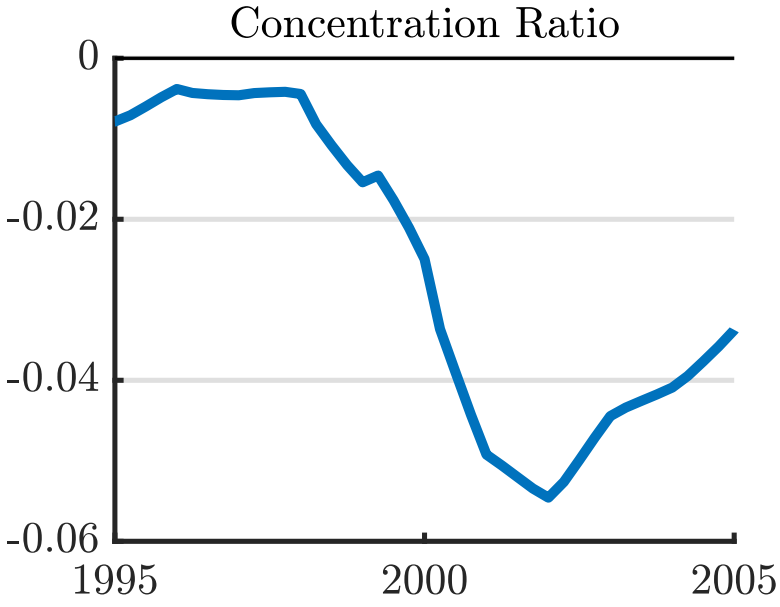
$$x_t^j - \bar{x}_t = \mathbf{Q}\left(x_{t-1}^j - \bar{x}_{t-1}\right) + \mathbf{G}\epsilon_t^j$$

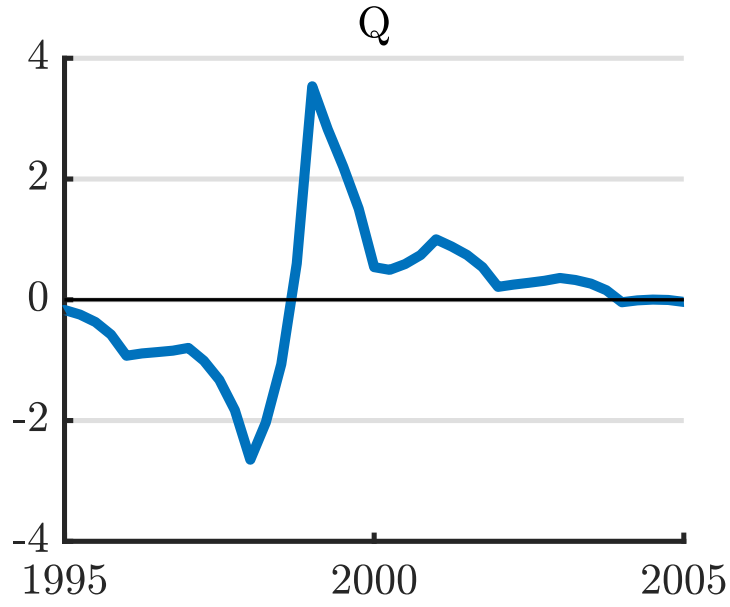
- Shocks iid: separate the likelihood into 43 industry components

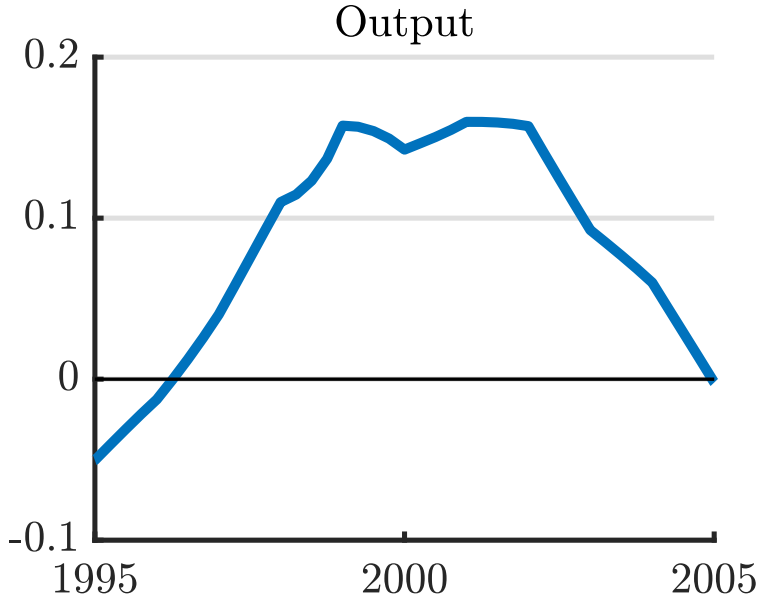
Treatment of Industry-Level Data

- Express industry-level data relative to aggregate
- For each industry series
  1. Compute a full set of time effects
  2. Subtract a industry-specific fixed effect and trend
  3. Work with the residuals
- Exploit these relative changes in identification

Industry-Level Observable: Info Publishing







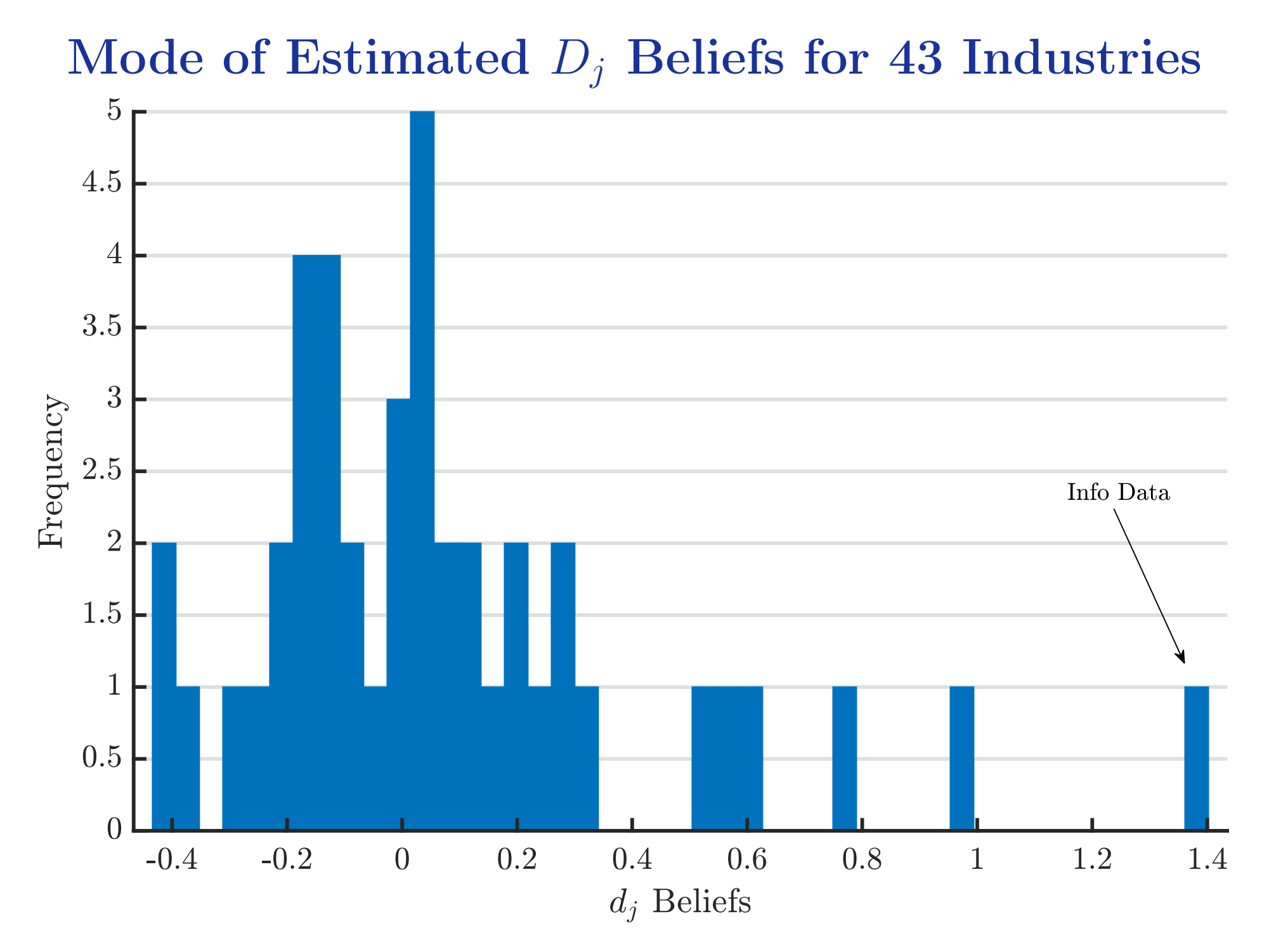
Estimates

Industry-Level Estimates

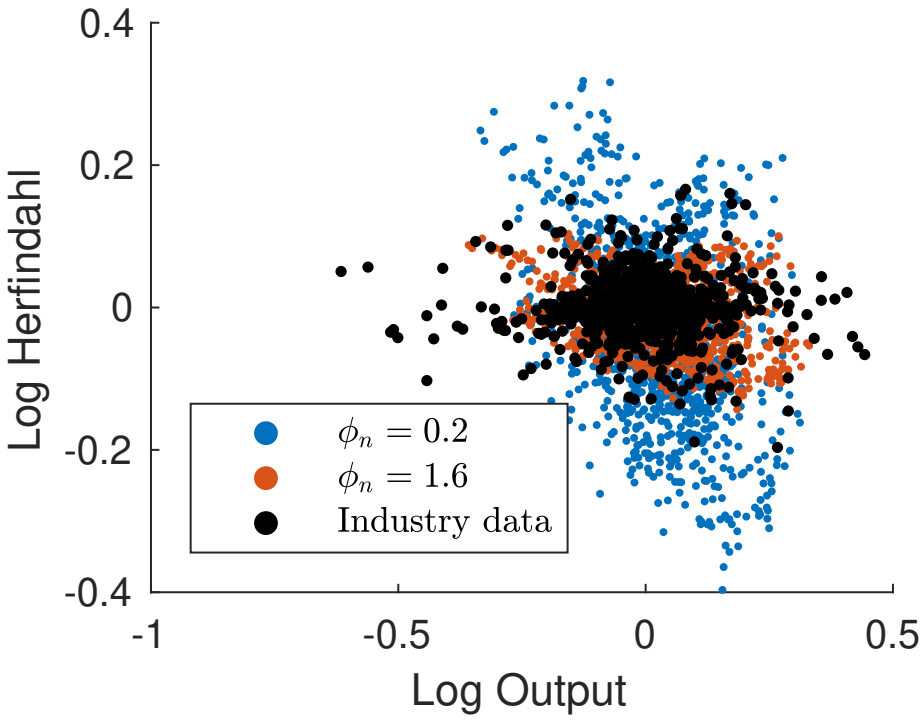
	Posterior		
Parameter	Median	10%	90%
ϕ^n	1.55	1.08	2.32
σ	0.40	0.38	0.43

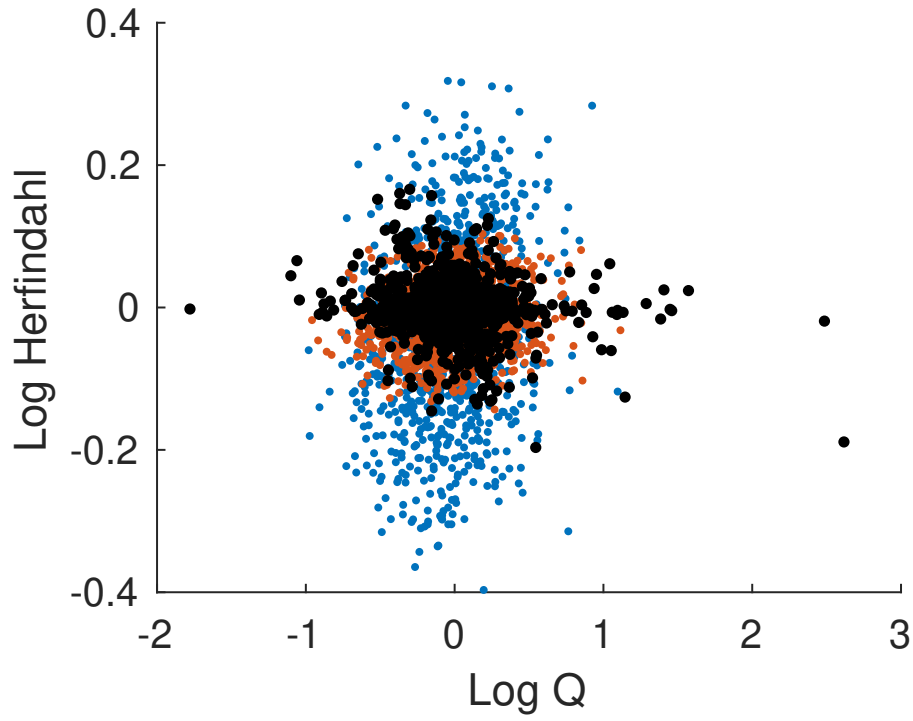
Log Demand Regimes (2 of 43)			
Durable Comp.	1.6	0.2	2.9
Info Data	4.1	3.1	4.4

