Skewed Business Cycles

Sergio Salgado, Fatih Guvenen, Nicholas Bloom

Cambridge Macro Seminar

April 25, 2023

Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Mean wage income change for US male workers: **−6.5%**

Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Median wage income change for US male workers: **+0.1%**

Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Median wage income change for US male workers: **+0.1%**
  - Q: How can the mean fall so much when the median barely moves?

Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Median wage income change for US male workers: **+0.1%**
  - Q: How can the mean fall so much when the median barely moves?
    - A: The wage distribution became much more left-skewed

Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Median wage income change for US male workers: **+0.1%**
  - Q: How can the mean fall so much when the median barely moves?
    - A: The wage distribution became much more left-skewed
  - Observation #1: Changing 3rd moment can change 1st moment directly (unlike changing 2nd moment).

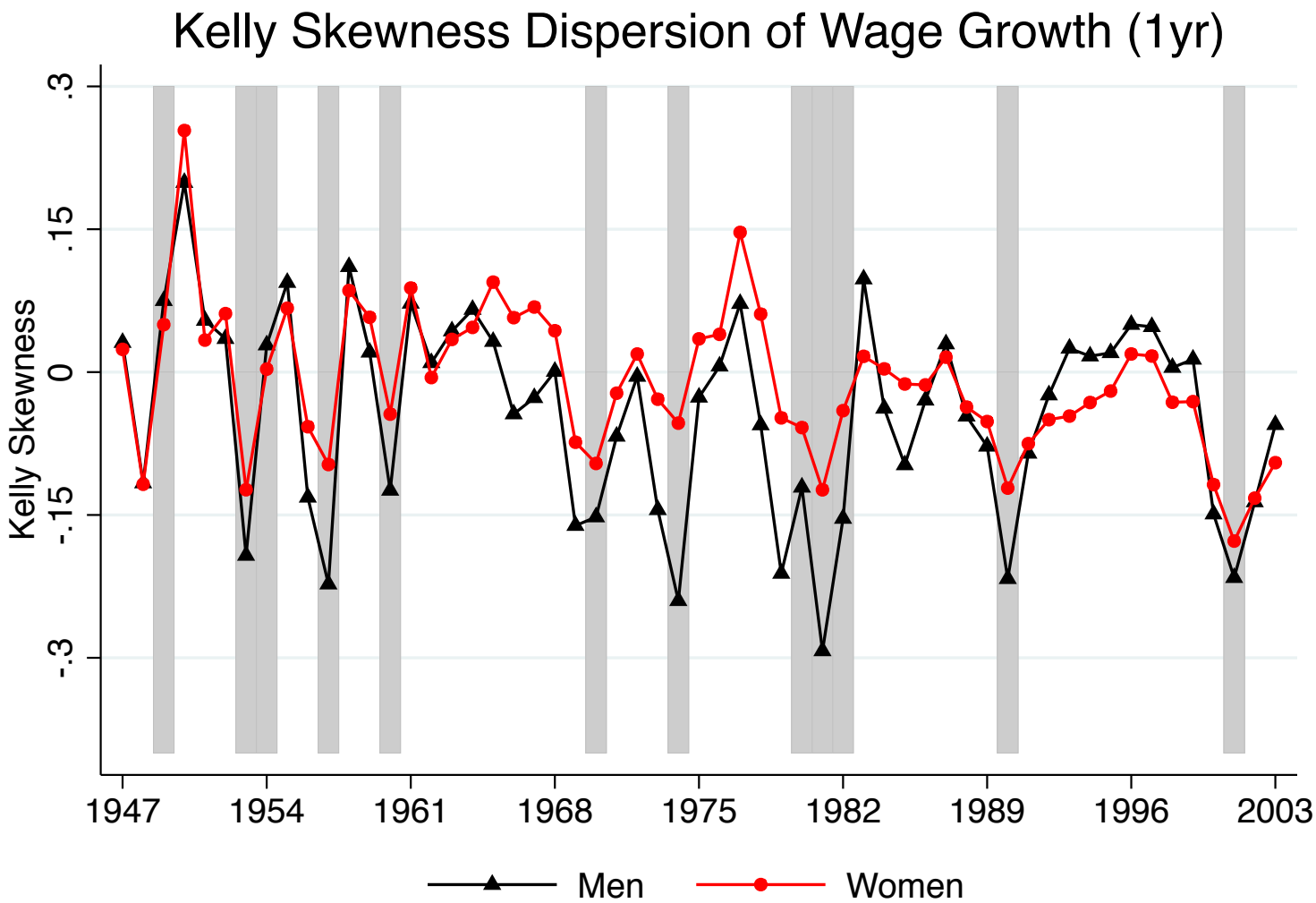
Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Median wage income change for US male workers: **+0.1%**
  - Q: How can the mean fall so much when the median barely moves?
    - A: The wage distribution became much more left-skewed
  - Observation #1: Changing 3rd moment can change 1st moment directly (unlike changing 2nd moment).
- Further: One-in-ten workers saw
  - 50+% rise in wage income
  - 60+% fall in wage income

Business Cycles: From Aggregates to Distributions

- During the Great Recession (2007–09):
  - Median wage income change for US male workers: **+0.1%**
  - Q: How can the mean fall so much when the median barely moves?
    - A: The wage distribution became much more left-skewed
  - Observation #1: Changing 3rd moment can change 1st moment directly (unlike changing 2nd moment).
- Further: One-in-ten workers saw
  - 50+% rise in wage income
  - 60+% fall in wage income
  - Observation #2: When distributions have large variance and long tails, focusing on changes in aggregates without considering tails is risky.

Paper inspired by income dynamics literature, which shows skewness of income growth is procyclical



Source: Guvenen, Ozkan, Song (JPE, 2014)

Can Skewness Shocks — "Risk Shocks" — Drive Recessions?

- Long literature on causes of business cycles: TFP shocks, monetary or financial shocks, uncertainty shocks, etc.
- Another possibility is firm-level left-skewed risk: micro risk increases in recessions

Can Skewness Shocks — "Risk Shocks" — Drive Recessions?

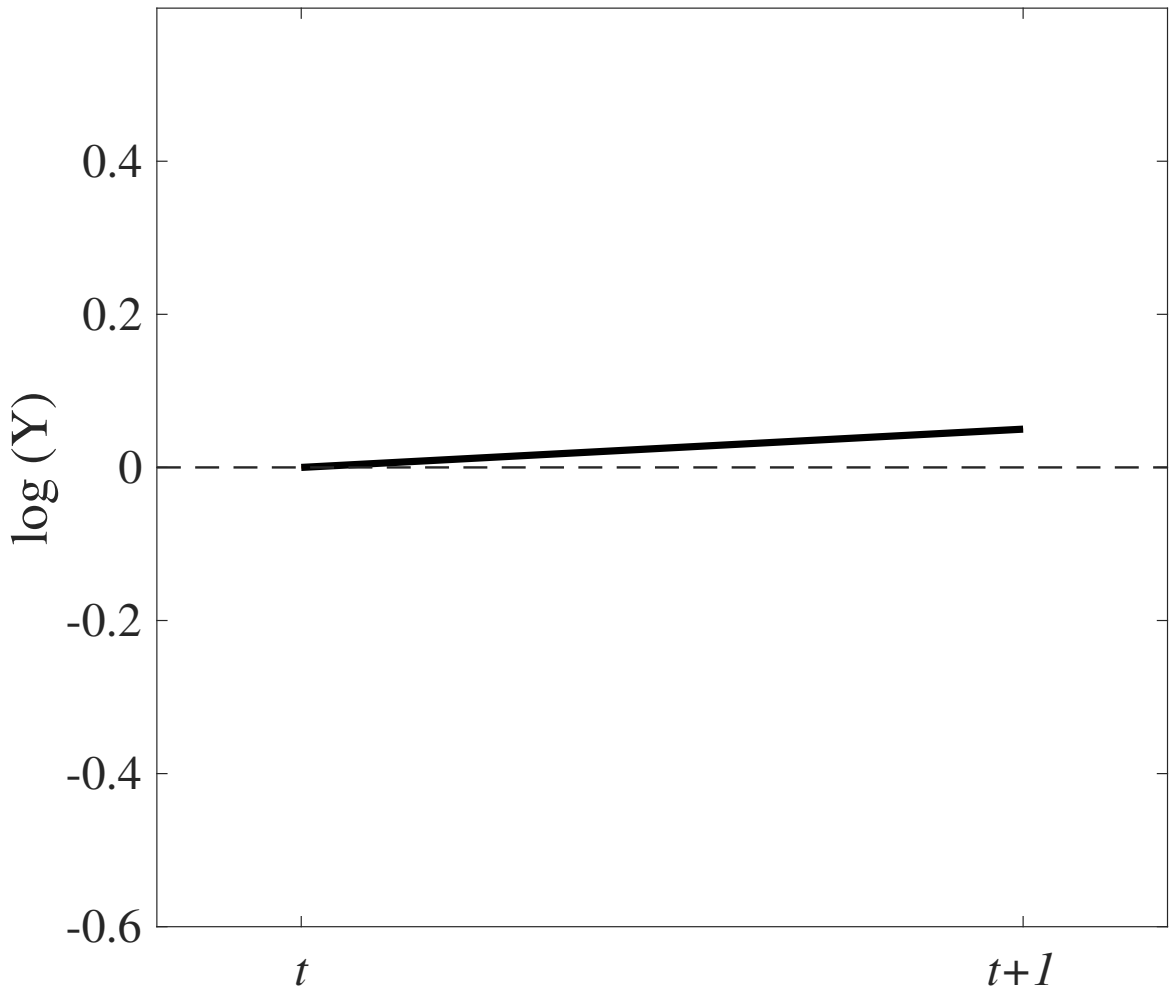
- Long literature on causes of business cycles: TFP shocks, monetary or financial shocks, uncertainty shocks, etc.
- Another possibility is firm-level left-skewed risk: micro risk increases in recessions

This paper takes two steps:

- We provide wealth of data showing firm-level skewness is (robustly) procyclical
- True not only for firm outcomes but also for TFP shocks to the firm.
- We calibrate micro-to-macro model showing this could drive recessions.

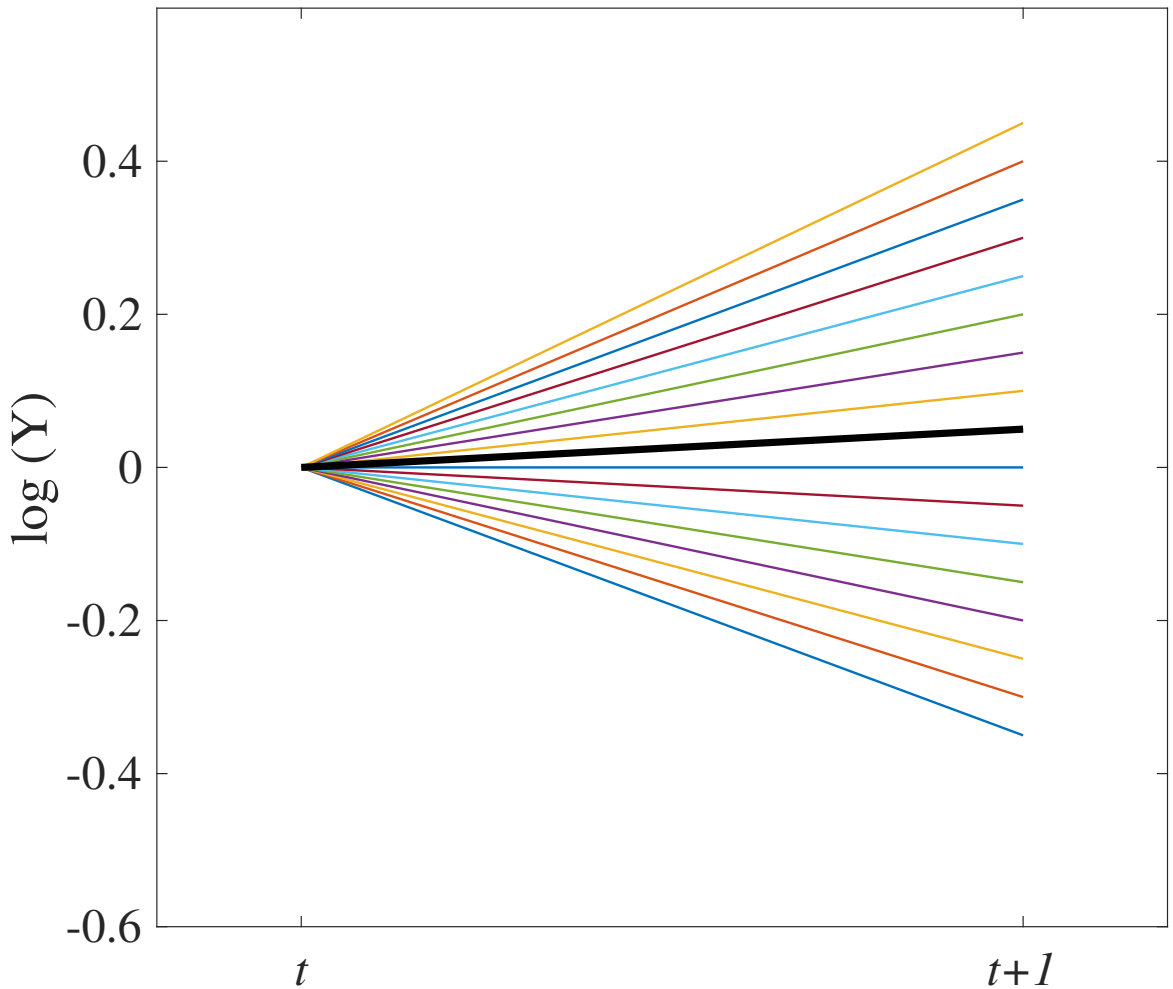
Skewness

Figure 1: Positive Median Growth Rate (e.g., Expansion)