Full Estimates


Mode of Estimated D_j Beliefs for 43 Industries
Frequency
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
d_j Beliefs
Info Data

Industry Identification of Estimate of ϕ_n



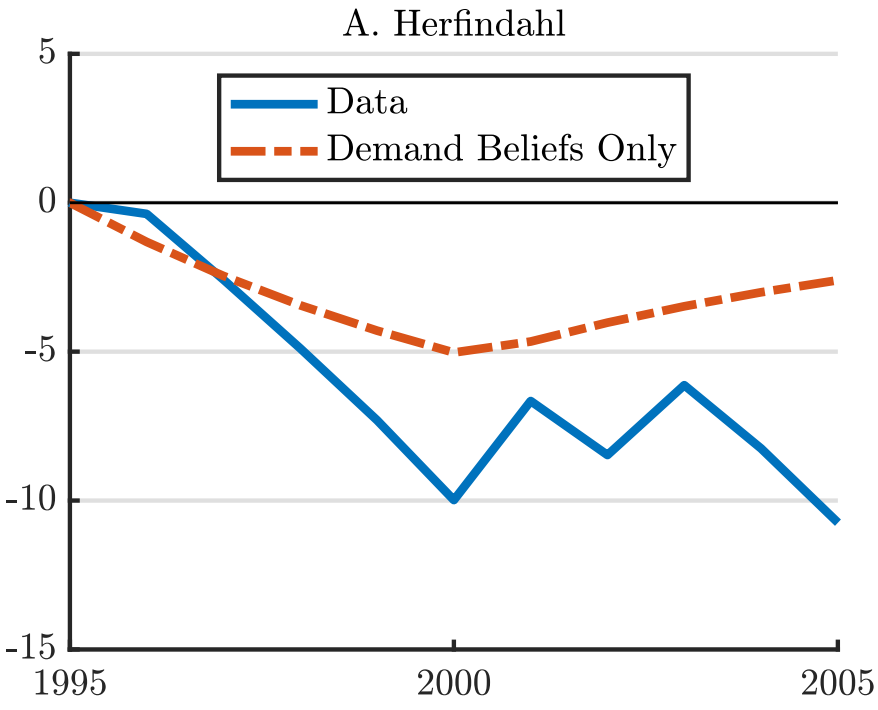


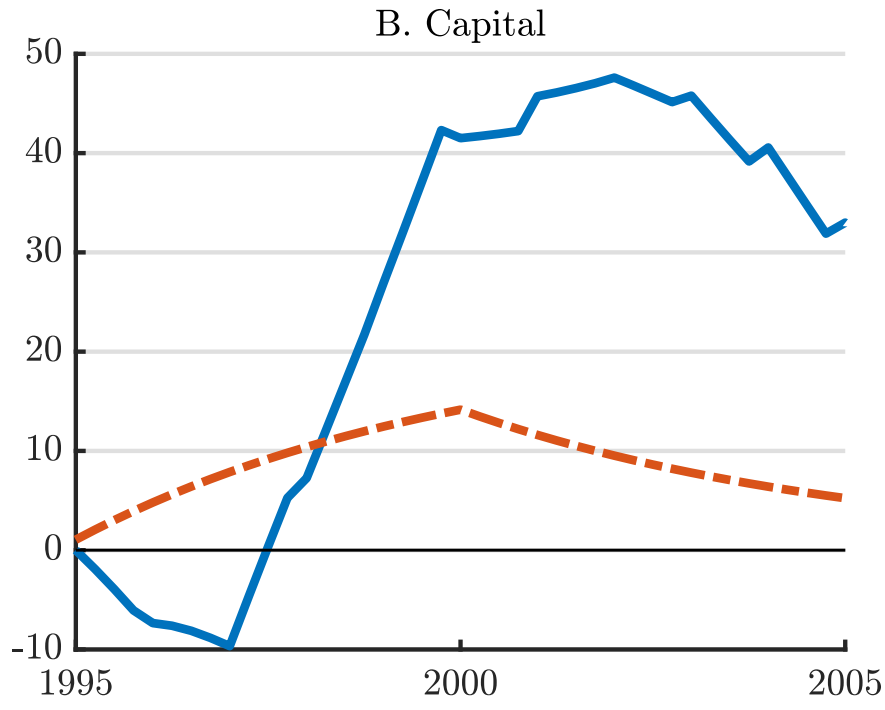
ϕ_n estimate implies:

- Following demand shock that raises Q_t to 10% after 1 year
- $\Rightarrow$ Number of firms increases by 1.4% after 2 years

Estimate of Demand Beliefs: Info Data

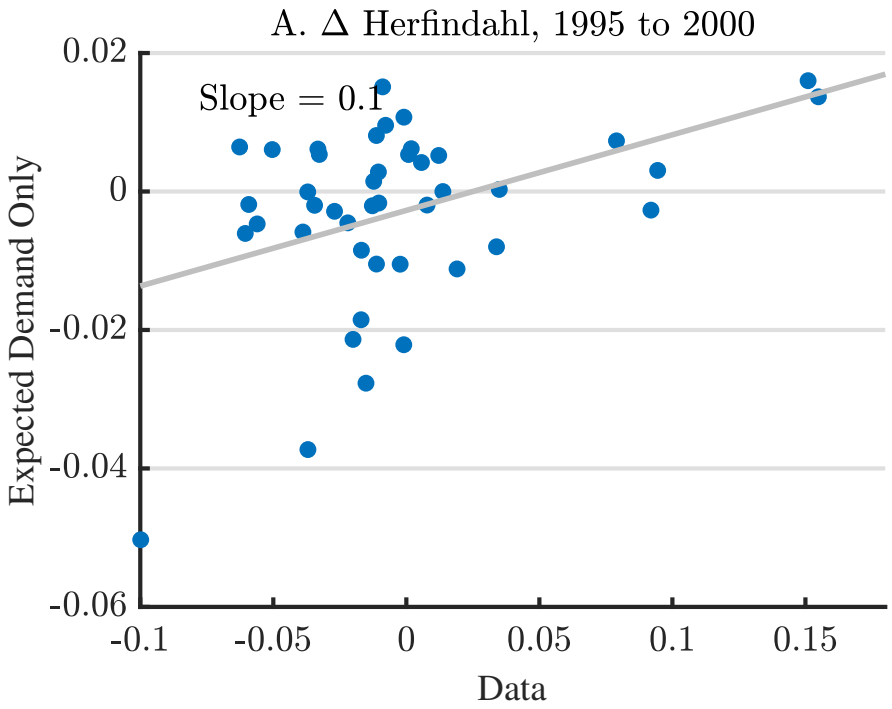
Example for Info Data Industry

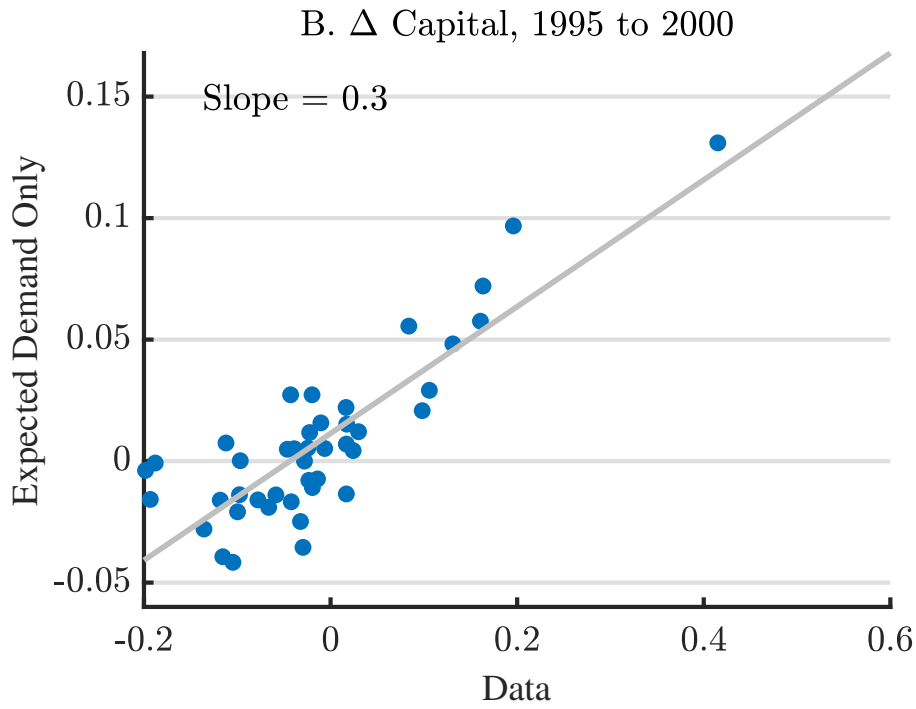




Estimate of Demand Beliefs: All Industries

- Accounts for about 10% of entry



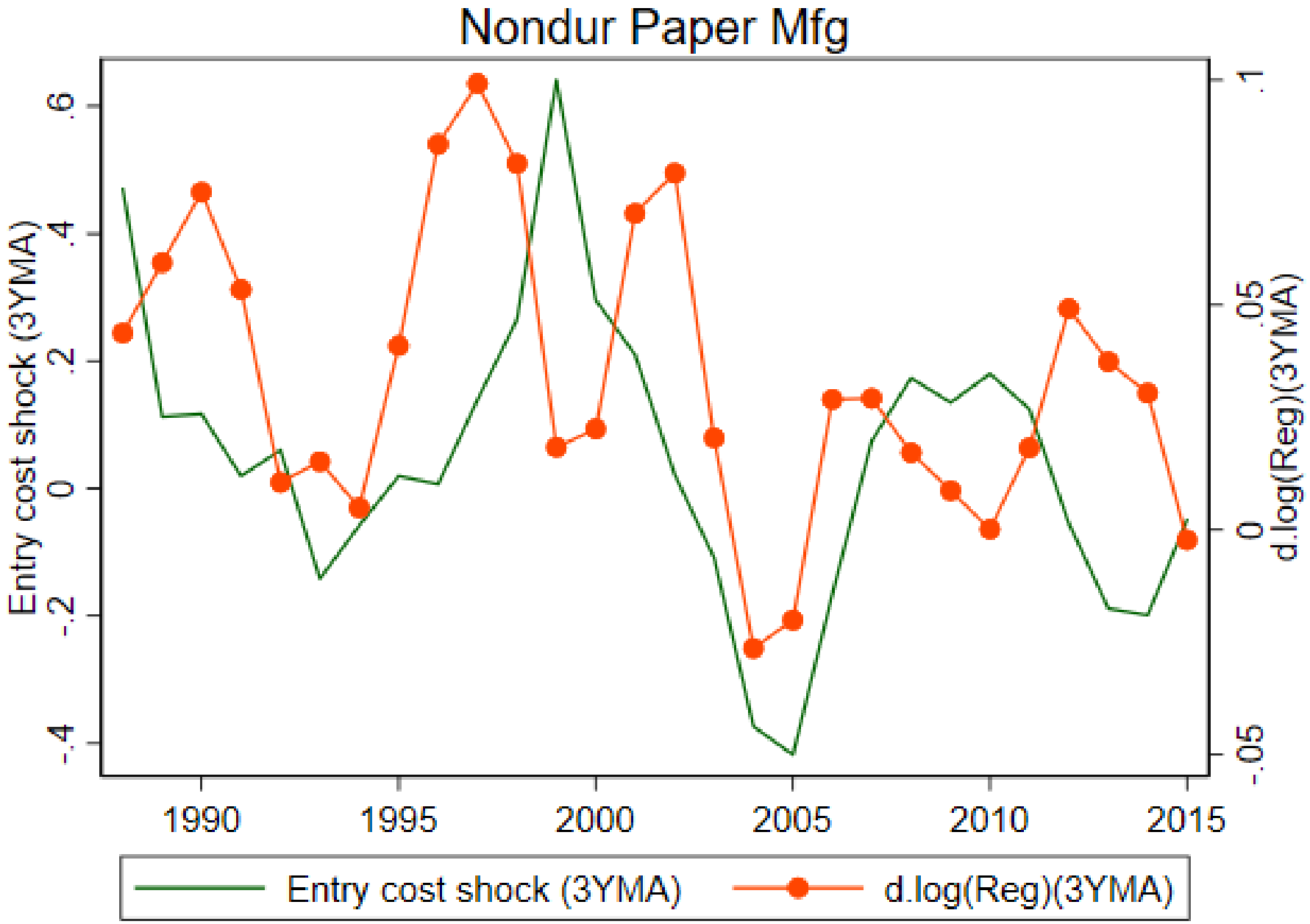


Interpretation of Entry Cost Shocks

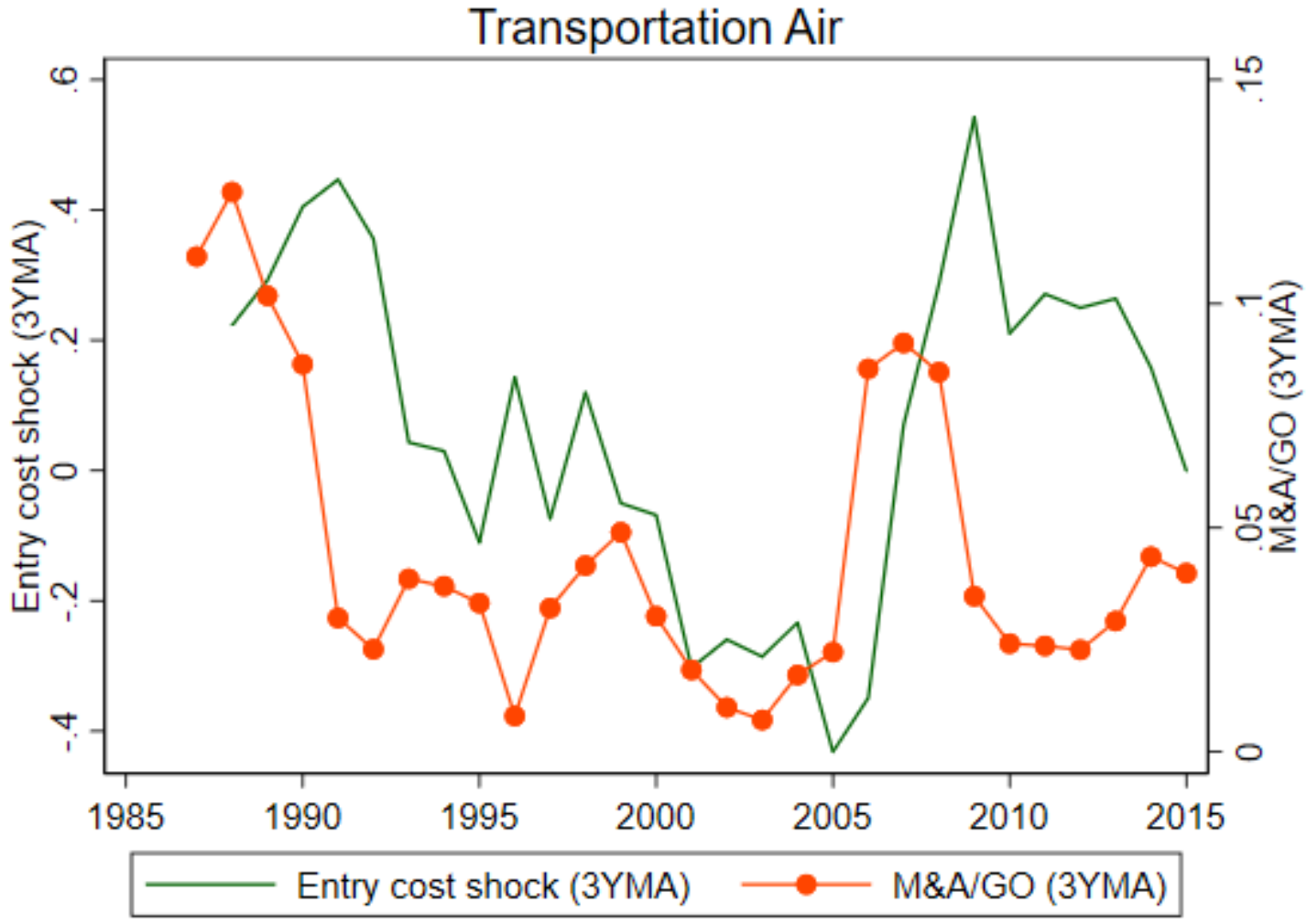
Empirical Proxies of Barriers to Entry

- Regulation Index:
  - Regulation based on RegData 3.1 from QuantGov
  - Machine learning / natural language processing techniques to construct measures of regulatory stringency at the industry level
  - Number of restrictive words or phrases such as ‘shall’, ‘must’ and ‘may not’ in each section of the Code of Federal Regulations
- Regulatory employment:
  - Census Occupational Employment Statistics
- M&A activity

Non-Durable Paper Manufacturing



Air Transport Industry



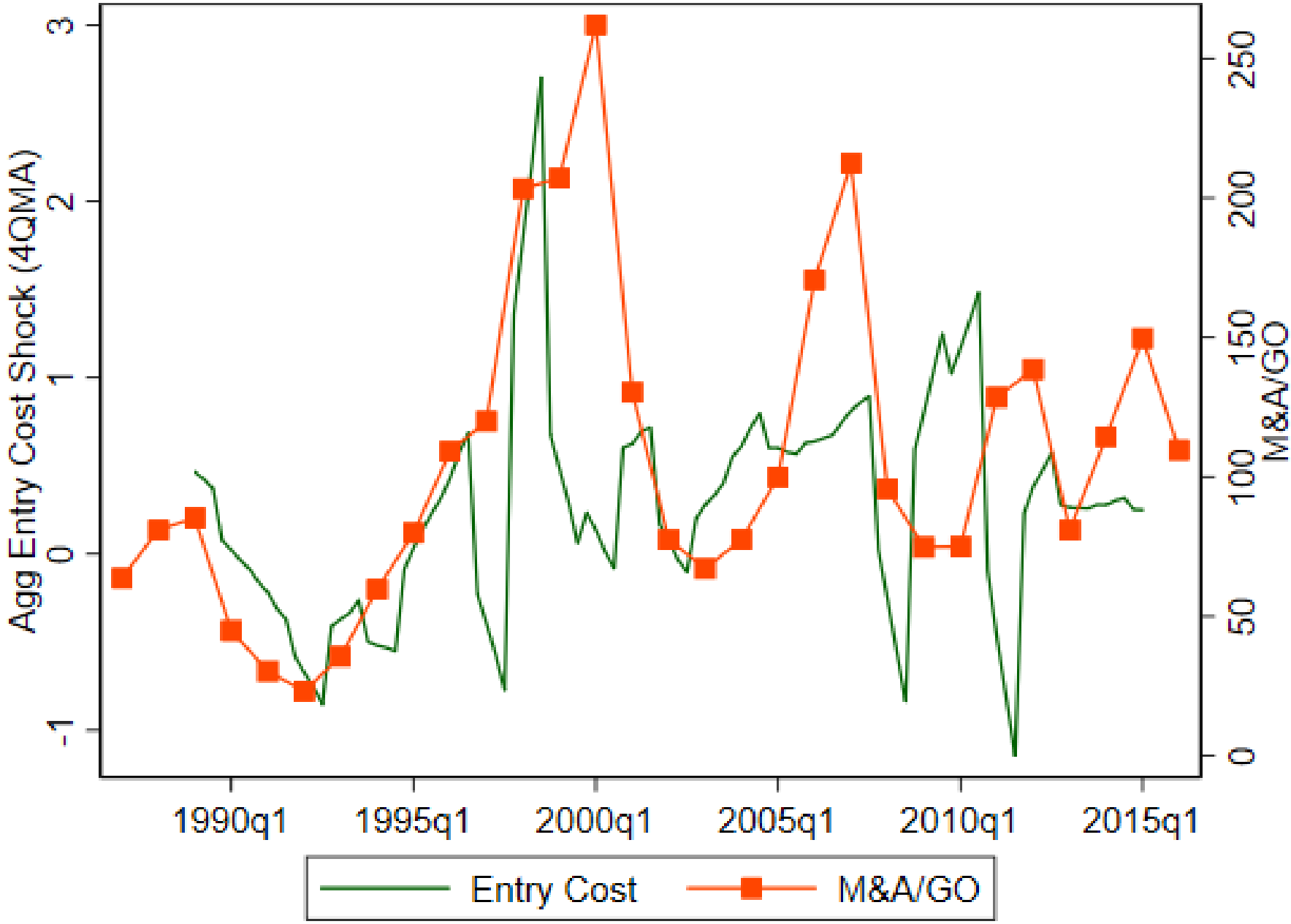
- Recent mergers: Delta-Northwest (2008), United-Continental (2010), Southwest-AirTran (2011), American-US Airways (2014)

The Economist on Airlines

Entry Costs Across All Industries

	$\zeta^{\kappa}_{j,t}$					
	(1) All	(2) Post-02	(3) Post-02	(4) Post-02	(5) All	(6) Post-02
$\Delta \log(\text{Reg Index}^{j}_{t-2,t-1})$	0.044**	0.047*			0.044**	
	(0.014)	(0.017)			(0.014)	
$\Delta \log(\text{Reg Emp}^{j}_{t,t+1})$			0.031*			
			(0.013)			
Mean(L.dRegIndex,F.dRegEmp)				0.038**		0.033**
				(0.009)		(0.010)
$\log(\text{M\&A}_{j,t})$(2Y MA)					0.047*	0.087*
					(0.021)	(0.037)
Ind FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
R2	.051	.091	.085	.095	.057	.11
Observations	837	358	358	358	837	358

What are the Entry Cost Shocks? Aggregate



Aggregate Implications

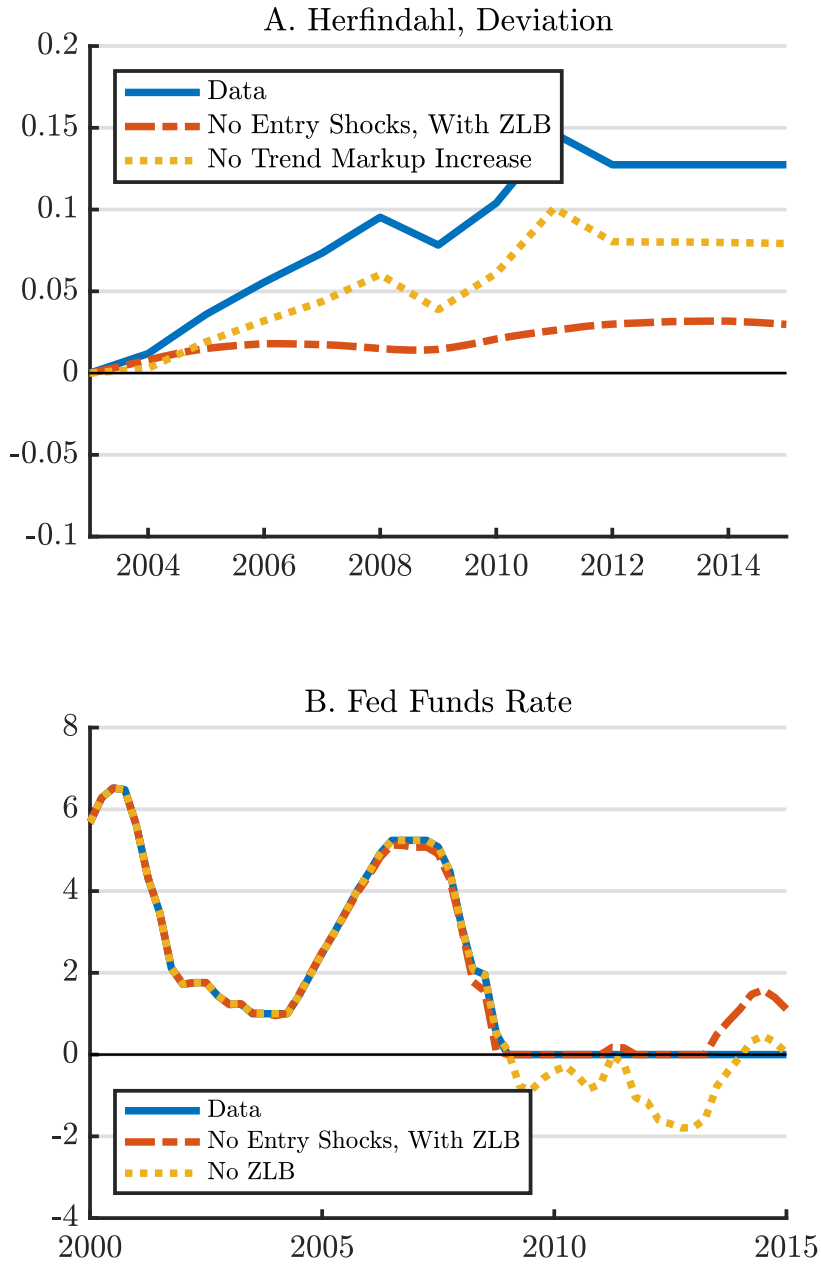
Aggregate Implications

- What are the aggregate implications of firm entry?
- Use the estimated elasticity of firm entry to Q, ϕ_n and:
  1. Estimate the aggregate model's parameters
  2. Filter the aggregate data for the shocks
- Experiments with estimated model
  1. Interpret changes in entry cost shocks
  2. Turn off aggregate entry cost shock from 2003