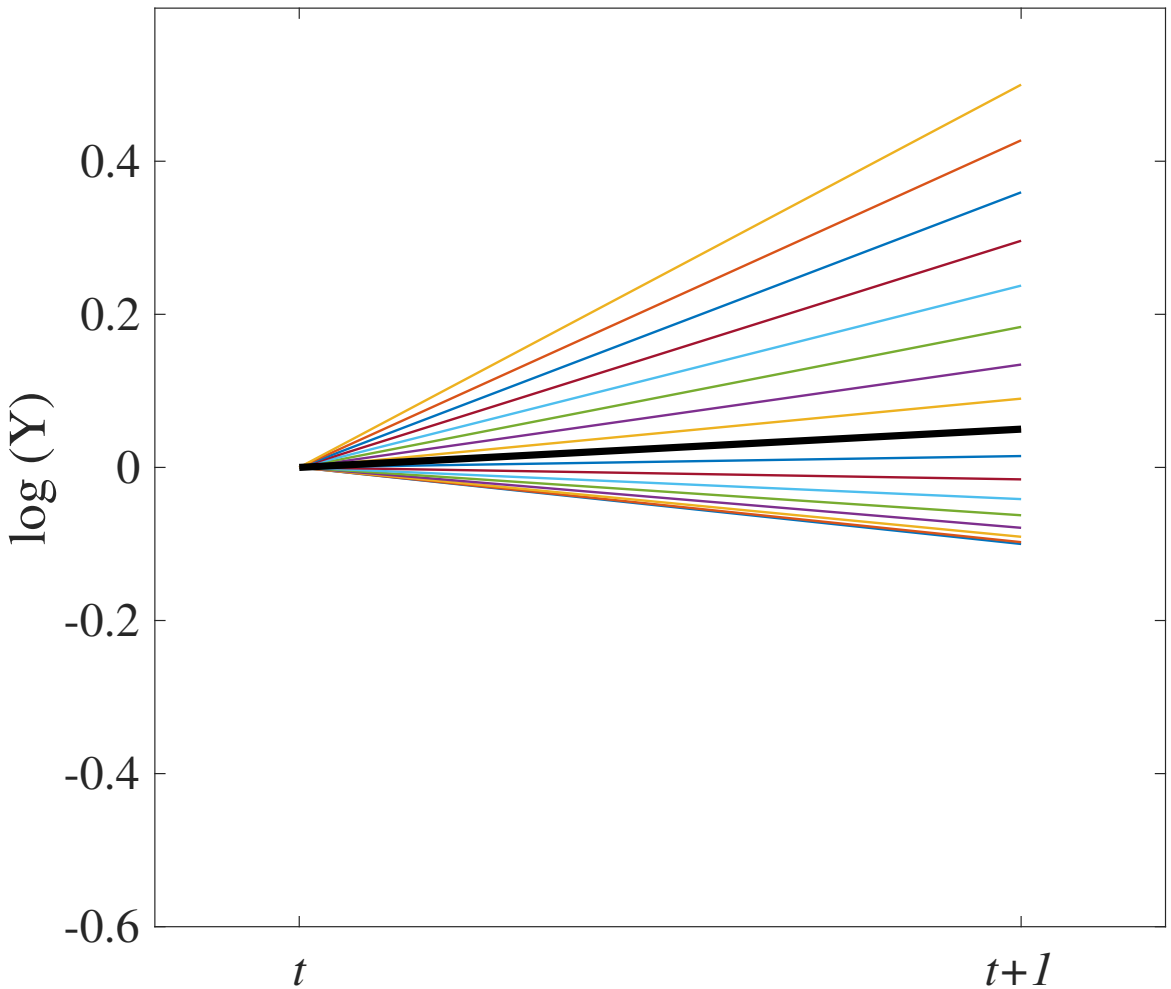
Skewness

Figure 1: Symmetric Growth Distribution: Zero Skewness



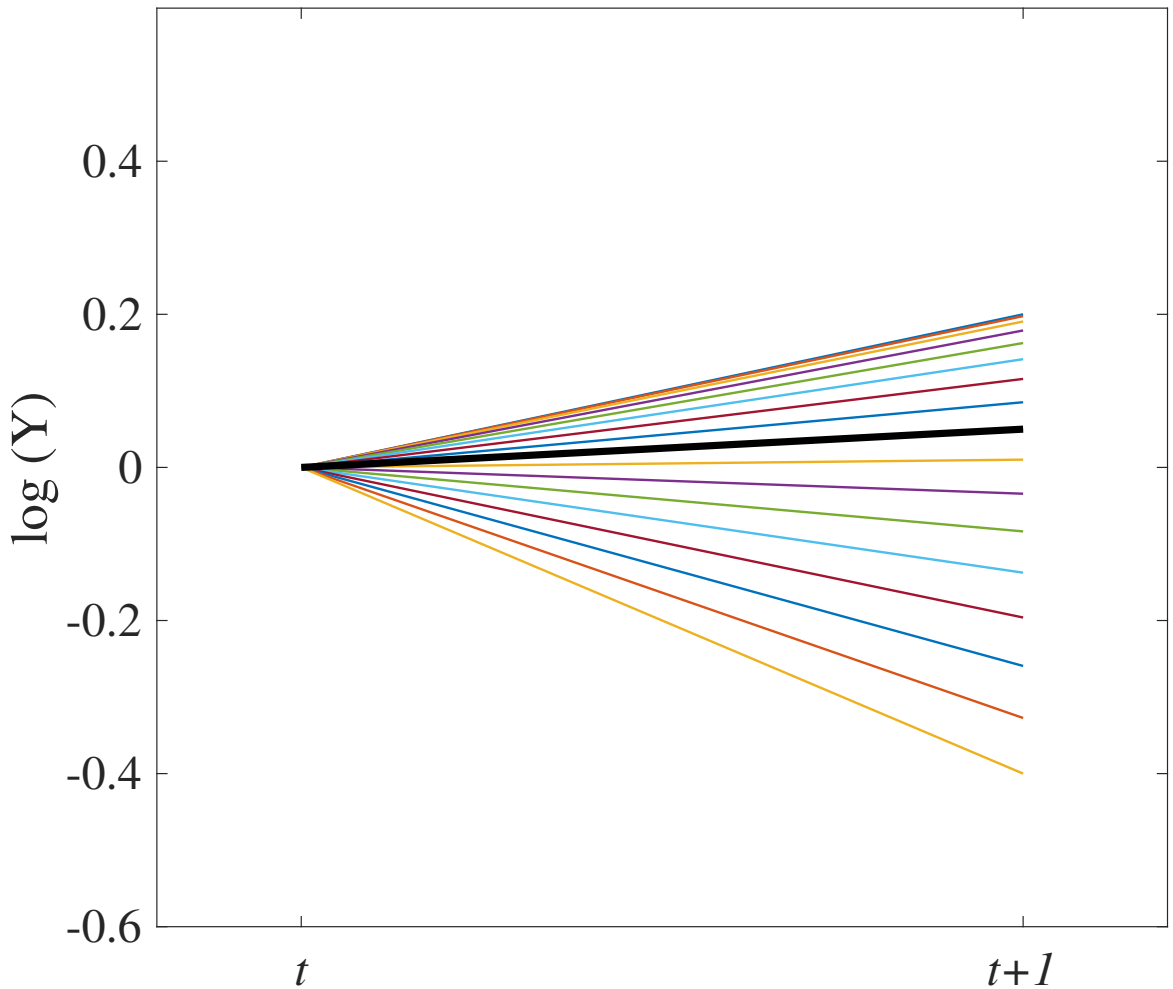
Skewness

Figure 1: Right-Skewed: Right Tail Longer than Left

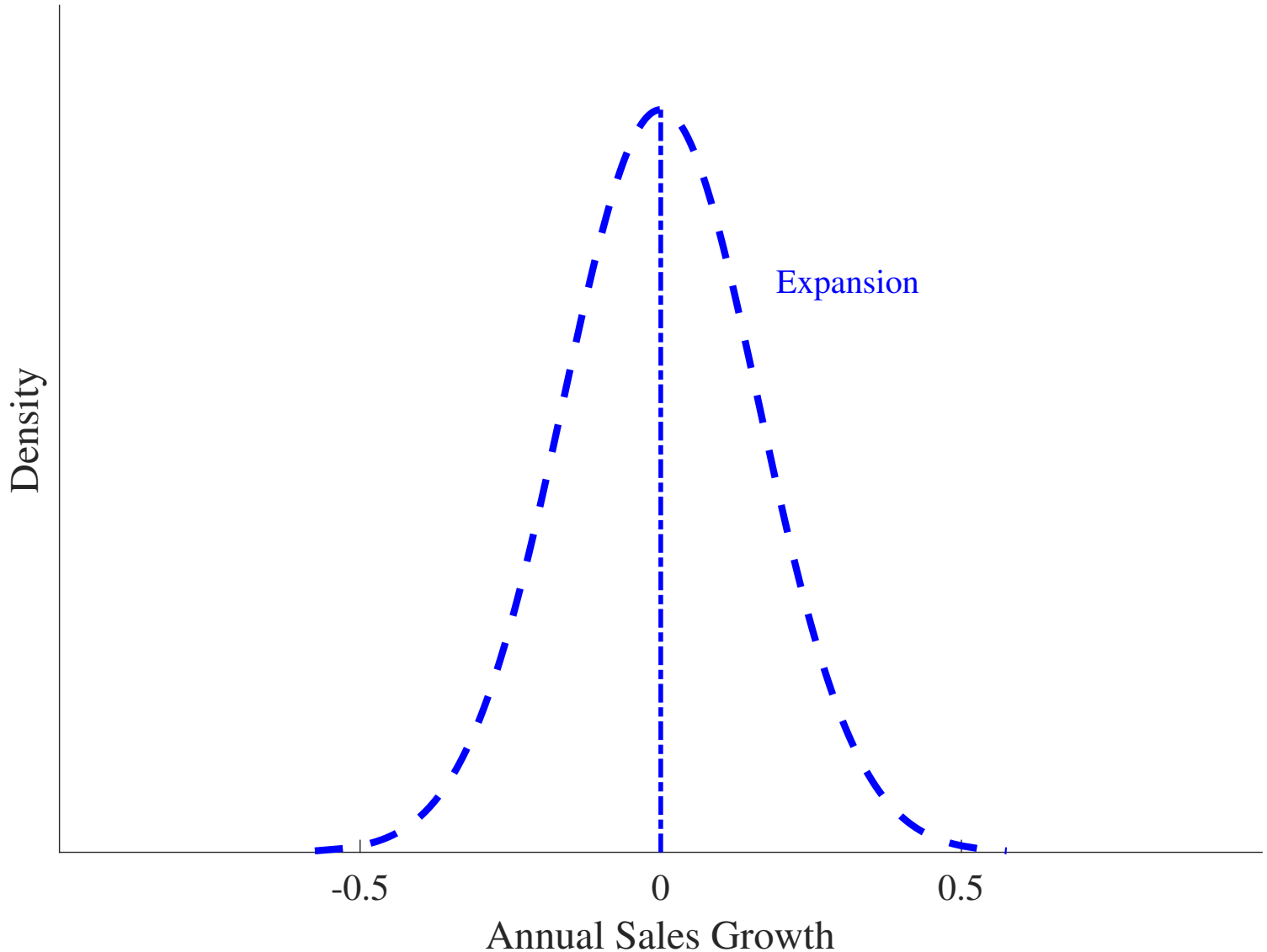


Skewness

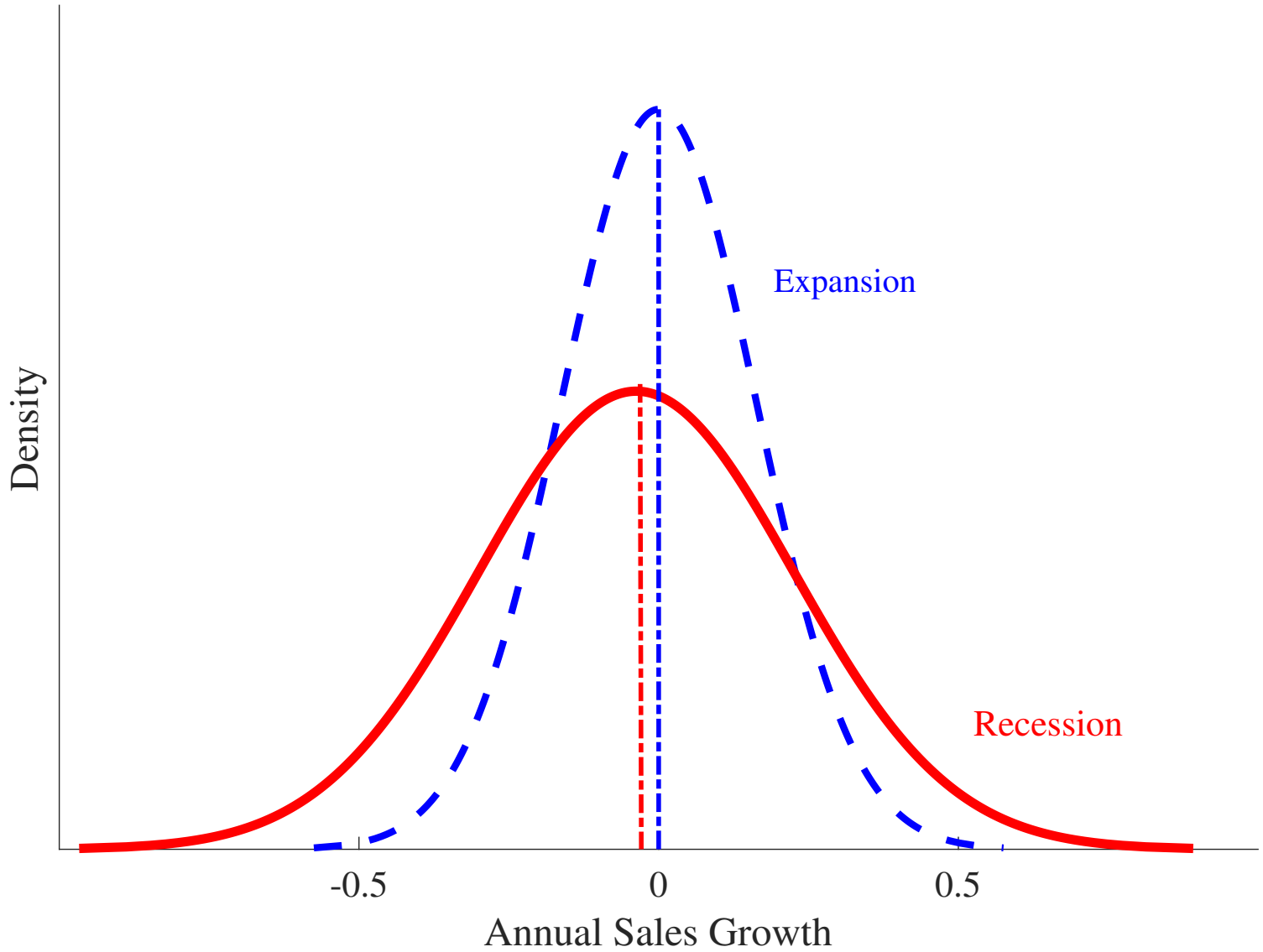
Figure 1: Left-Skewed: Left Tail Longer than Right



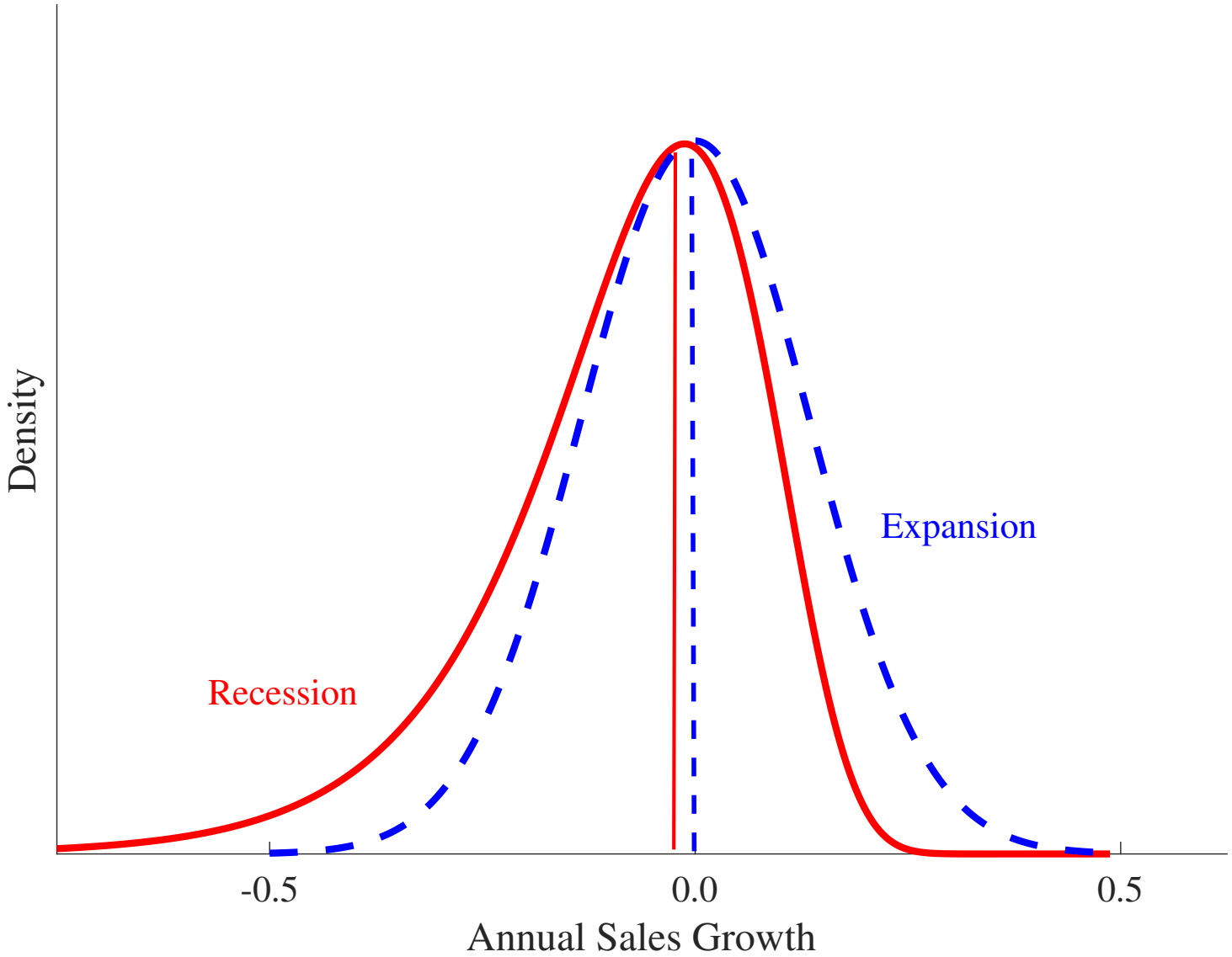
Two Perspectives on Distributions over the Business Cycle



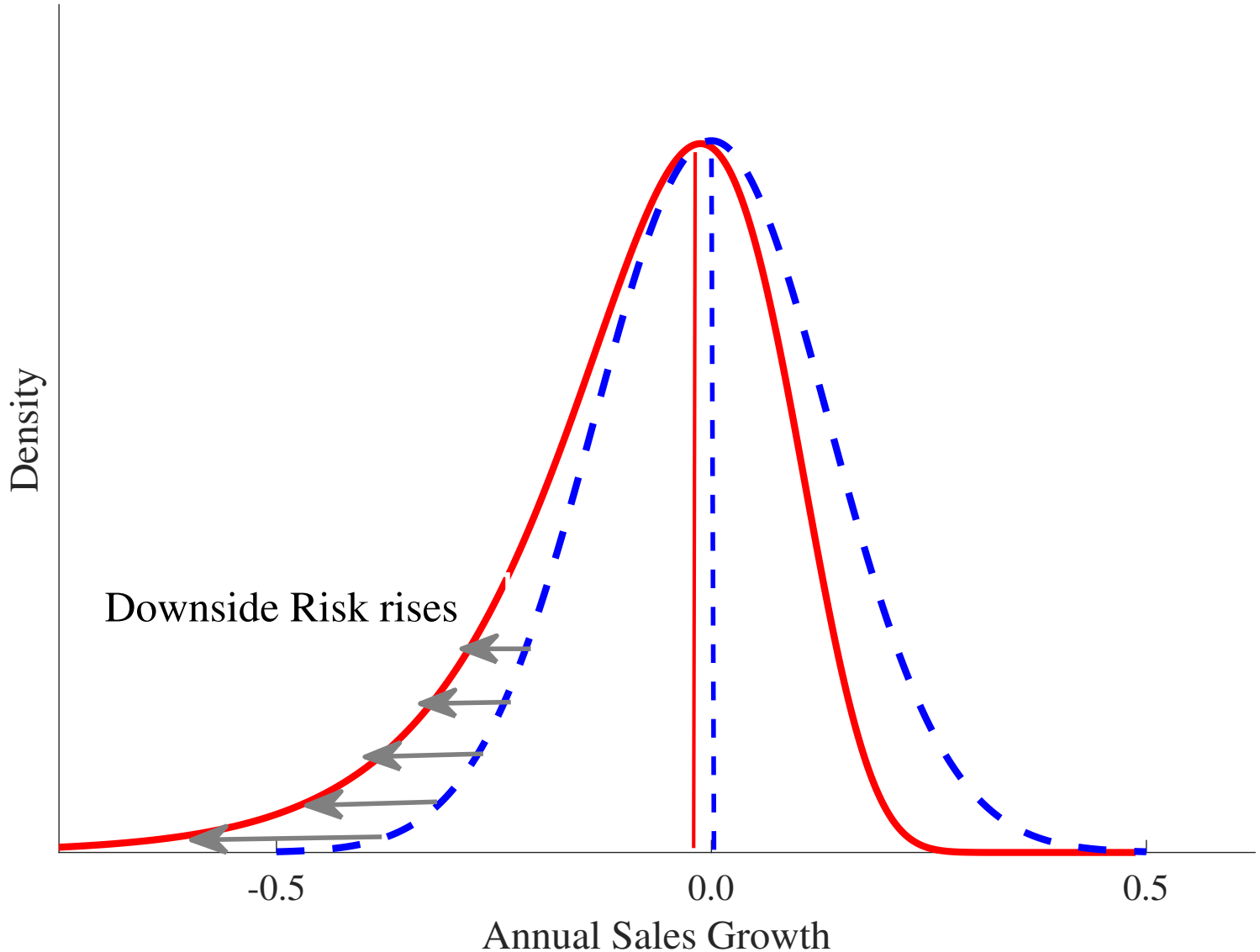
Perspective 1: Countercyclical Variance



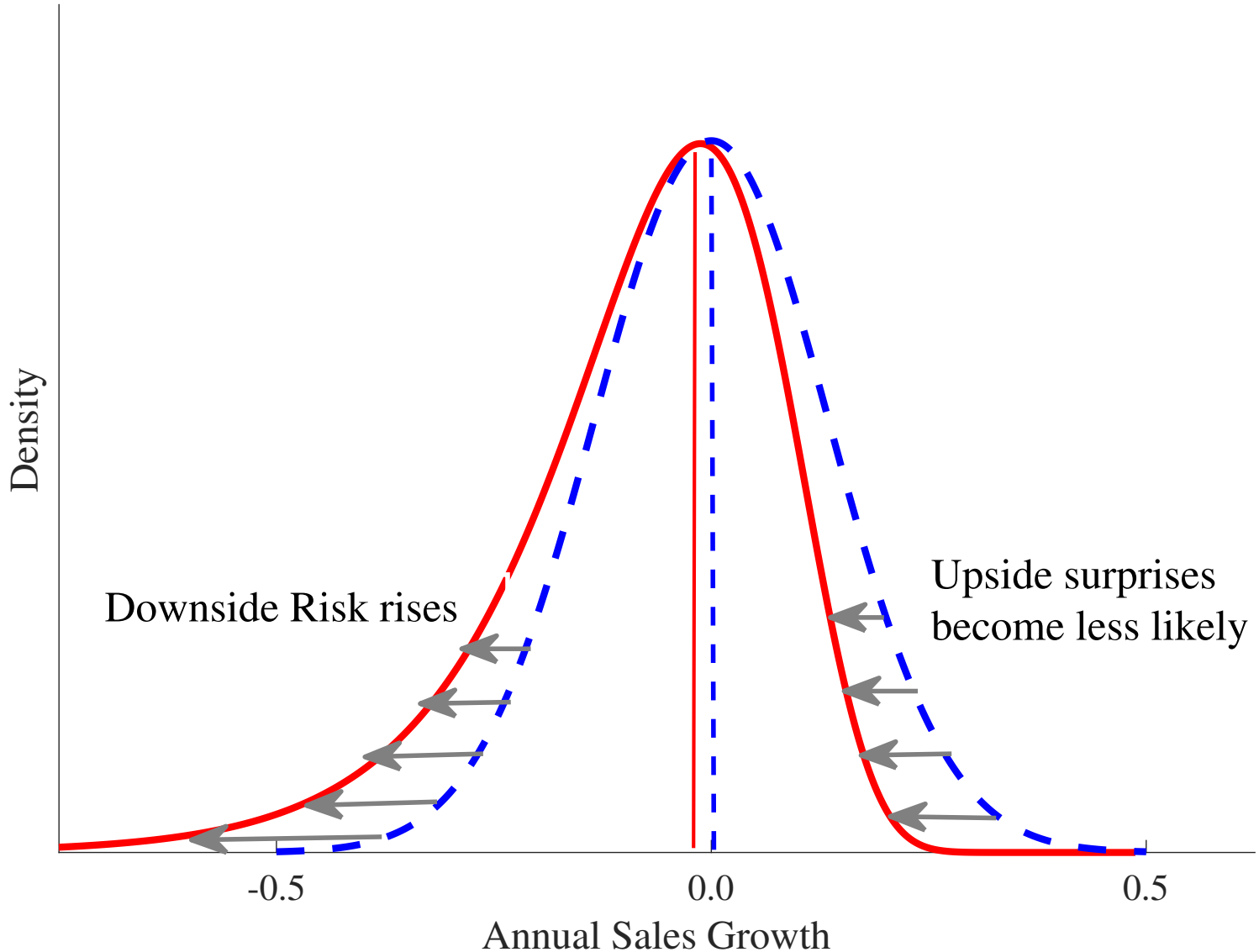
Perspective 2: Procyclical Skewness



Perspective 2: *Downside Risk Rises in Recessions*



Perspective 2: … *And Upside "Surprises" Become Less Likely*



This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

Results: New Business Cycles Fact

- In recessions downside risk rises, upside surprises become less likely

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

Results: New Business Cycles Fact

- In recessions downside risk rises, upside surprises become less likely →

  Skewness of firms' growth is strongly procyclical

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

Results: New Business Cycles Fact

- In recessions downside risk rises, upside surprises become less likely $\rightarrow$

  Skewness of firms' growth is strongly procyclical $\rightarrow$ asymmetric risk

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

Results: New Business Cycles Fact

- In recessions downside risk rises, upside surprises become less likely $\rightarrow$

  Skewness of firms' growth is strongly procyclical $\rightarrow$ asymmetric risk
- Robust feature of business cycles
  Across countries, industries, and firm characteristics (size, age, etc.)