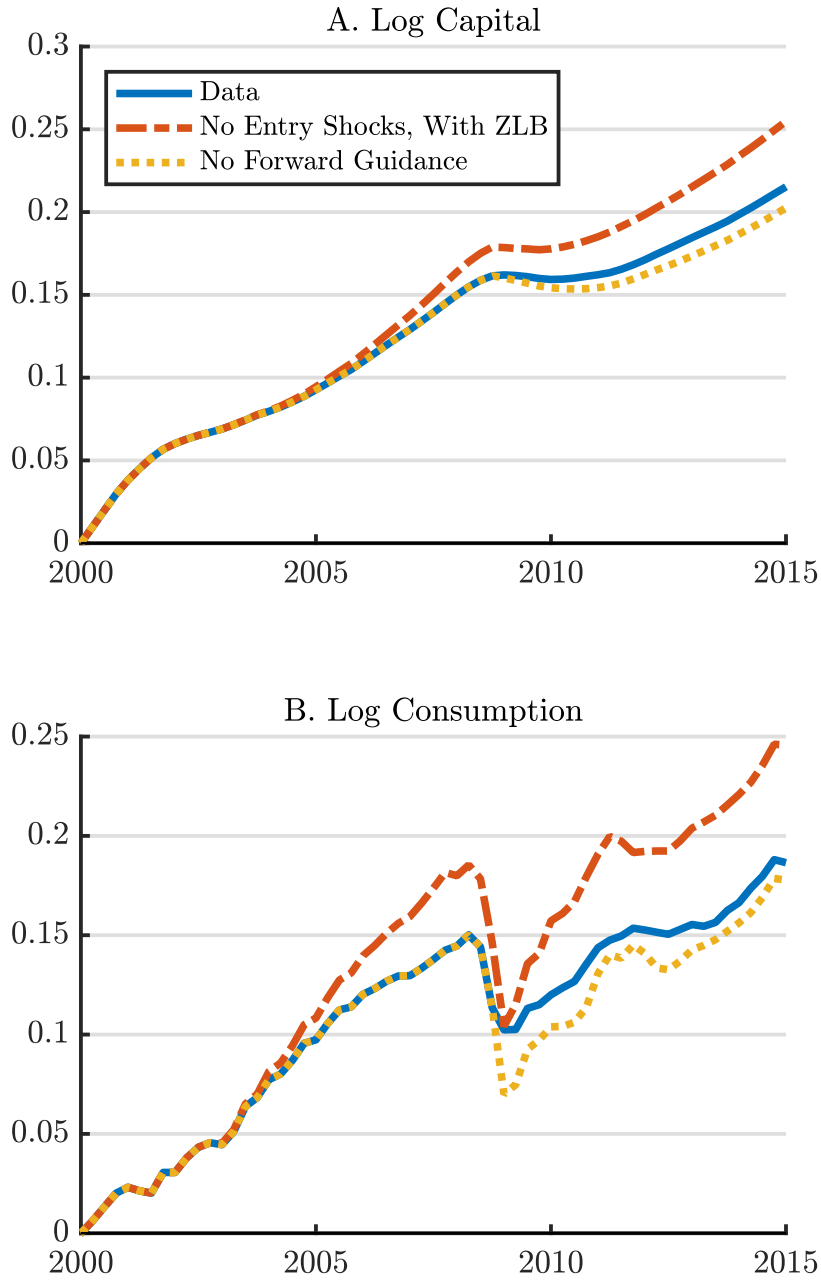
Variance Decomposition of Aggregate Variables

Variable	Tech.	Pref.	Infl.	Risk P.	Policy	Entry Cost
Fed Funds Rate	3.9	13.8	31.6	23.1	26.1	1.6
Output	81.7	0.7	0.1	4.2	0.0	13.2
Consumption	83.9	1.5	0.7	3.4	0.1	10.4
Net Investment	54.6	7.4	1.2	26.2	1.2	9.3
Employment	16.0	3.0	41.1	9.5	9.8	20.7
Inflation	1.7	17.3	15.1	34.6	24.6	6.6
Herfindahl	46.0	1.1	0.1	6.8	0.0	46.0
Natural Rate	4.2	19.0	0.0	27.3	0.0	49.6

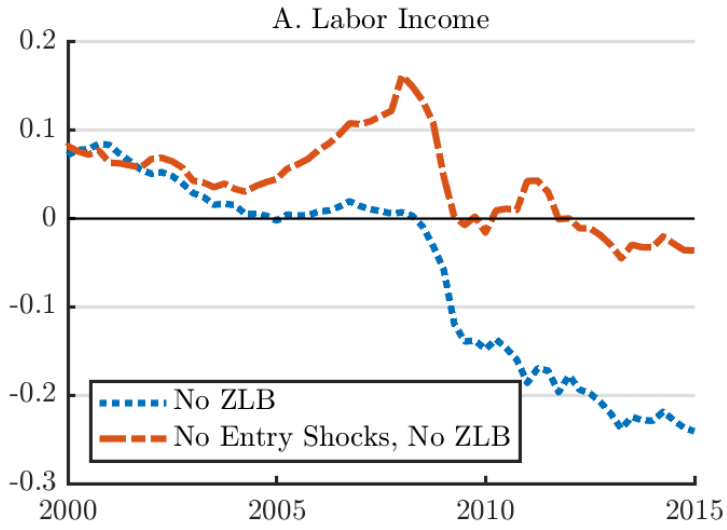
Less Entry, Lower FF Rate

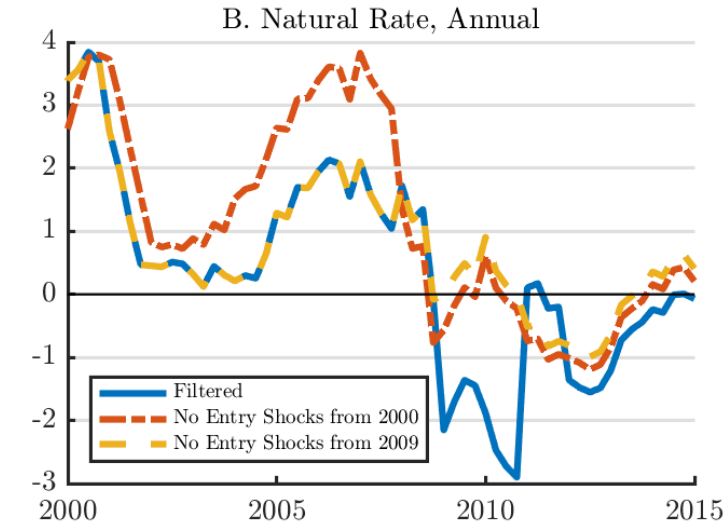


Less Investment, Consumption



Lower Wage Income, Natural Rate



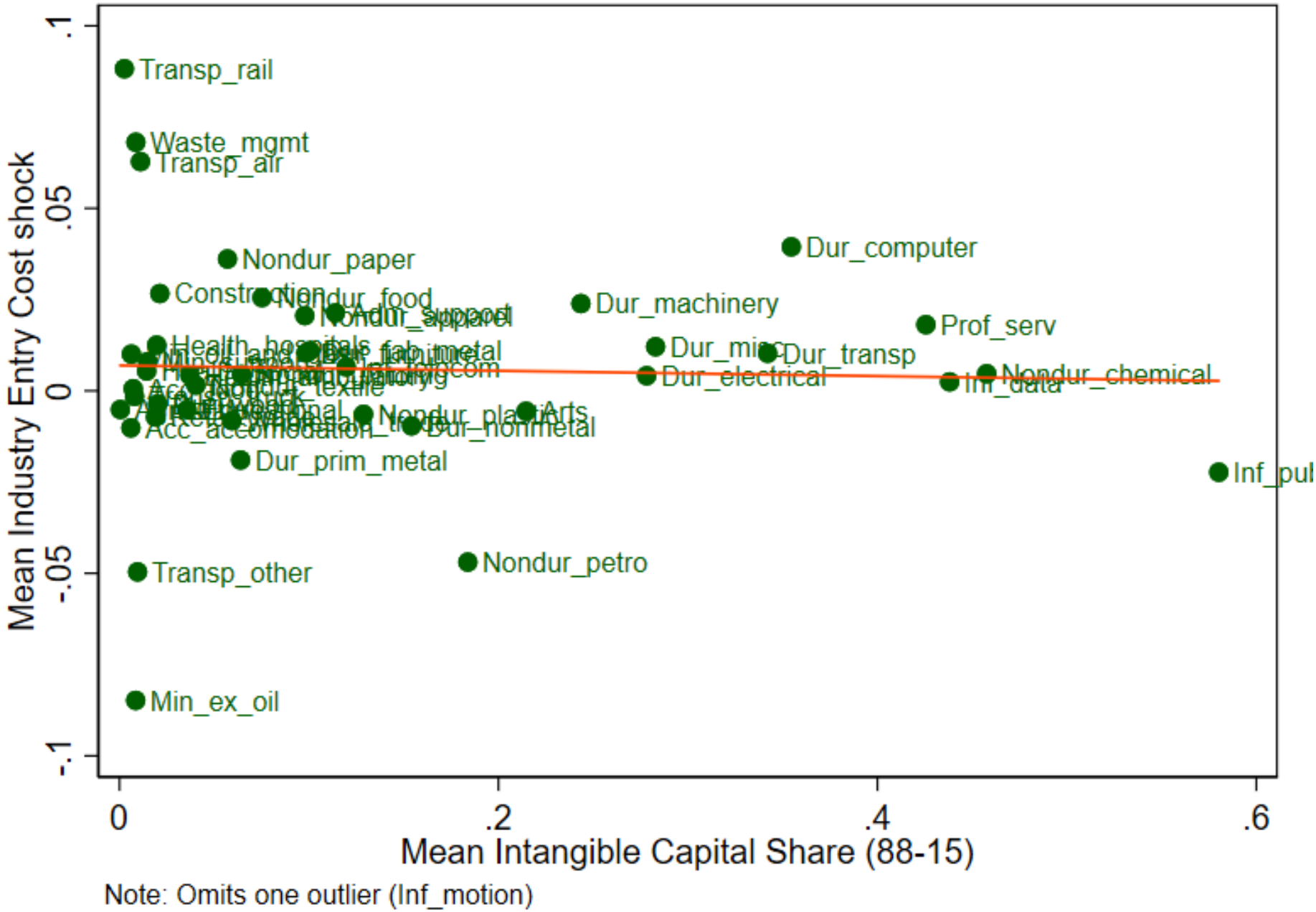


Conclusion

- US industries have become more concentrated
  - Lower competition has led to lower investment
  - We find an increase in entry costs
  - We link those entry costs to regulation/M&A
- Europe has trended the other way Comparison
  - Decreasing concentration
  - Low investment in Europe and low valuations/high risk premia
  - If true, then probably cyclical

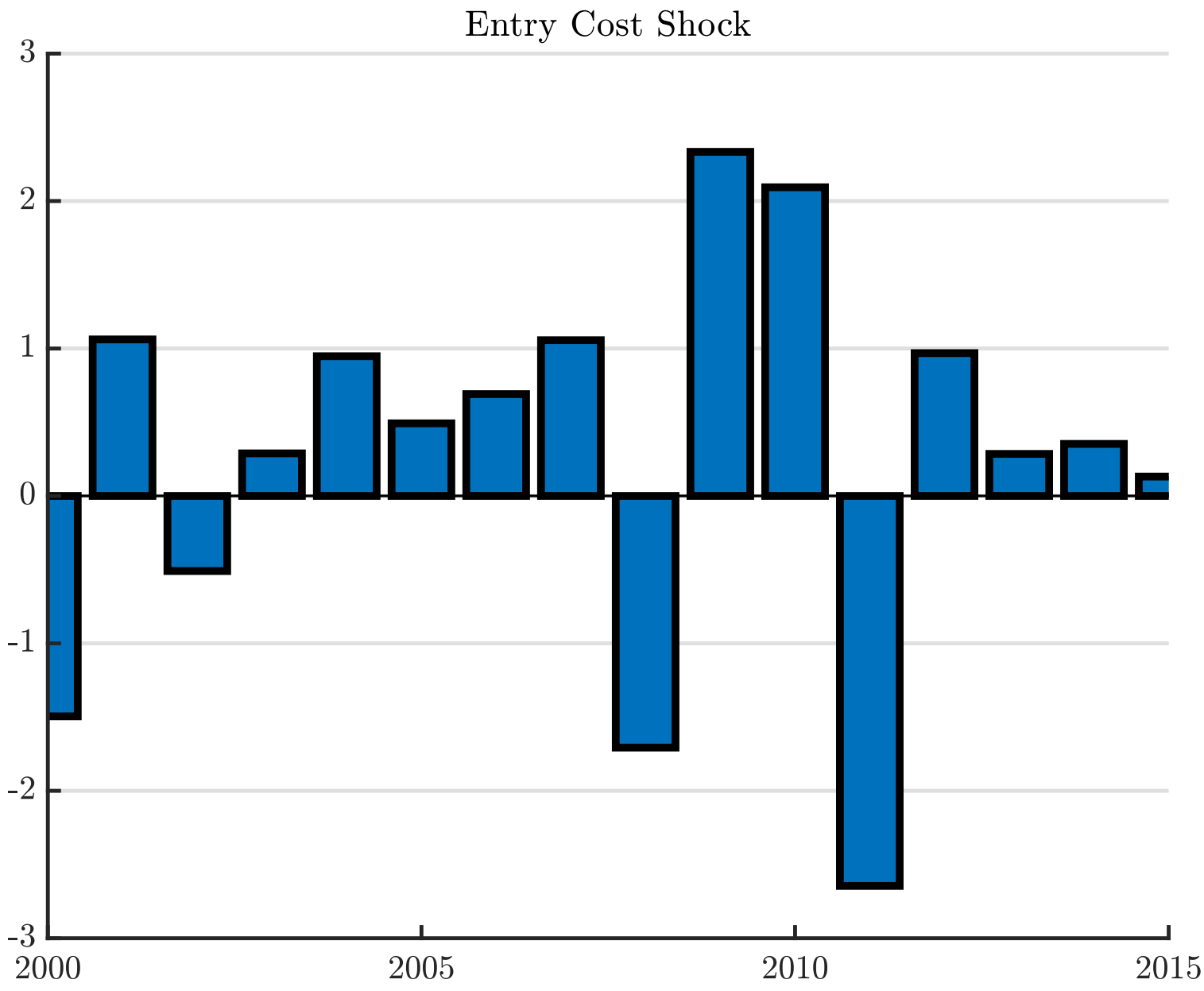
Appendix

What are the Entry Cost Shocks?



Note: Omits one outlier (Inf_motion)

Aggregate Entry Cost Shock



How Should We Interpret These Facts?