This Paper: Empirics

Empirical Analysis

- Study the distribution of firm growth rates and productivity
  Sales growth, employment growth, TFP growth, and stock returns
- United States: Census & non-Census firm-level panel data since '70s
- Cross-country: Firm-level panel data for 47 countries and 20+ years

Results: New Business Cycles Fact

- In recessions downside risk rises, upside surprises become less likely $\rightarrow$

  Skewness of firms' growth is strongly procyclical $\rightarrow$ asymmetric risk
- Robust feature of business cycles
  Across countries, industries, and firm characteristics (size, age, etc.)
- Skewness shock associated with persistent decline in production and employment (VAR evidence for the United States)

This Paper: Model

Quantitative Model

This Paper: Model

Quantitative Model

- Risk averse entrepreneurs
- Asymmetric response of firms to shocks
  Borrowing constrains and adjustment costs to capital
- Idiosyncratic productivity: time-varying variance and skewness

This Paper: Model

Quantitative Model

- Risk averse entrepreneurs
- Asymmetric response of firms to shocks
  Borrowing constrains and adjustment costs to capital
- Idiosyncratic productivity: time-varying variance and skewness

What is the Macro Impact of a Skewness Shock?

Drop in the skewness of firm-level productivity shocks

- Significant and persistent decline in economic activity
- Skewness shock (mean and variance constant) $\rightarrow$ 1.7% decline in Output
- Decline in Consumption (1.0%), Investment (15%), Hours (1.5%)
- A combined variance+skewness shock generates $\rightarrow$ 2.0% decline in Output

Road Map

- Empirical Results
- Robustness
- Skewness During COVID-19
- VAR Results
- Model and Quantitative Results

Road Map

- Empirical Results
- Robustness
- Skewness During COVID-19
- VAR Results
- Model and Quantitative Results

Data Sources

United States:

- Census LBD: Annual employment, age, and industry
  Panel of entire nonfarm private sector firms for 1976-2019
- Census LBD-R: Annual revenues
  Panel of entire nonfarm private sector firms for 1998-2018
- Census ASM/CMF: Annual employment, sales, and productivity
  Panel of manufacturing establishments for 1977-2019
- Compustat/CRSP: Quarterly and annual sales, employment, and stock prices
  Panel of publicly traded firms for 1970-2020

Data Sources

United States:

- Census LBD: Annual employment, age, and industry
  Panel of entire nonfarm private sector firms for 1976-2019
- Census LBD-R: Annual revenues
  Panel of entire nonfarm private sector firms for 1998-2018
- Census ASM/CMF: Annual employment, sales, and productivity
  Panel of manufacturing establishments for 1977-2019
- Compustat/CRSP: Quarterly and annual sales, employment, and stock prices
  Panel of publicly traded firms for 1970-2020

Cross-Country

- BvD Osiris: Annual sales and employment
  Panel of publicly traded firms in 40 countries for 1989-2018
- Global Compustat: Stock prices
  Panel of publicly traded firms in 28 countries for 1970-2019
- BvD Amadeus: Annual sales, employment, and productivity
  Panel of private and publicly traded firms in 17 countries for 1989-2018

Consistent Sample Selection

United States: Compustat

- Firms incorporated in the United States
- Firms with 10+ years of data

United States: Census, LBD, and LBRD+R

- Firms with 1+ employee
- ASM: Manufacturing establishments with 10+ years

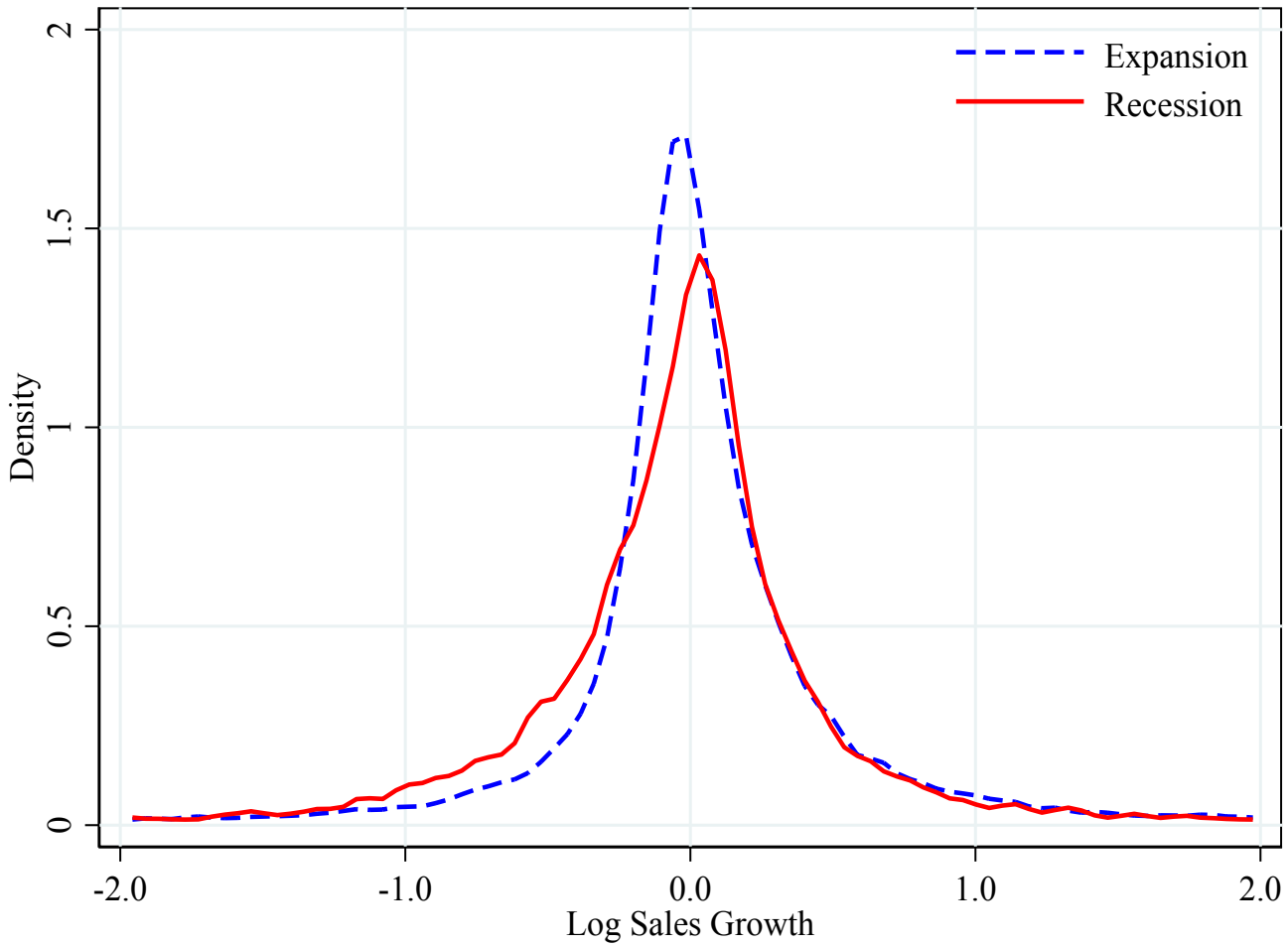
Cross-Country: BvD Amadeus and BvD Osiris

- Firms with 10+ years of data
- Country/years with 100+ firms
- Countries with 10+ years of data

Empirical Results

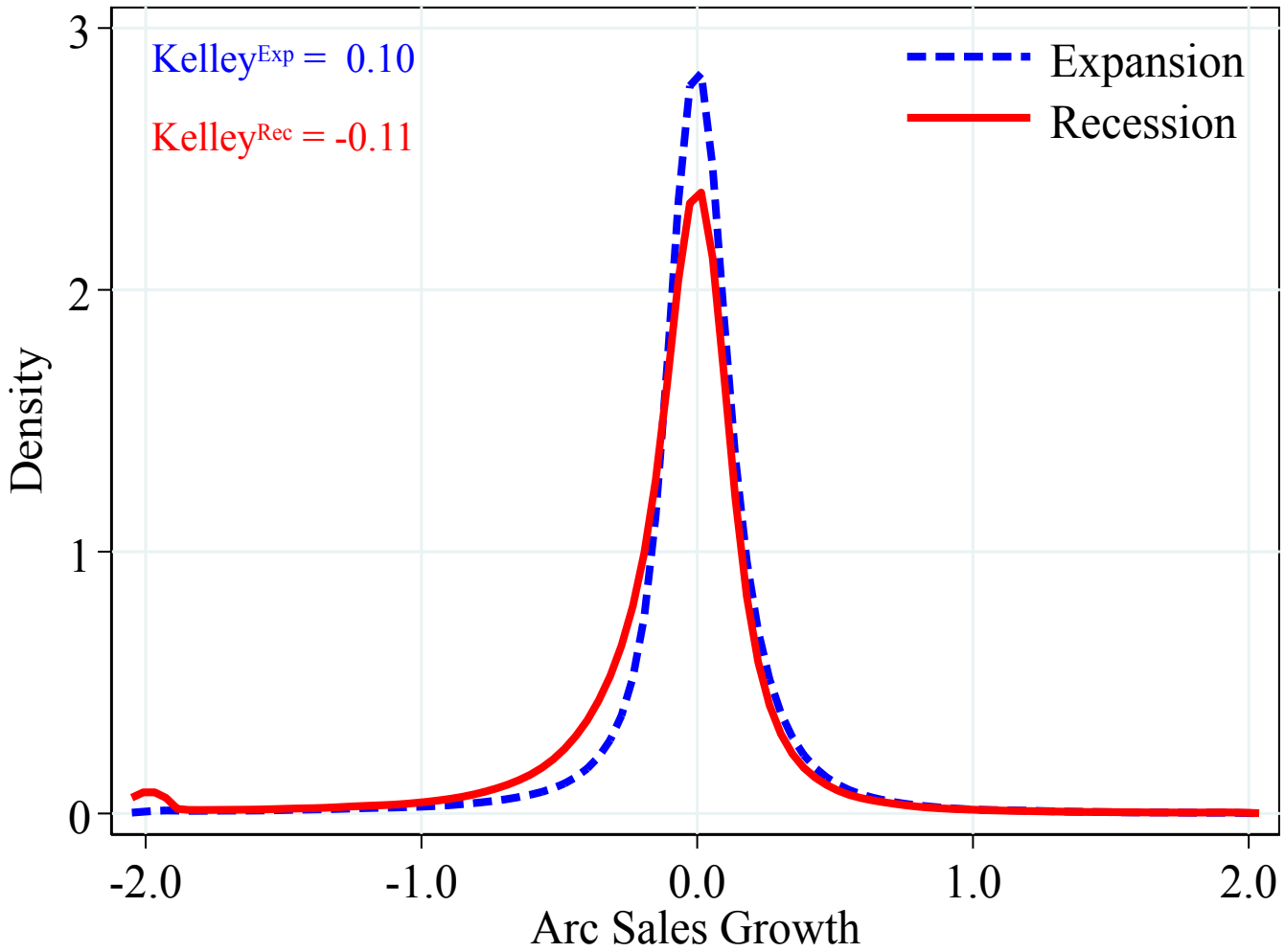
Sales Growth Becomes Left-Skewed During Recessions

Figure 2: Compustat: Sales Growth



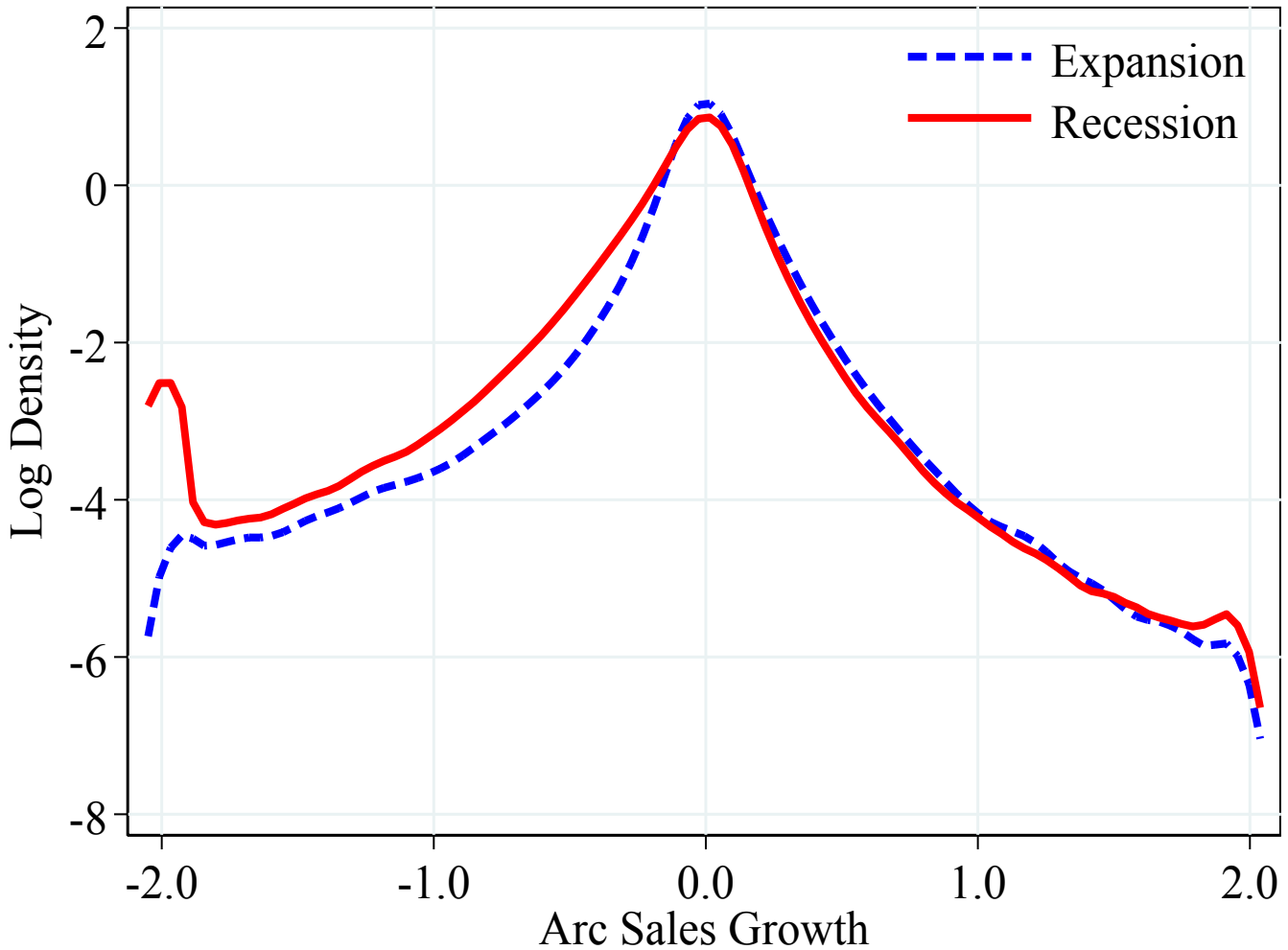
Sales Growth Becomes Left-Skewed During Recessions

Figure 3: LBD+R: Sales Growth



Sales Growth in Log Scale—easier to see tails

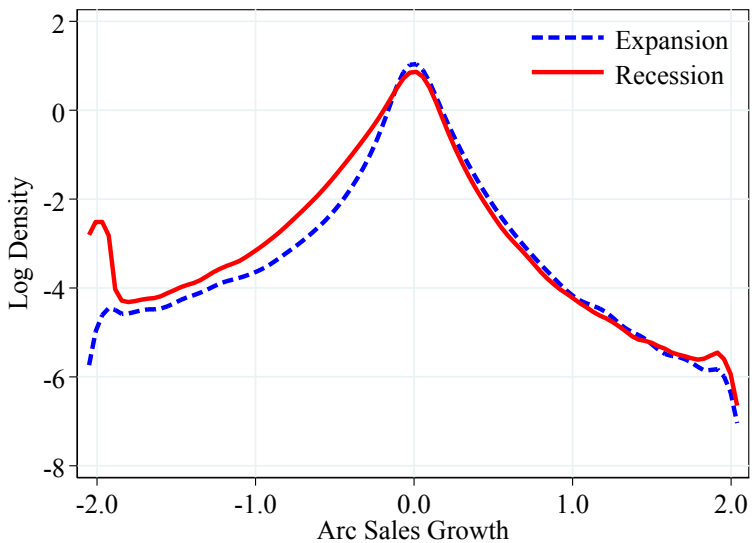
Figure 4: LBD+R: Sales Growth



Sales & Employment Growth in Log Scale

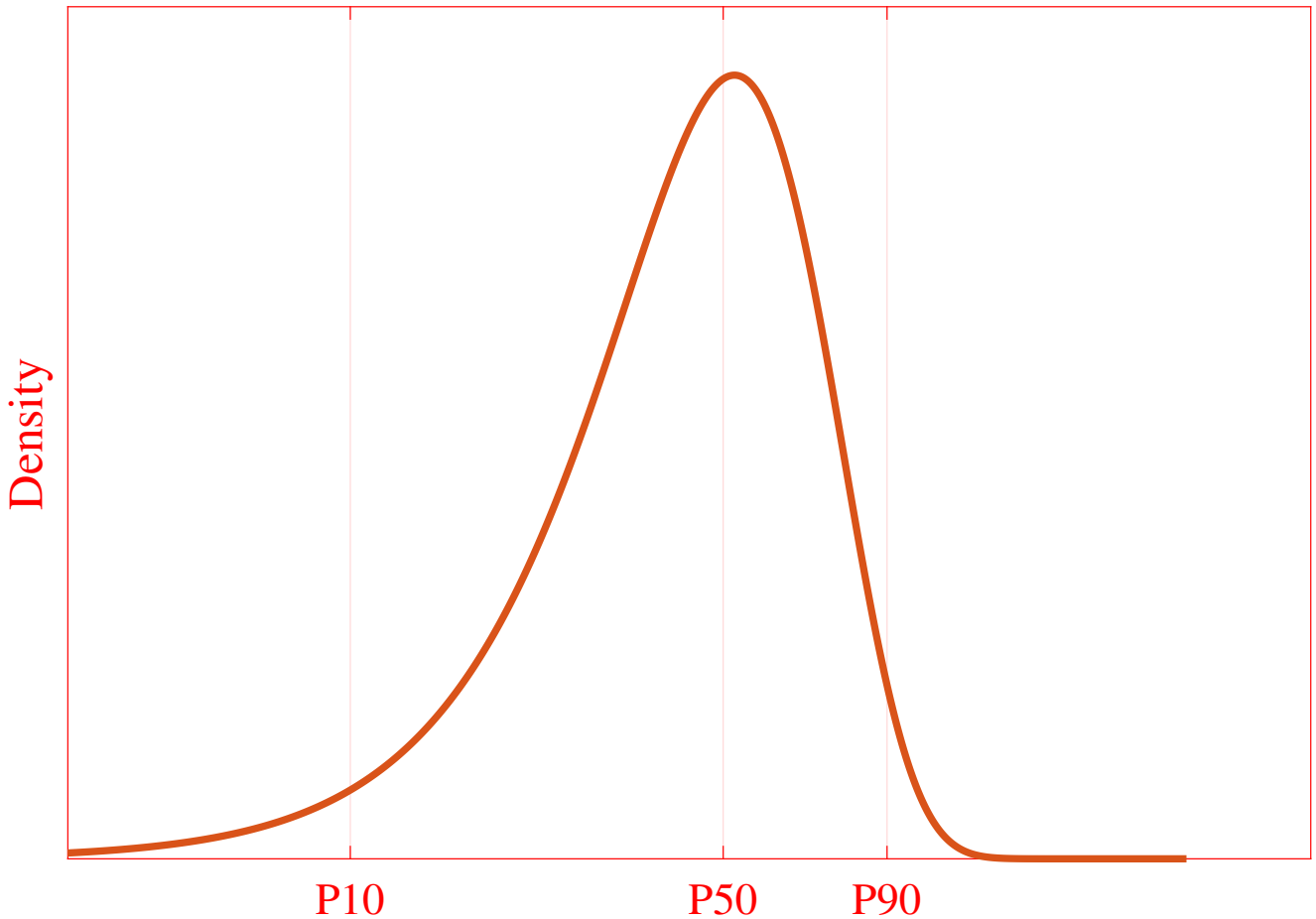
Figure 5: The Skewness of Firm Outcomes Is Lower During Recessions