- Drop in the price of capital?
- Intangible assets
  - Peters and Taylor '16, Alexander and Eberly '16
- Superstar firms?
  - Autor '17
- Globalization
  - Feenstra and Weinstein '17, Fresard and Valta '15, Hombert and Matray '15
- Decreasing Domestic Competition, DDC
  - Furman '15, Gutiérrez and Philippon '17

How Should We Interpret These Facts? #2

- Drop in the price of capital?
  - Timing is wrong, as fall in price of capital occurs before 2000
- Intangible assets
  - 25% of the gap between Q and N/K explained by intangible intensity, so not much
  - National accounts does include IP investment
  - Argument not necessarily true for industries like airlines
- Superstar firms?
  - Implies TFP correlated with concentration, but not so from 2000
  - Leaders are investing less, when it should be more Evidence
  - Concentration trends not observed so much in Europe
- Globalization?
  - Measurement? investment gap appears in consolidated firm-level data, which includes investment in US and outside
  - External Profits? GP (2017) BPEA show profits have increased faster than foreign sales, so profits being shifted out of the US

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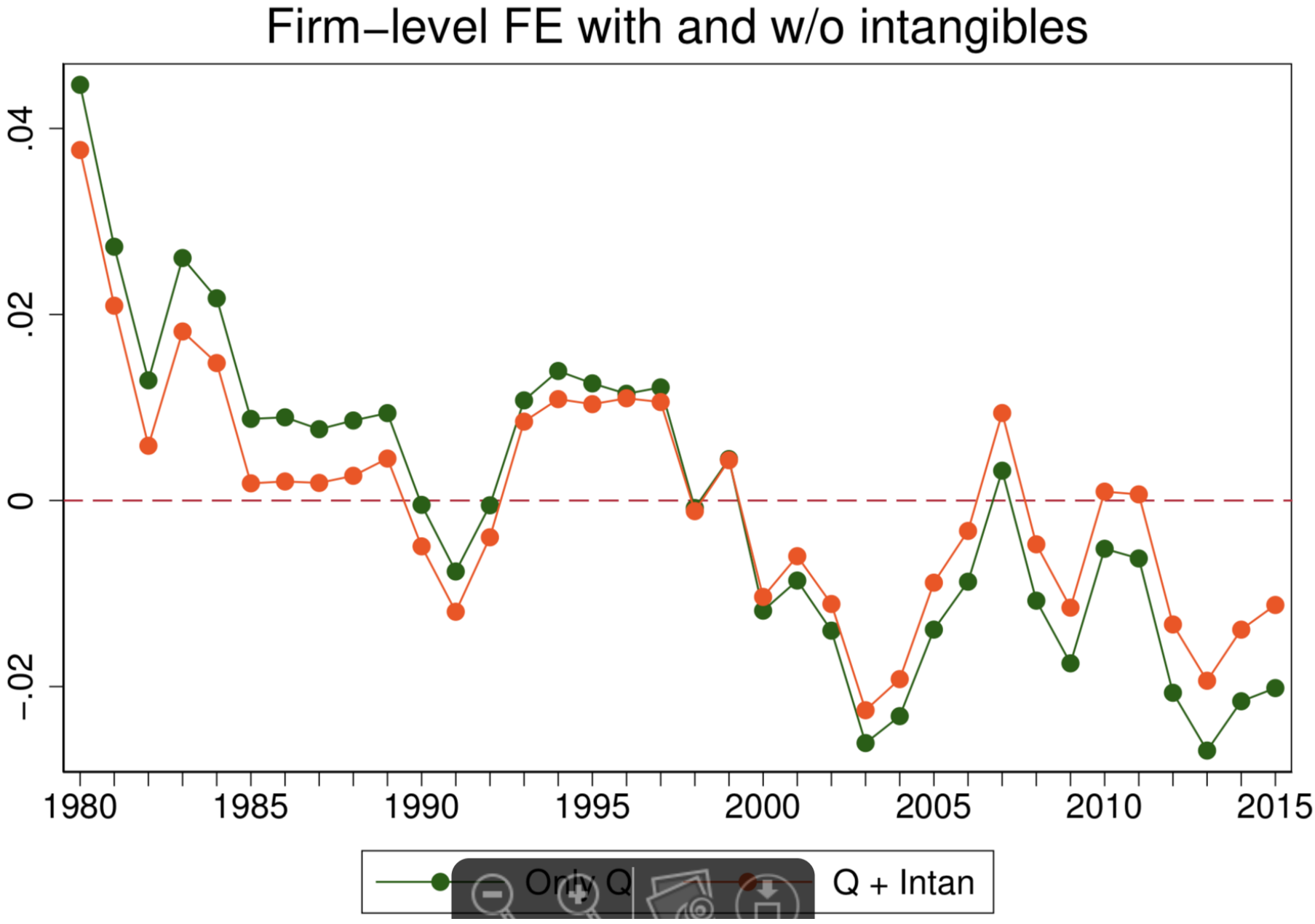
Intangibles: Gutierrez and Philippon (2017)



Productivity: Gutierrez and Philippon (2017)

Select Discussion: Super Star

- Our interpretation of the hypothesis (Autor et al.)
  - Not simply a description of skewness.
  - But an explanation for concentration: efficiency instead of market power
- What we find: some support in the 1990s, but not after 2002.

	(1)	(3)
	ΔTFP	
	97-02	02-12†
ΔCensus CR4	**0.481****	**0.051**
	[4.439]	**[0.301]**
Observations	469	297
R^2	4%	0%

Notes: T-stats in brackets. + p<0.10, * p<0.05, ** p<.01. † TFP change to 2009 due to data availability

EXTRA: Measures of Concentration & Entry

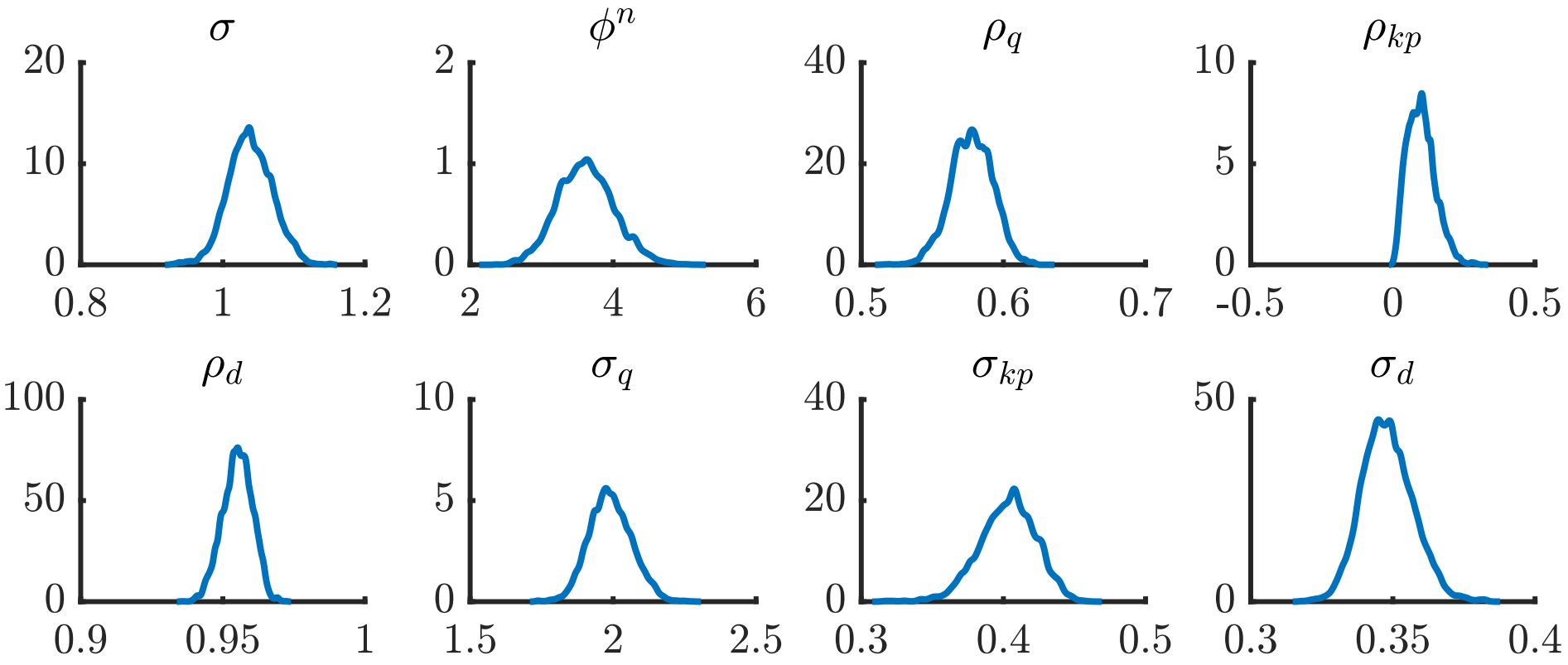
- Traditional Herfindahl + Common ownership adjustment (Azar, et. al. (2016))

$$MHHI = \sum_j s_j^2 + \sum_j \sum_{k \neq j} s_j s_k \frac{\sum_i \beta_{ij} \beta_{ik}}{\sum_i \beta_{ij}^2}$$

$$= HHI + HHI^{adj}$$

- Other measures including entry, share of sales by top #10 firms, etc. also significant

Posteriors for Common Industry Parameters



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Q Data

- Flow of funds
- Ratio of market value to the replacement cost of capital including intangibles

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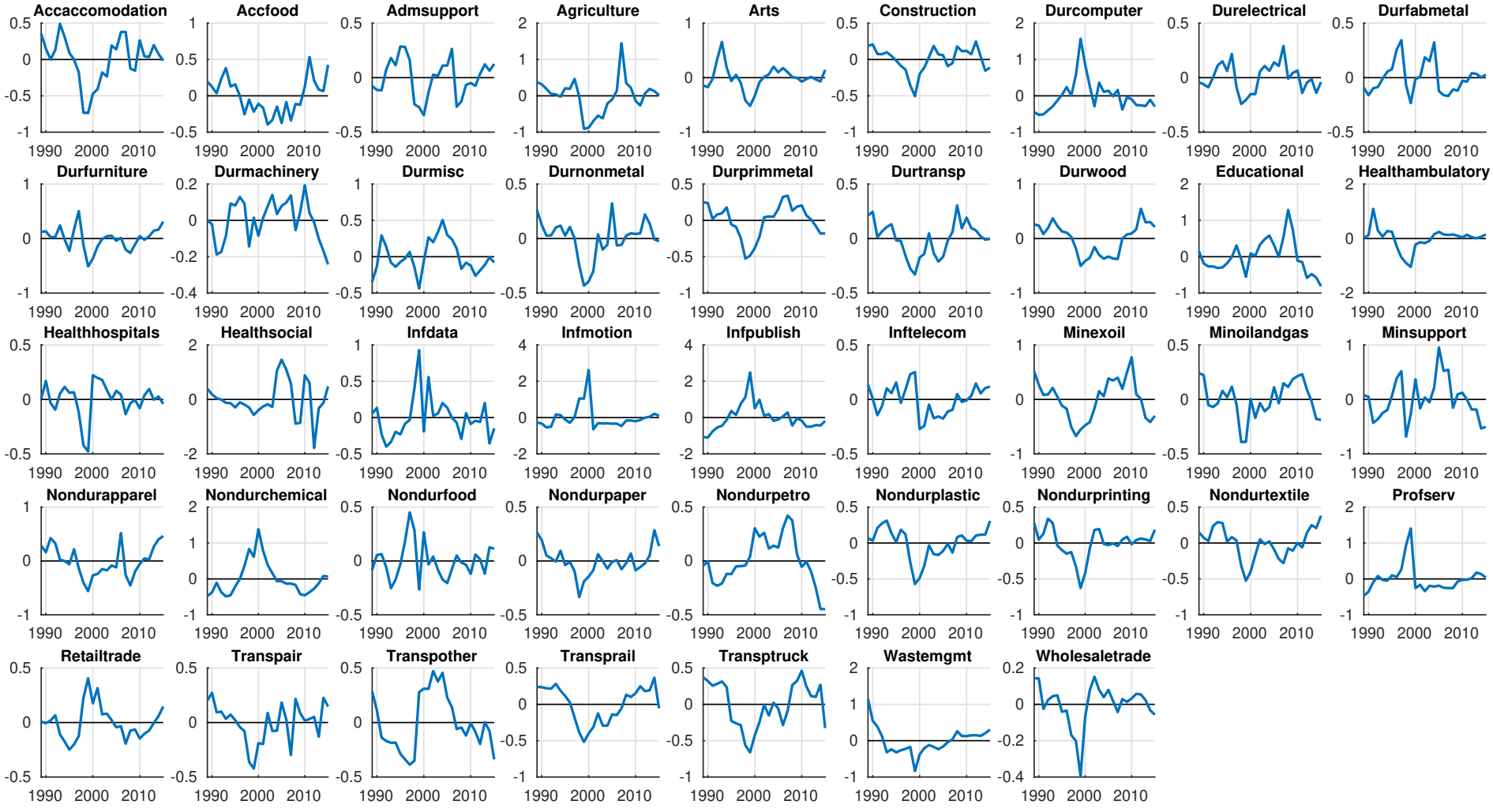
Q