(a) LBD+R: Sales Growth

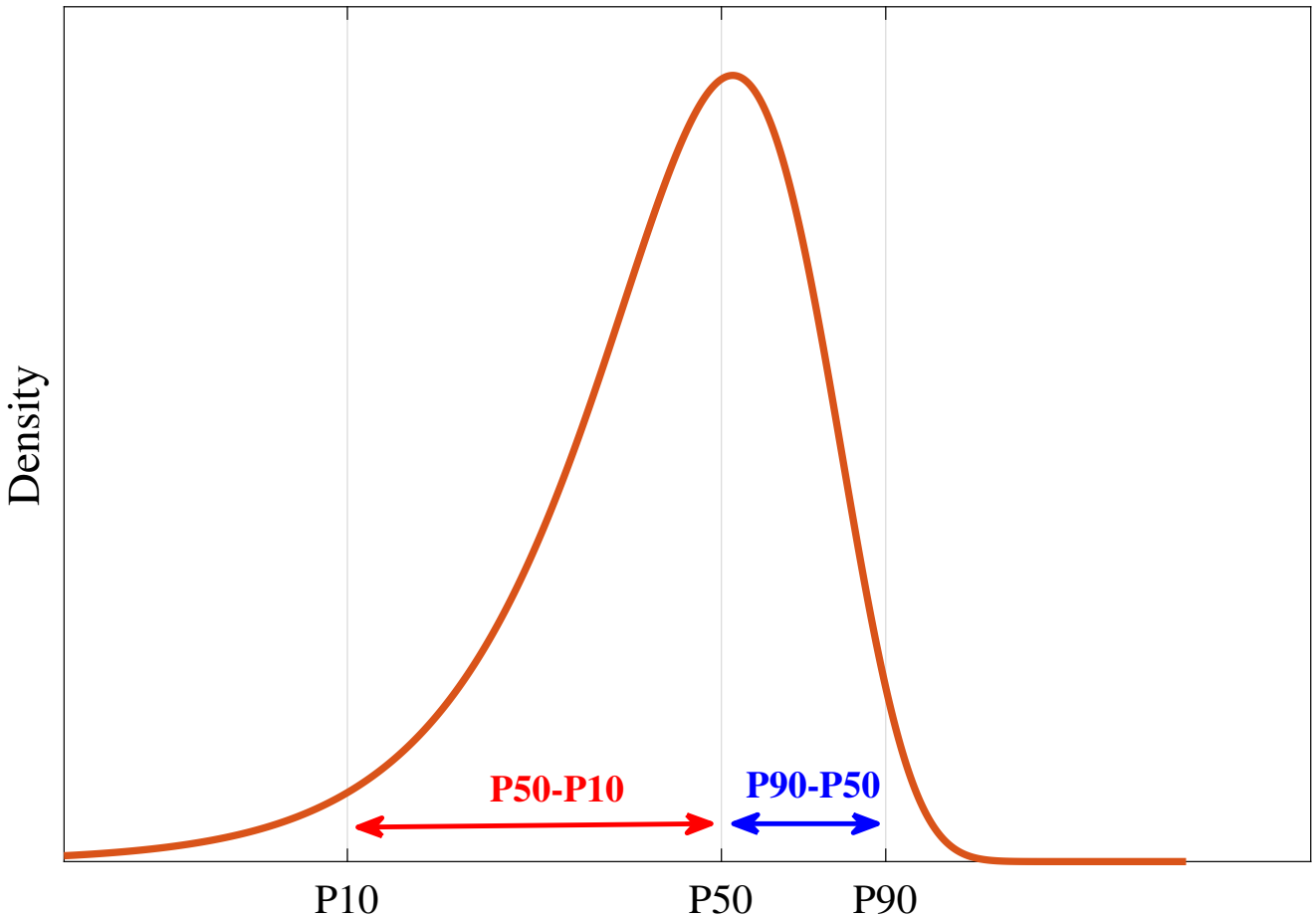


(b) LBD: Employment Growth

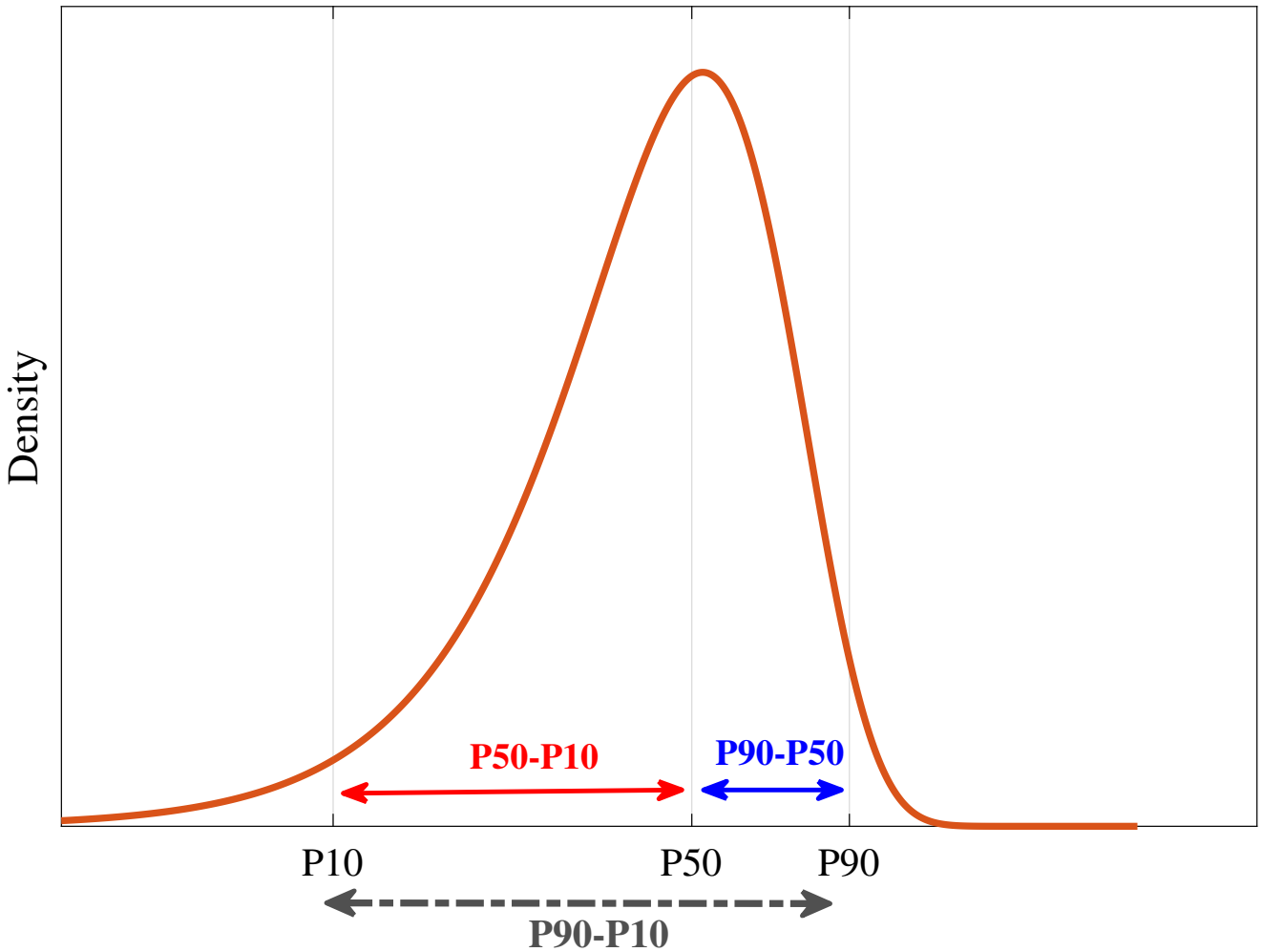
Kelley Skewness: A Robust Measure of Skewness



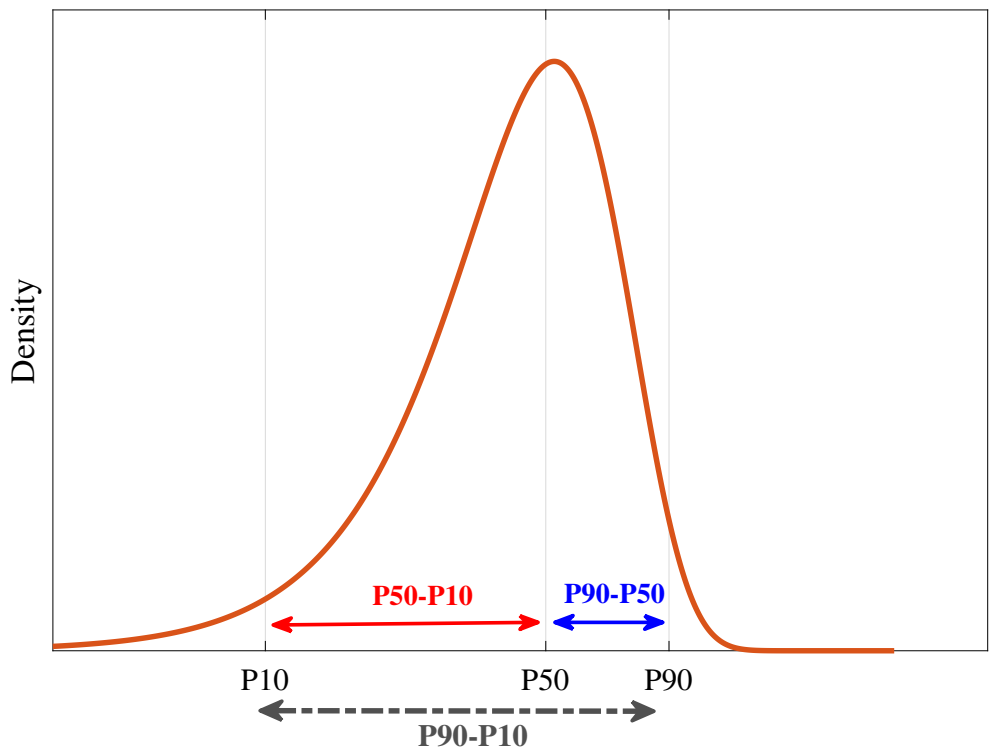
Kelley Skewness: A Robust Measure of Skewness



Kelley Skewness: A Robust Measure of Skewness



Kelley Skewness: A Robust Measure of Skewness



Kelley Skewness = S_K

$$S_K = \frac{(P90 - P50) - (P50 - P10)}{(P90 - P10)}$$

$$= \underbrace{\frac{(P90 - P50)}{(P90 - P10)}}_{\text{\%Right tail}} - \underbrace{\frac{(P50 - P10)}{(P90 - P10)}}_{\text{\%Left tail}}$$

Skewness of Sales Growth is Procyclical (LBD+R)

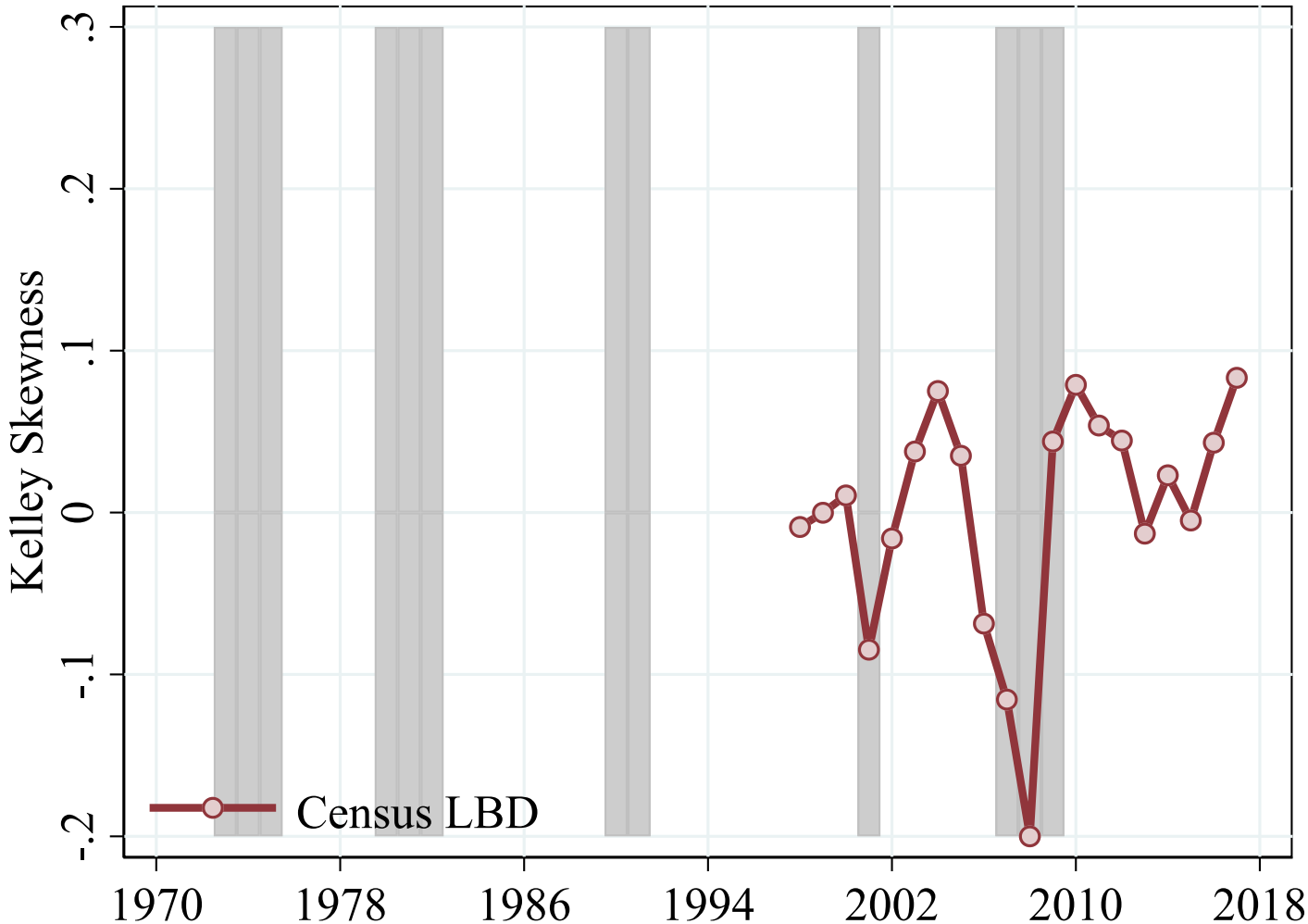


Figure 6: Skewness of Firm-Level Sales Growth is Procyclical

Skewness of Sales Growth is Procyclical (+Compustat)

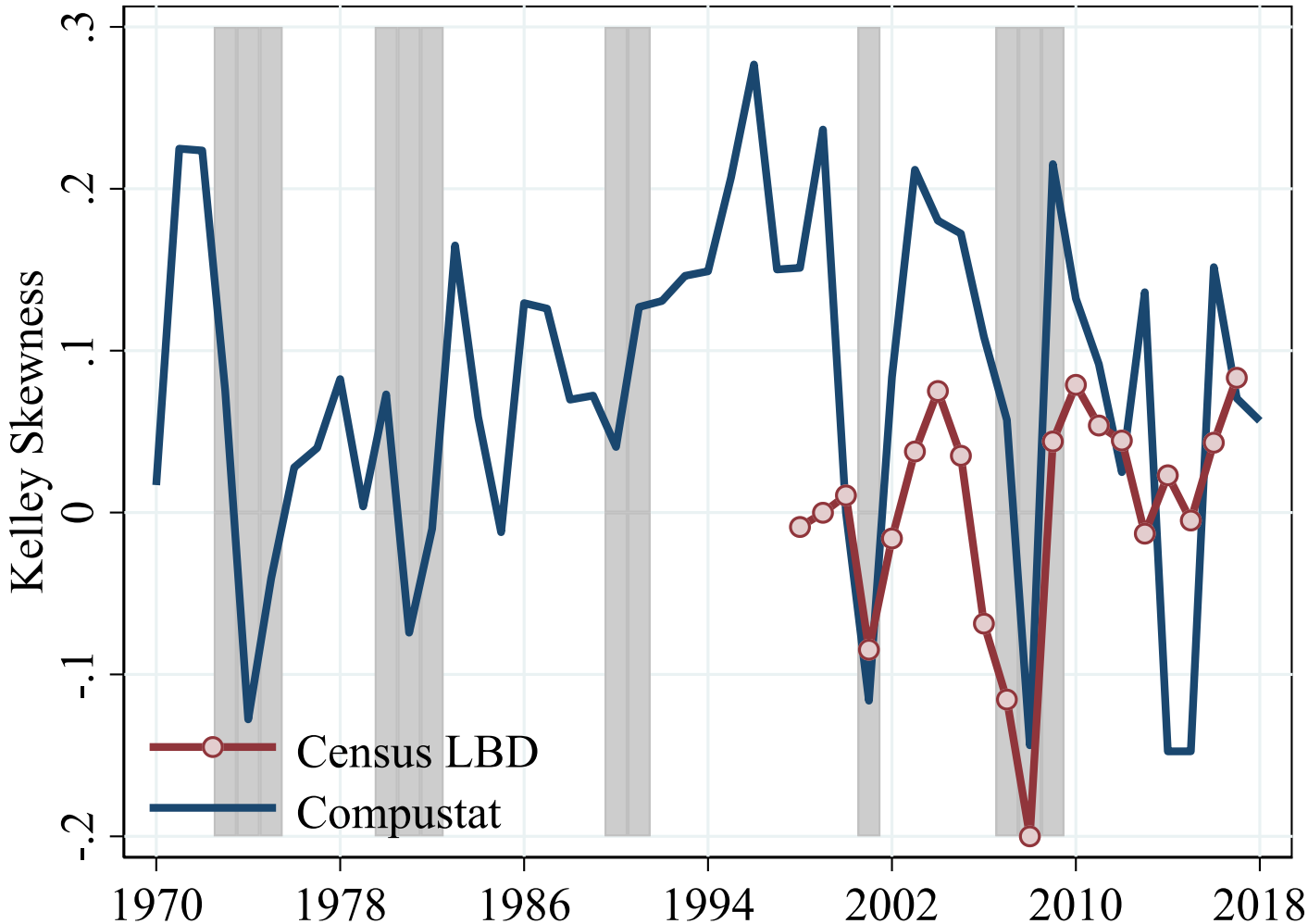


Figure 7: Skewness of Firm-Level Sales Growth is Procyclical

Same Pattern for Employment Growth (LBD)

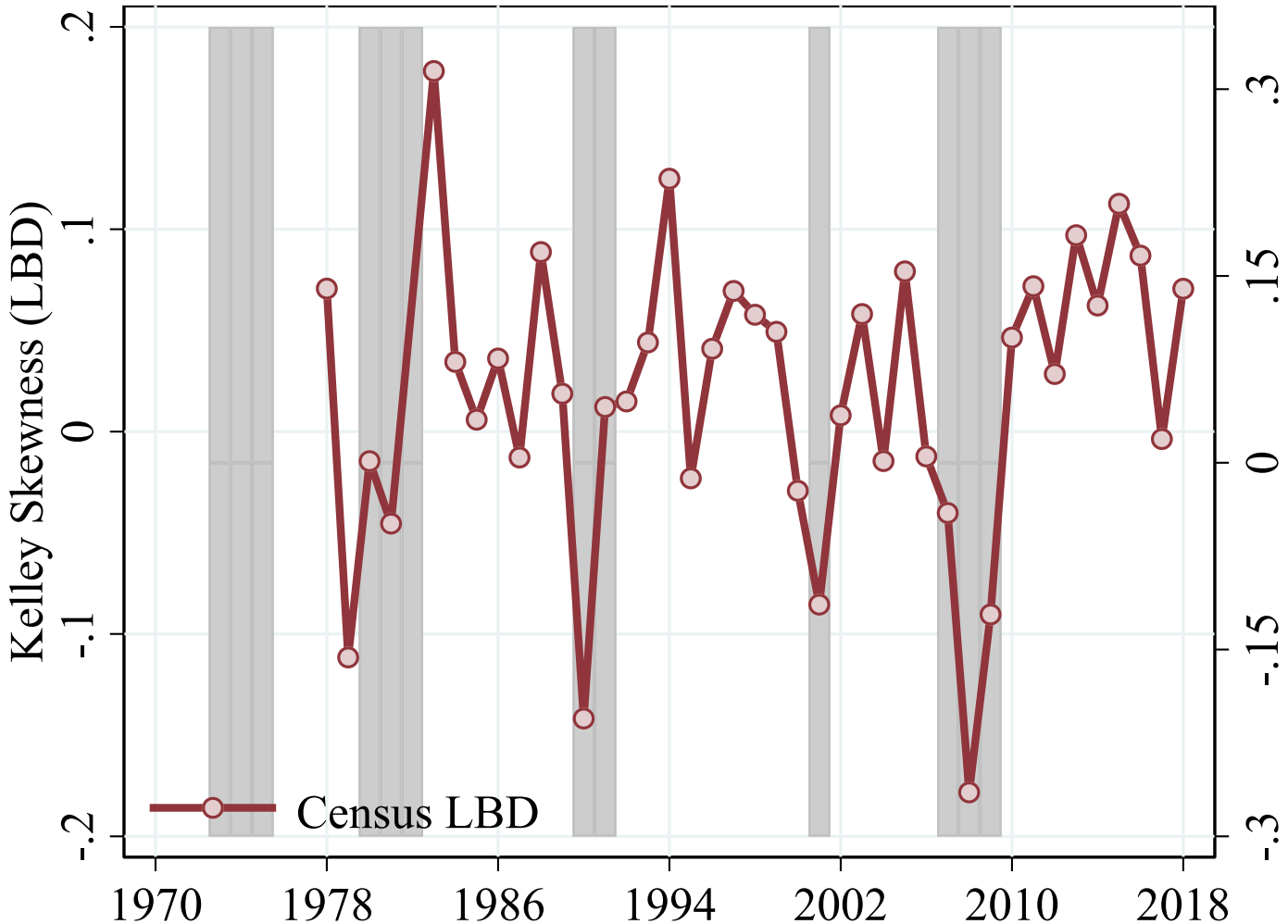
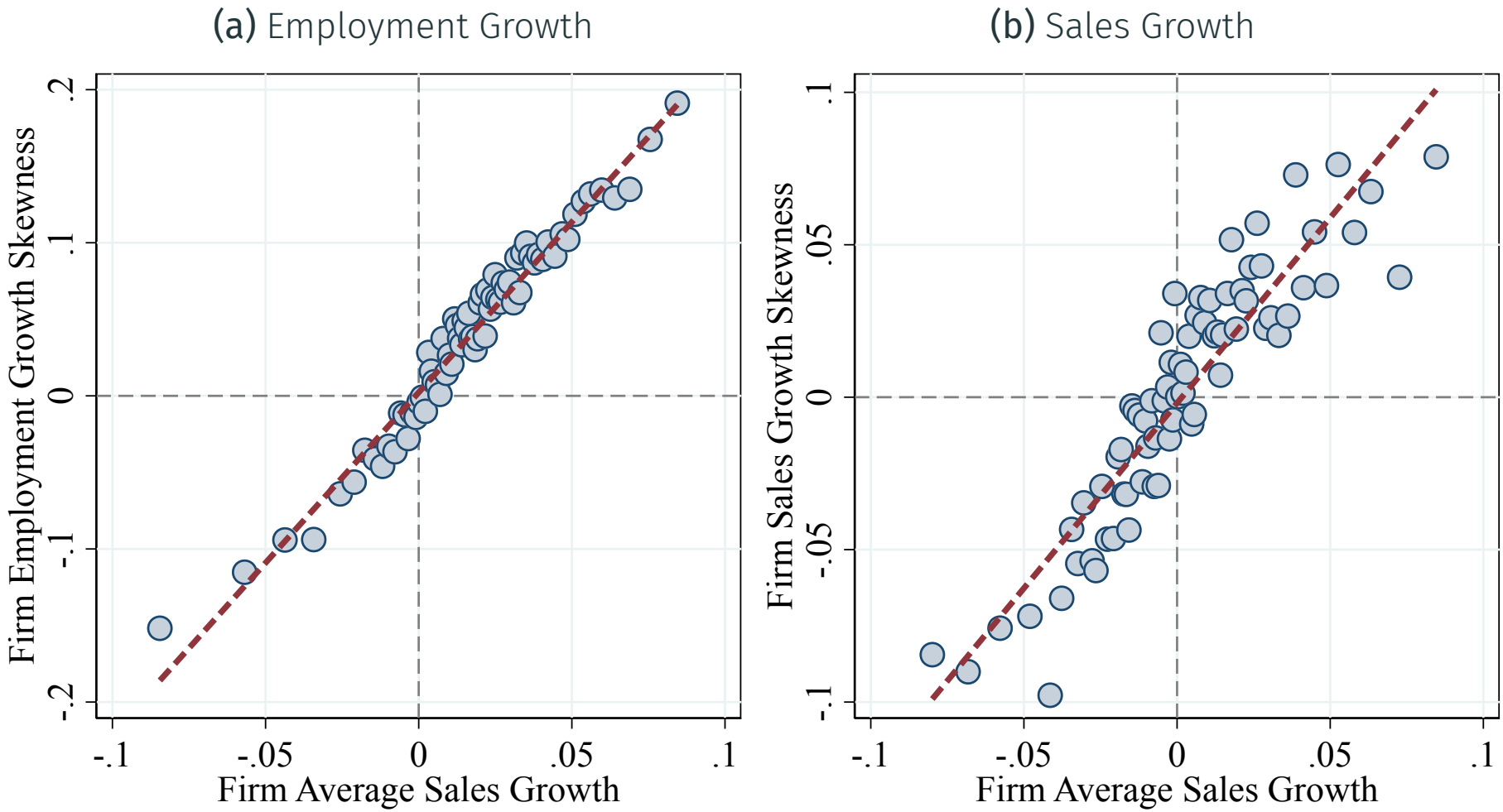


Figure 8: Skewness of Firm-Level Employment Growth is Procyclical

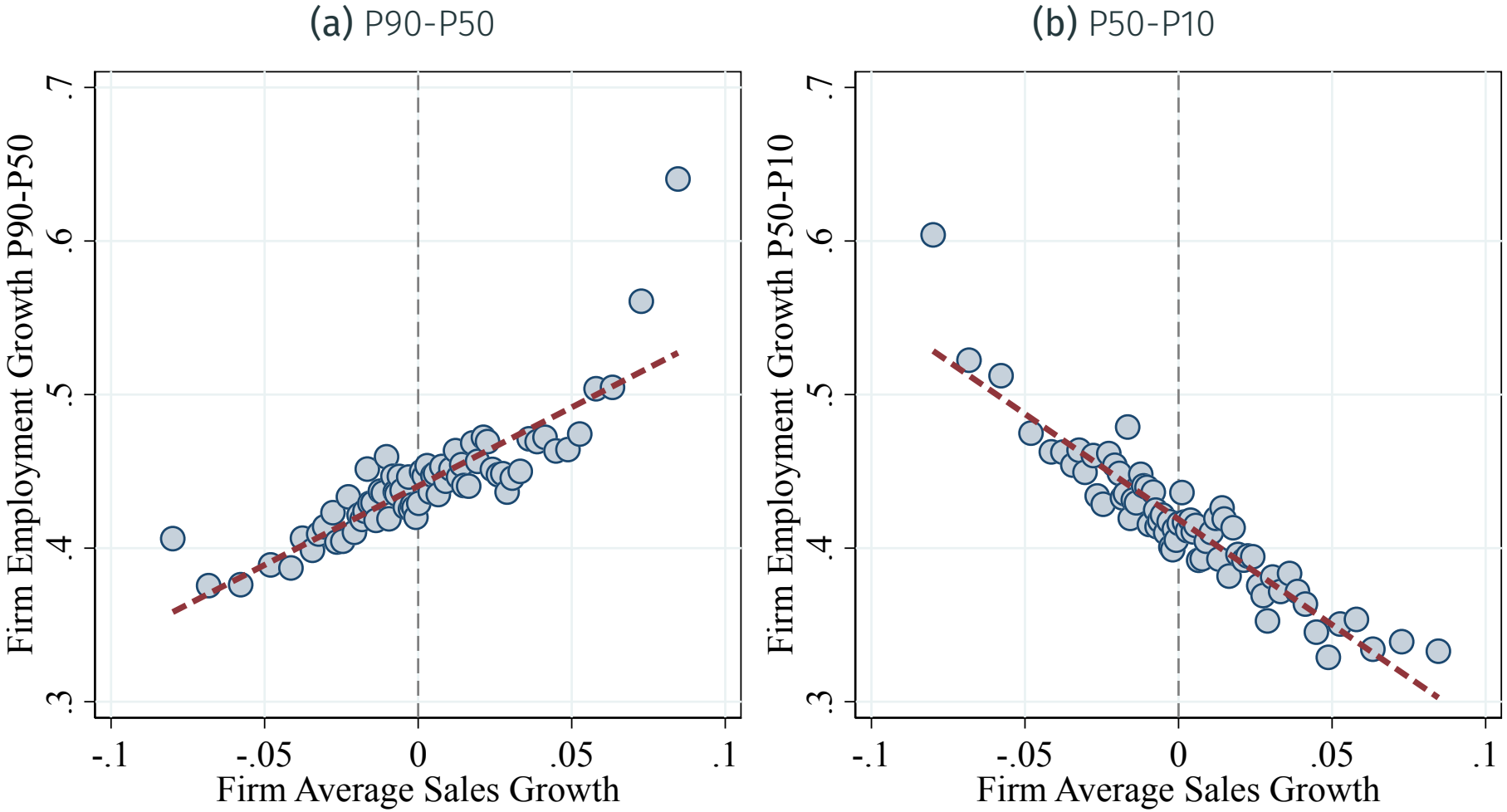
Skewness Versus Average Growth Across US Industries