Accaccomodation
Accfood
Admsupport
Agriculture
Arts
Construction
Durcomputer
Durelectrical
Durfabmetal
Durfurniture
Durmachinery
Durmisc
Durnonmetal
Durprimmetal
Durtransp
Durwood
Educational
Healthambulatory
Healthhospitals
Healthsocial
Infdata
Infmotion
Infpublish
Inftelecom
Minexoil
Minoilandgas
Minsupport
Nondurapparel
Nondurchemical
Nondurfood
Nondurpaper
Nondurpetro
Nondurplastic
Nondurprinting
Nondurtextile
Profserv
Retailtrade
Transpair
Transpother
Transprail
Transptruck
Wastemgmt
Wholesaletrade

Concentration Ratio Data

- Compustat for BEA segments
- Patterns verified against aggregated firm-level census data
- Corrected for the import share, as in Feenstra and Weinstein '17
- Series from Compustat/BEA have a 65-70% correlation in levels and 40-50% in 5-year changes

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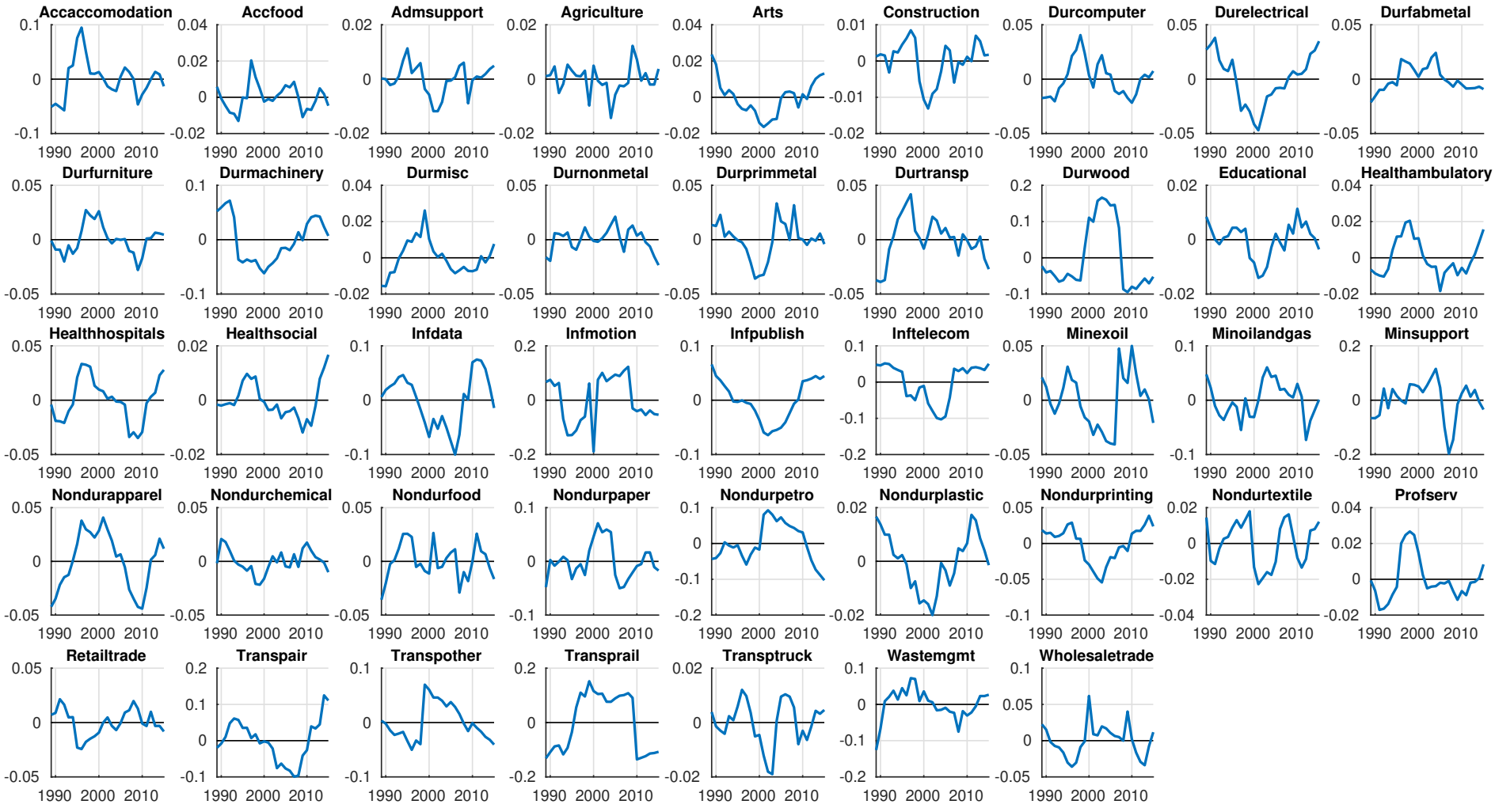
Concentration Ratios



Nominal Output Data

- BEA

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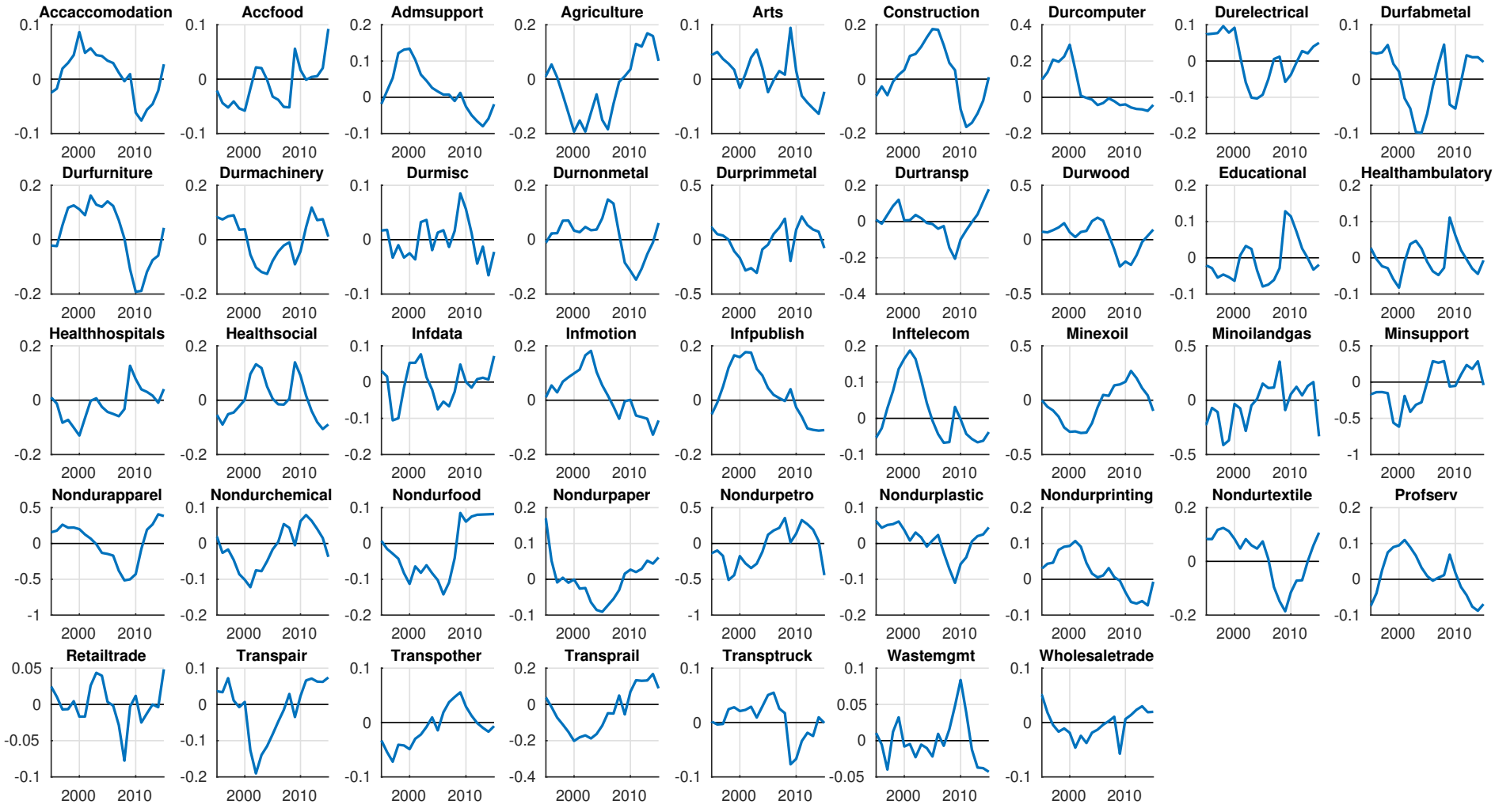
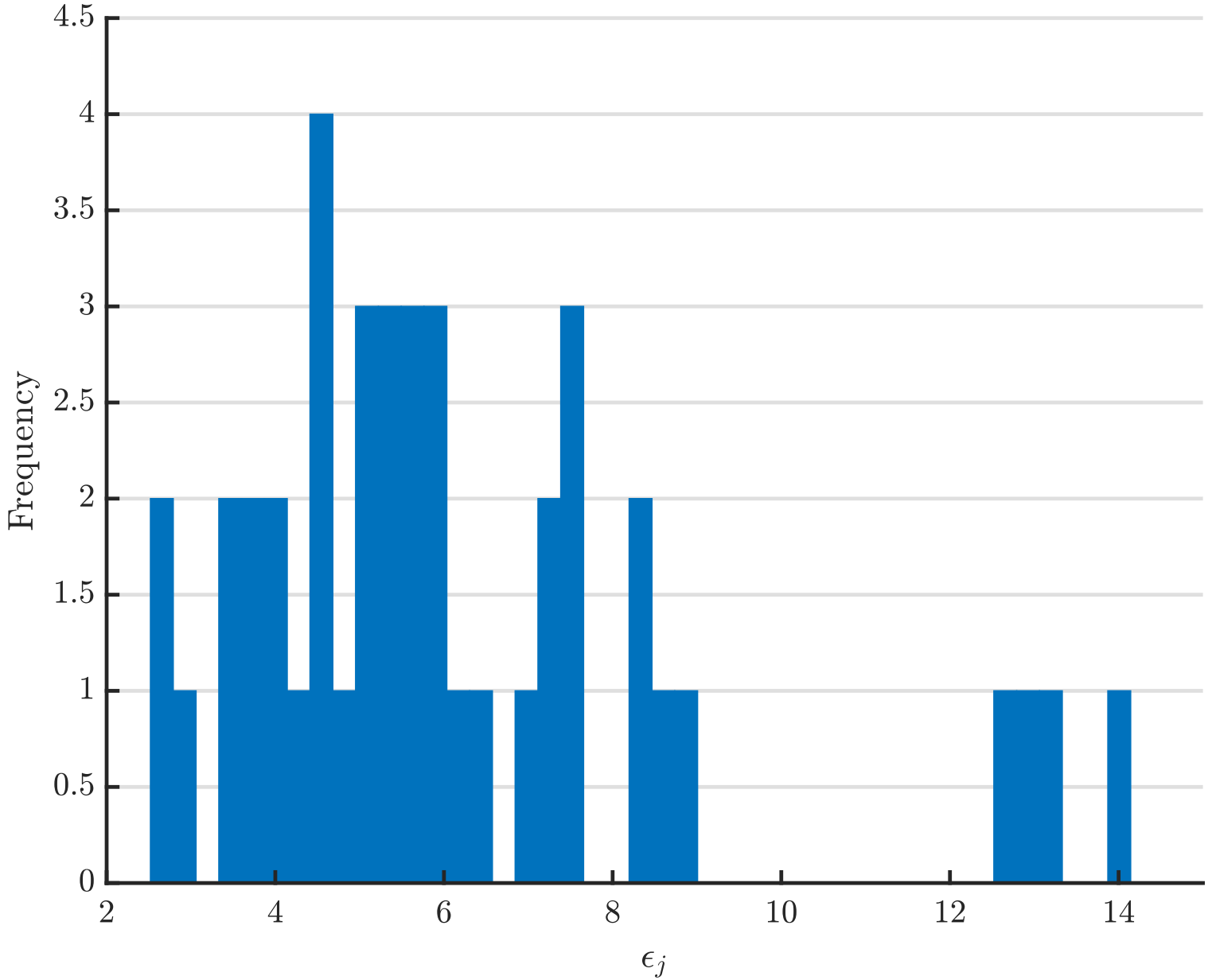
Nominal Output



Calibrated ε_j for a given σ



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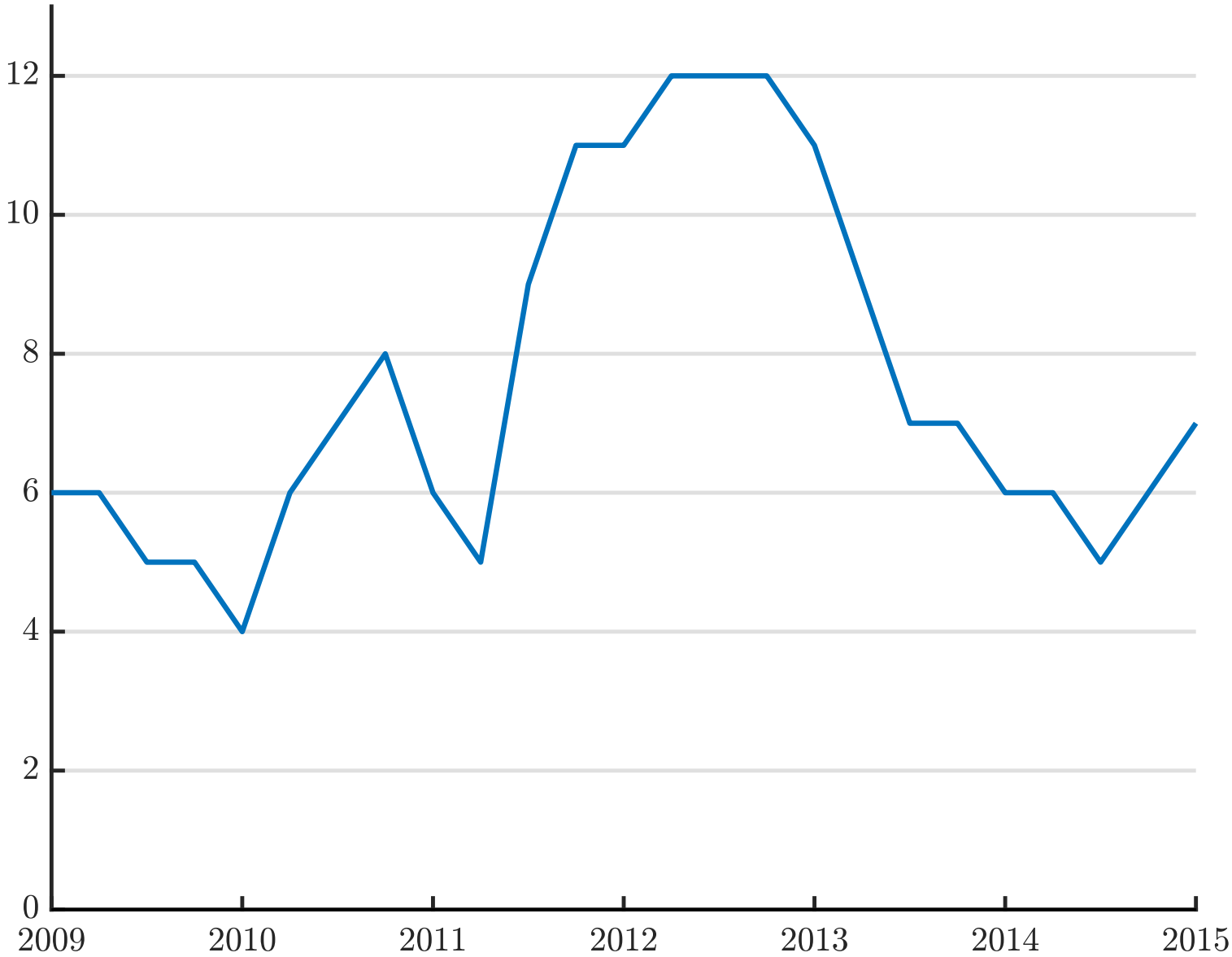
ZLB Durations in Quarters



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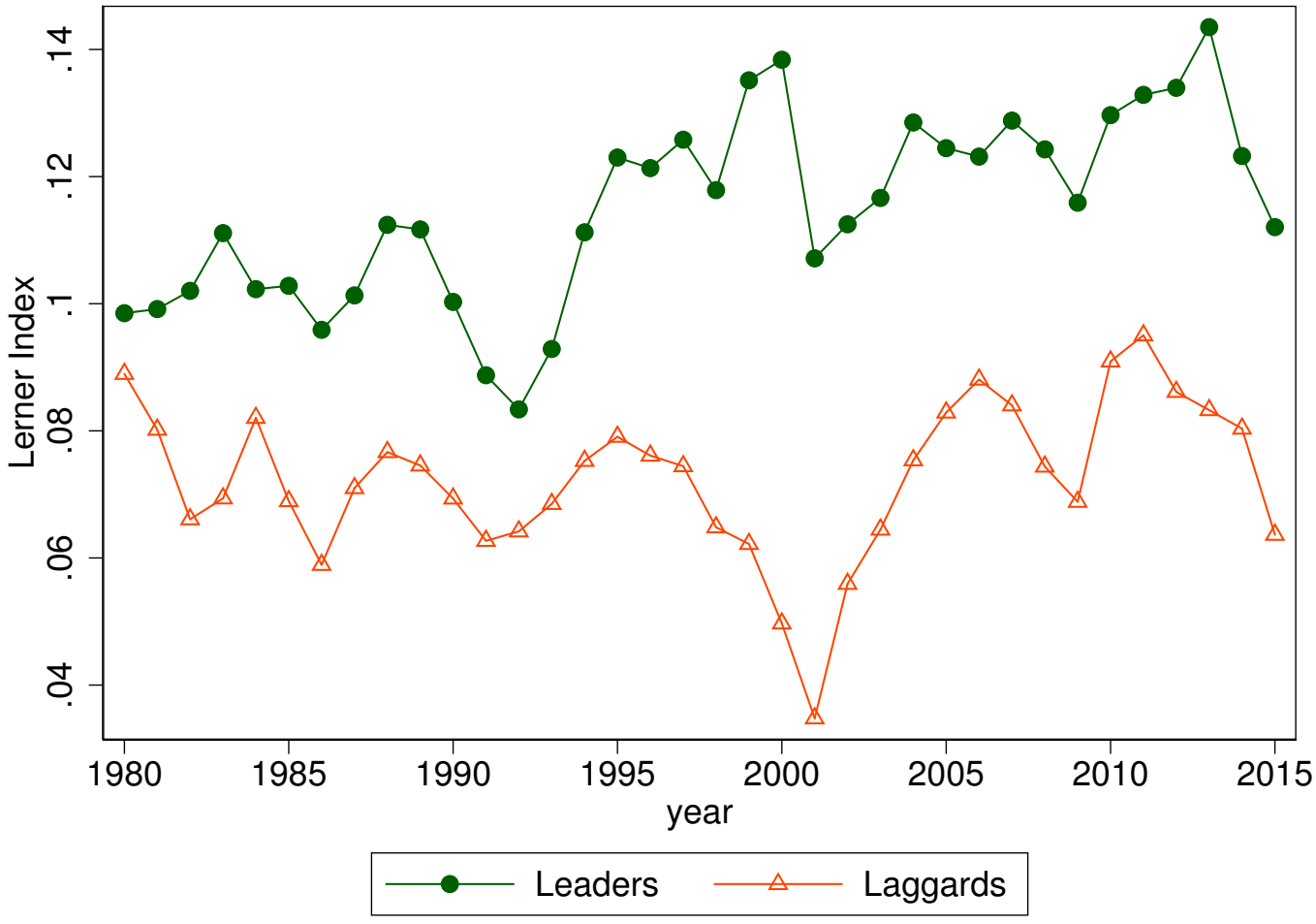
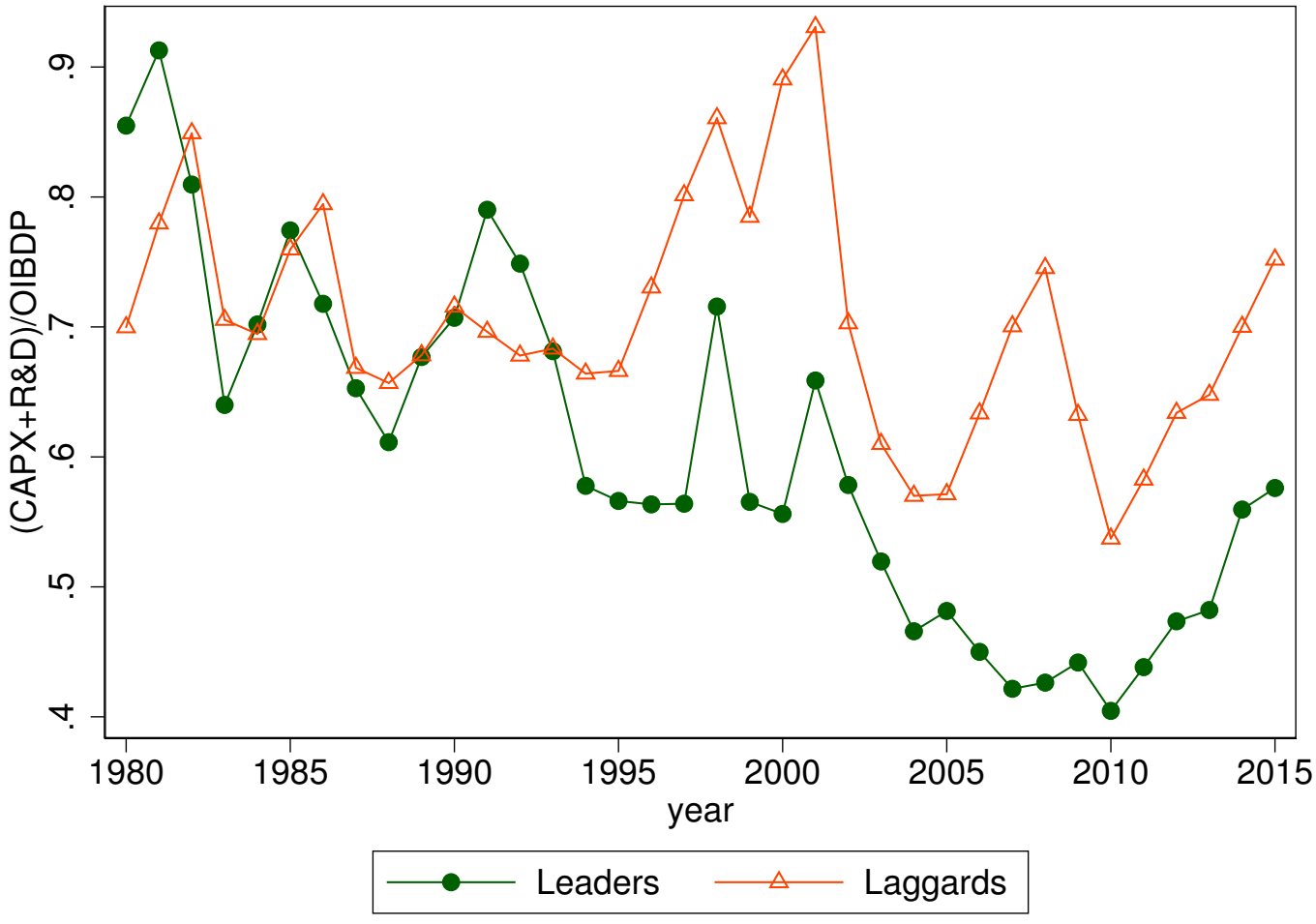
Margins Increased for Industry Leaders



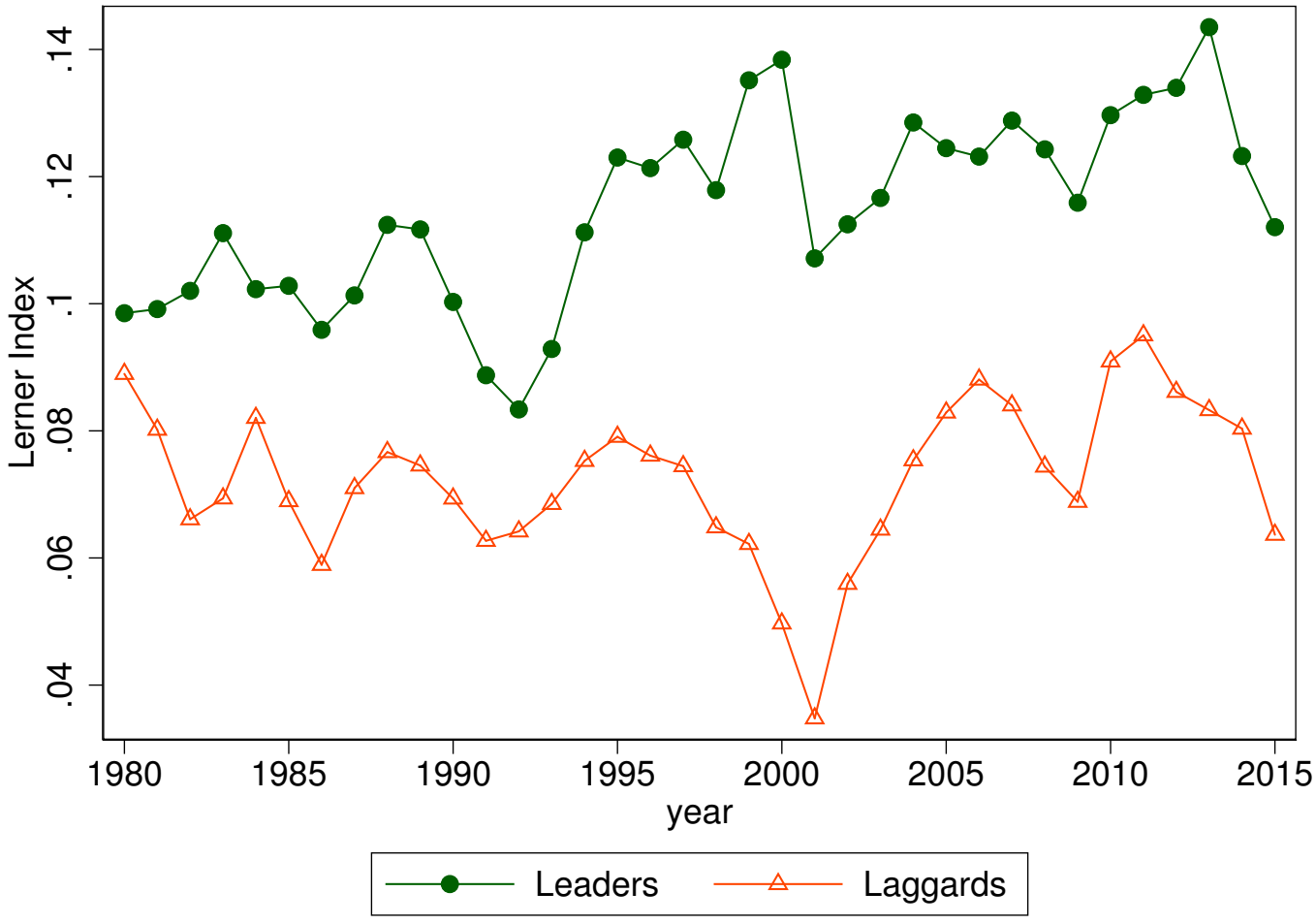
Note: Leaders includes all firms with the highest (lowest) market value (MV) that combined account for ~33% of MV within each industry and year.

Leaders Explain Investment Gap #1



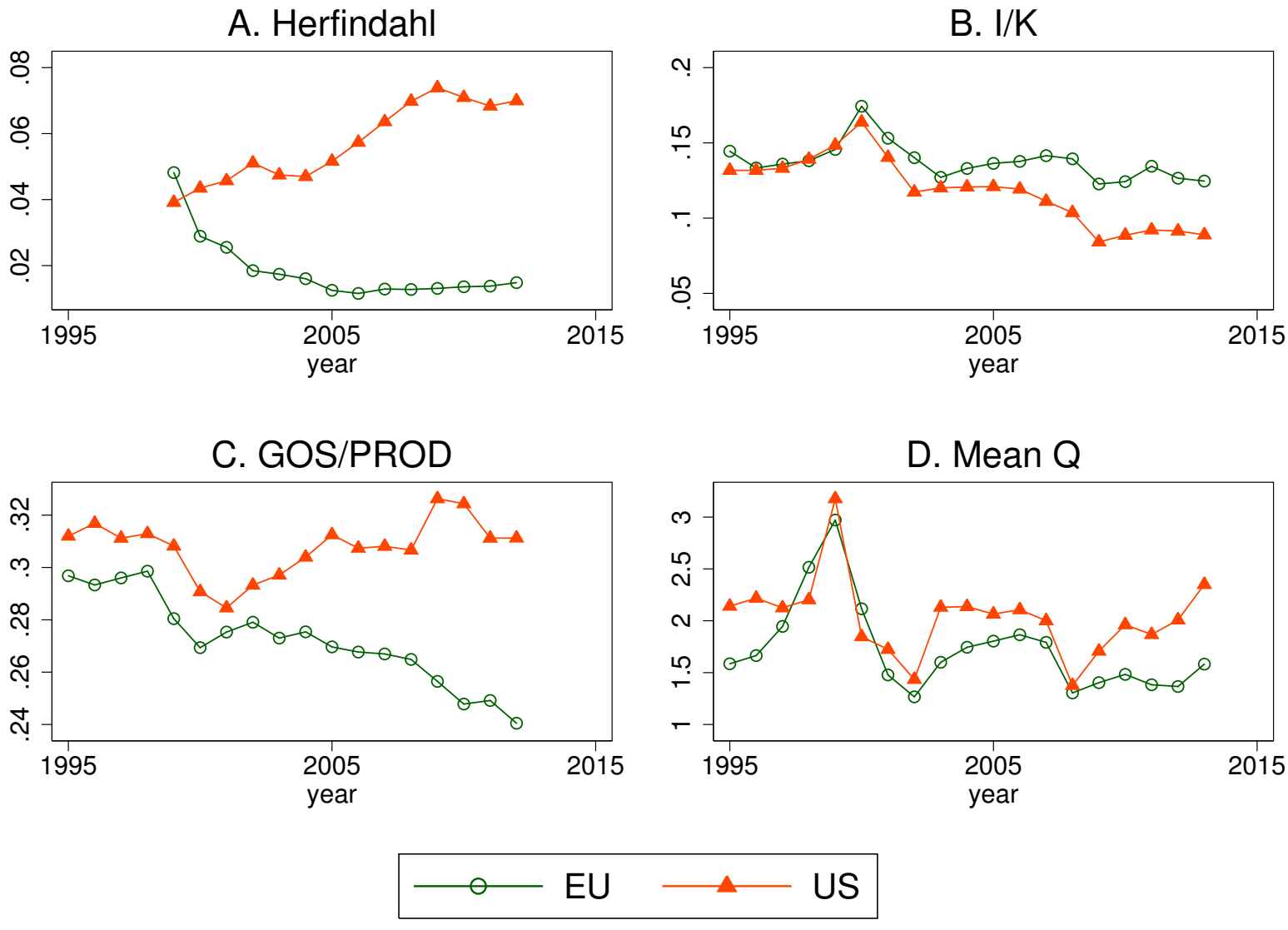
Note: Leaders (laggards) include all firms with the highest (lowest) market value (MV) that combined account for ~33% of MV within each industry and year.

Margins Increased for Industry Leaders

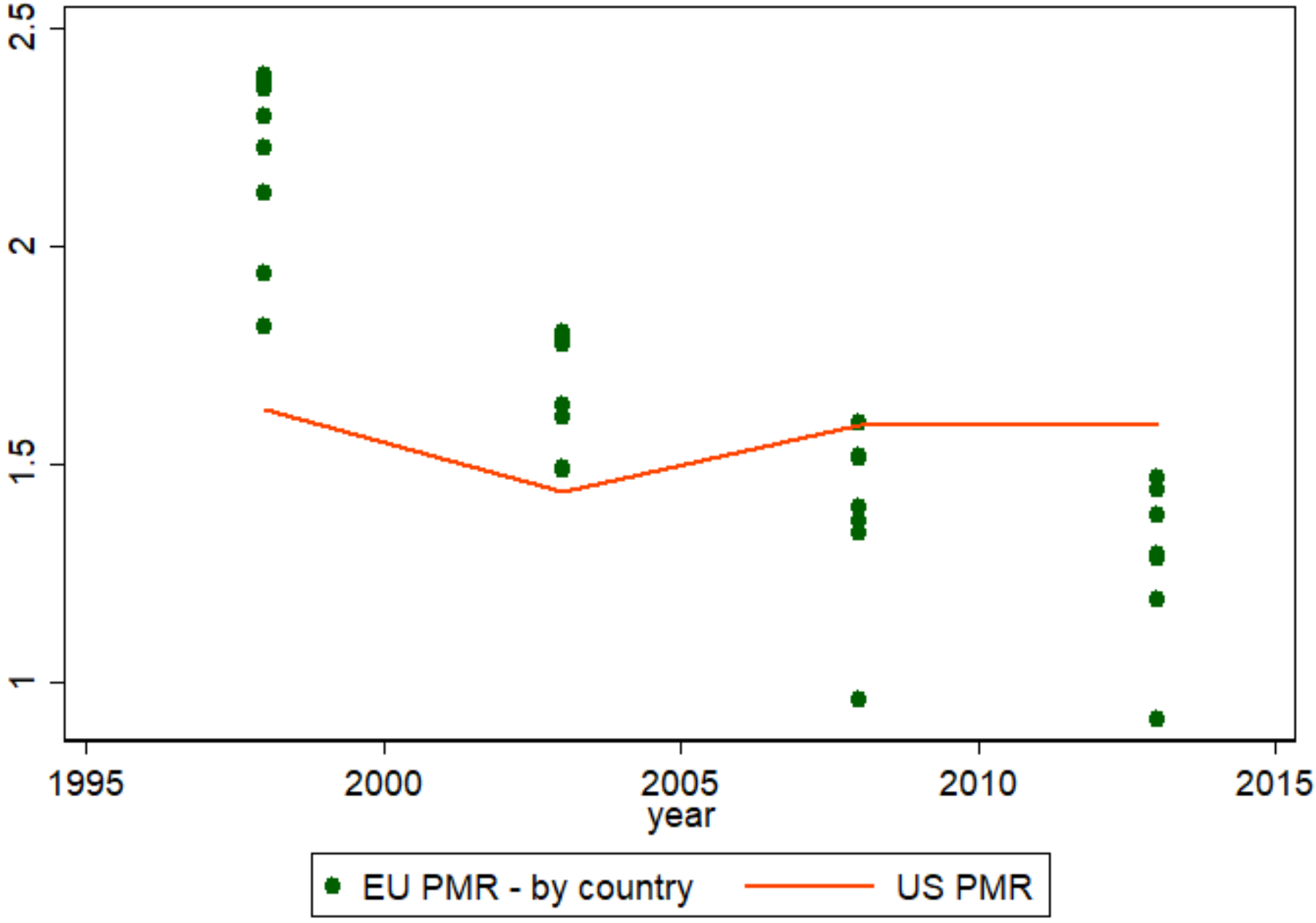


Note: Leaders includes all firms with the highest (lowest) market value (MV) that combined account for ~33% of MV within each industry and year.

EU vs US


A. Herfindahl
.02
.04
.06
.08
1995
2005
2015
year
B. I/K
.05
.1
.15
.2
1995
2005
2015
year
C. GOS/PROD
.24
.26
.28
.3
.32
1995
2005
2015
year
D. Mean Q
1
1.5
2
2.5
3
1995
2005
2015
year
EU
US

EU vs US: OECD Product Market Regulations



A Calvo-Style Entry Specification

- Staggered entry. Pay κ today, each period there is a chance λ of entry each period

Other Parameters

δ	0.025
ϕ^k	20
β	0.99
α	$1/3$
δ^n	$0.09/4$

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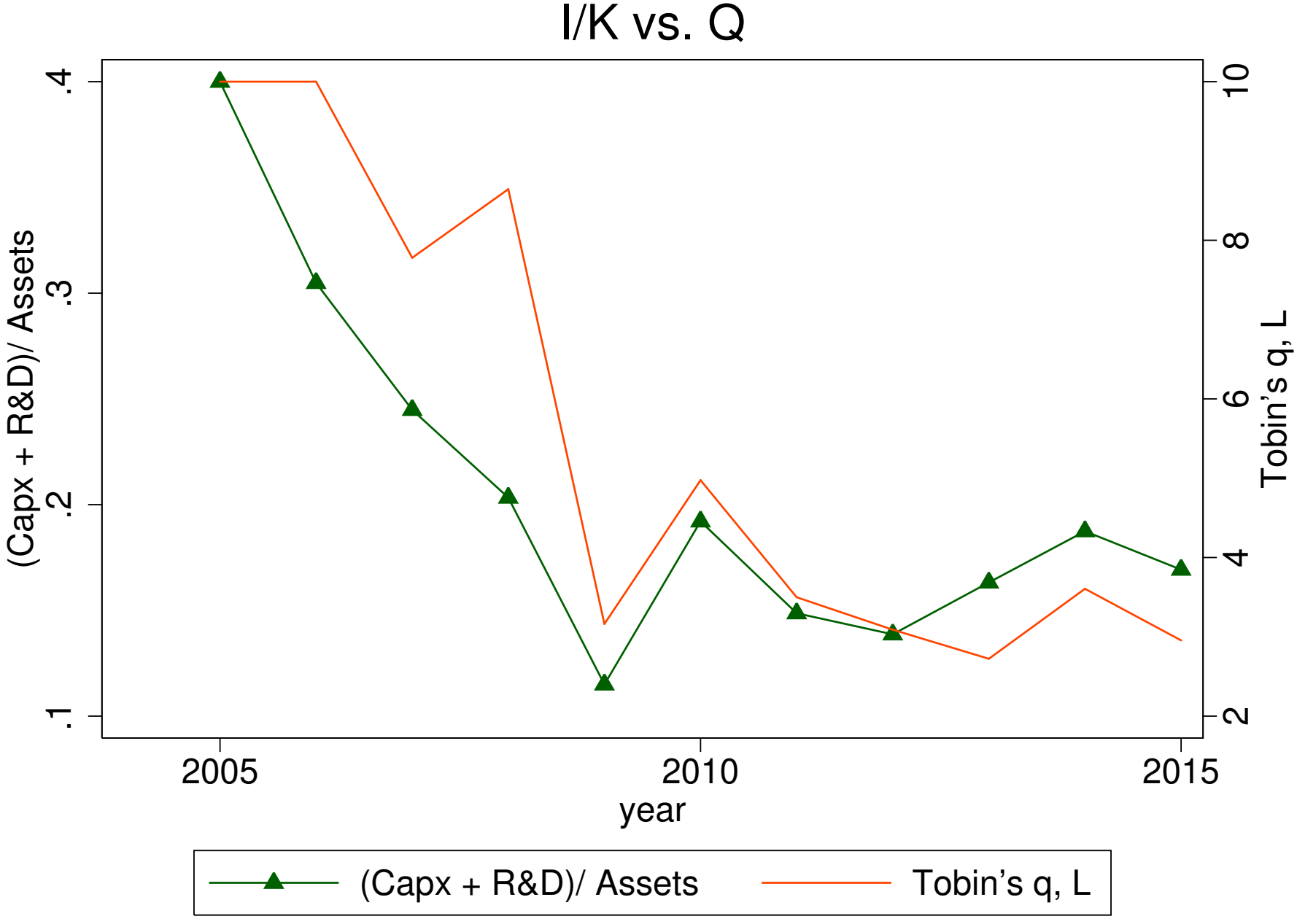
Google


I/K vs. Q
(Capx + R&D)/ Assets
.1
.2
.3
.4
Tobin's q, L
2
4
6
8
10
2005
2010
2015
year
(Capx + R&D)/ Assets
Tobin's q, L