Skewness Versus Average Growth Across US Industries



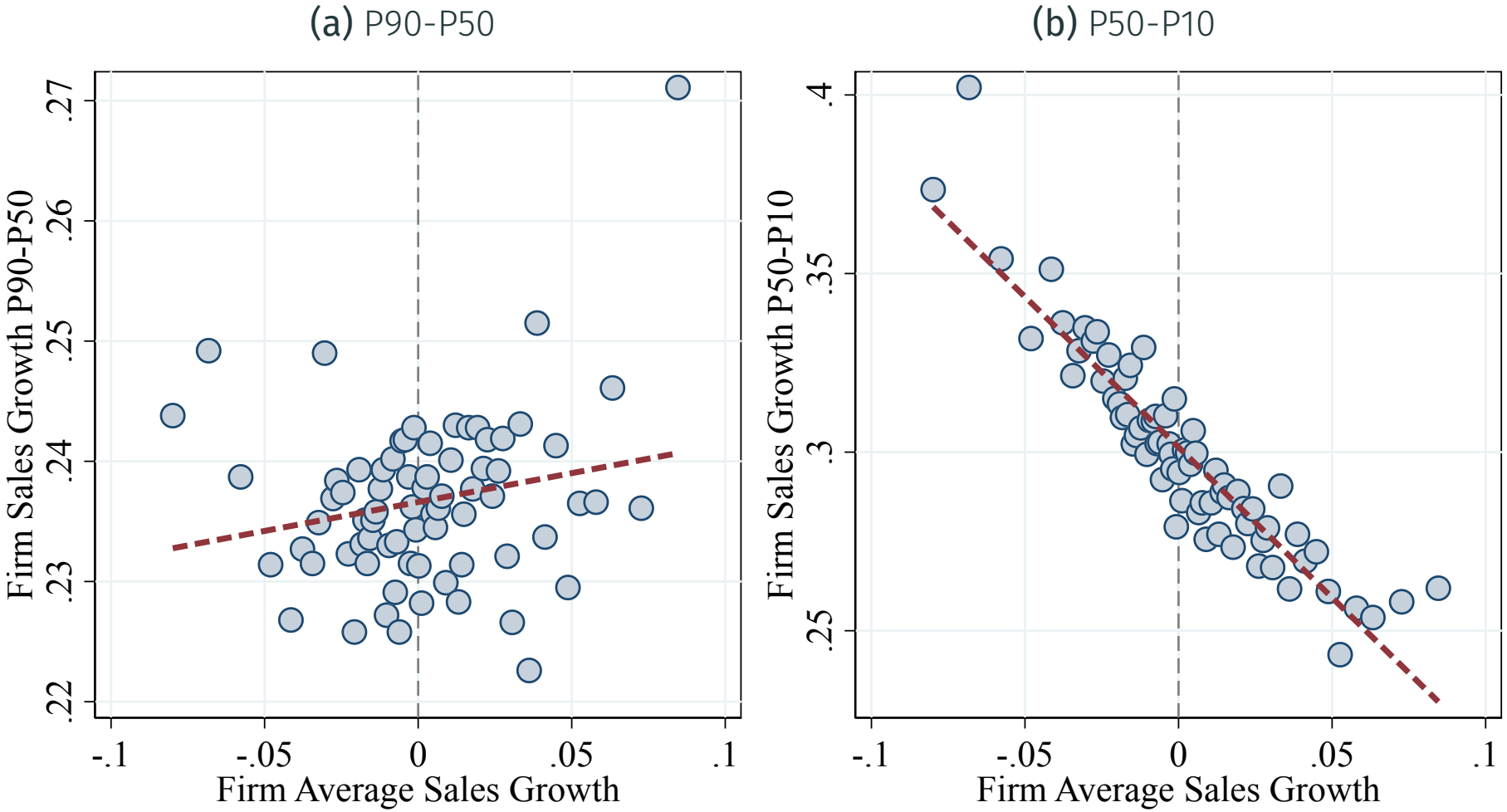
Unit of analysis: About 280 4-digit NAICS industries

Right and Left-Tail Dispersion: Employment Growth



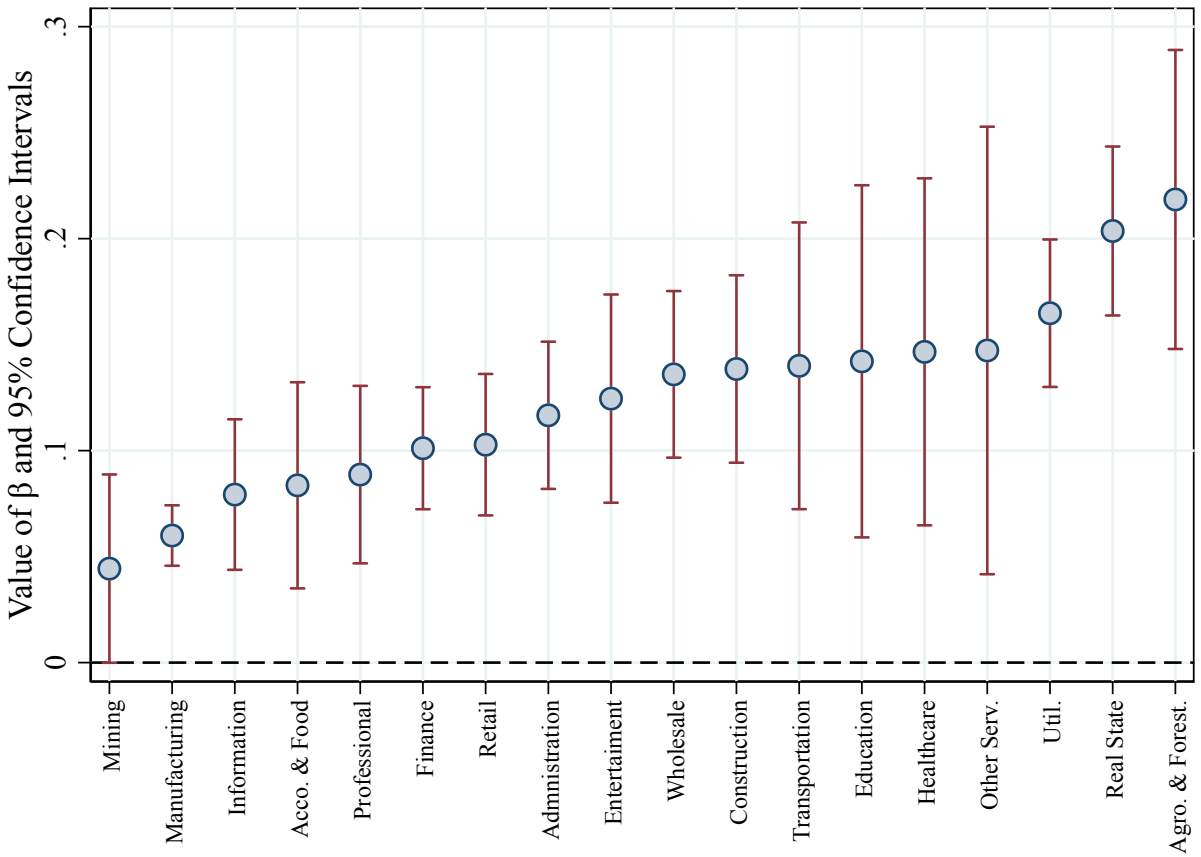
Unit of analysis: About 280 4-digit NAICS industries

Right and Left-Tail Dispersion: Sales Growth



Unit of analysis: About 280 4-digit NAICS industries

Within-Industry Skewness of Sales Growth (Compustat)



Regression coefficients of within-industry regression

$$KSK_{jt} = \alpha + \beta \Delta S_{jt} + \delta_t + \varepsilon_{jt}$$

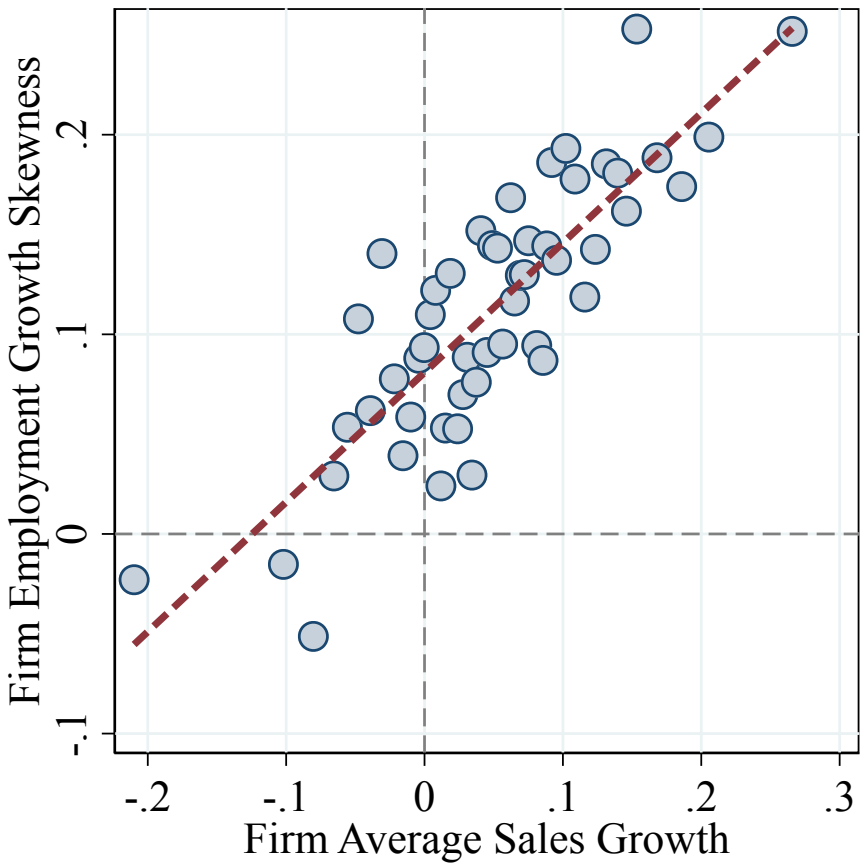
Notes: US data from all **Compustat firms** with +10 years of data for the 1970-2017 period. Total firm-quarter observations: 205K.

- NB: Employment growth is very similar.

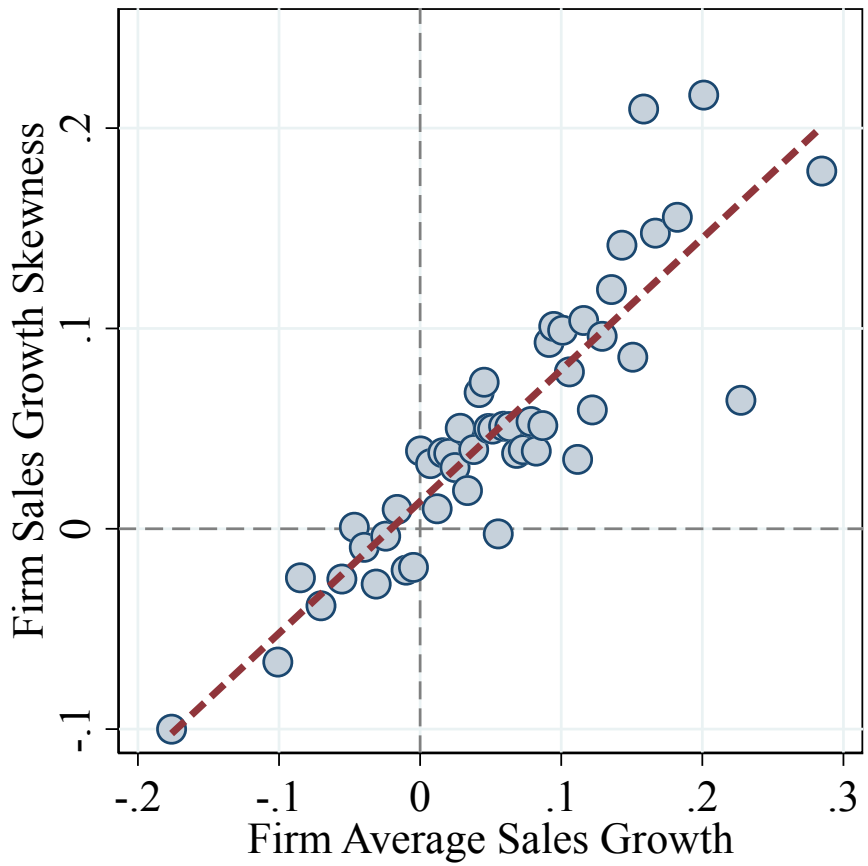
Cross-Country Evidence

Skewness is Procyclical in a Panel of 44 Countries

(a) Employment Growth

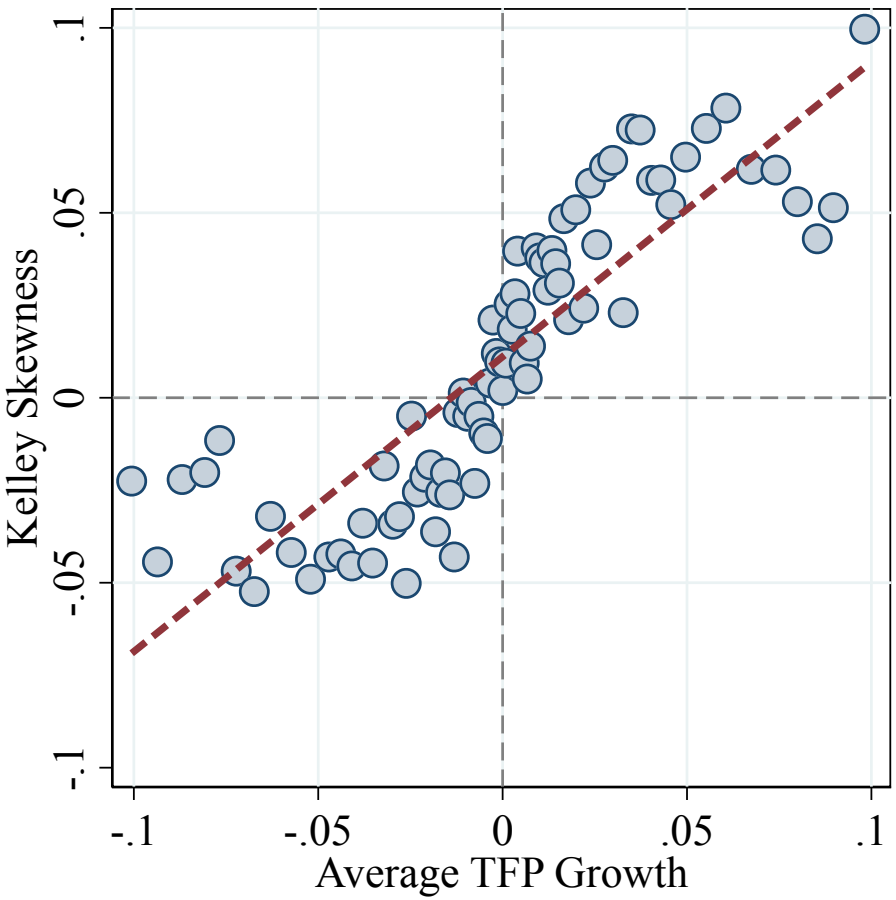


(b) Sales Growth

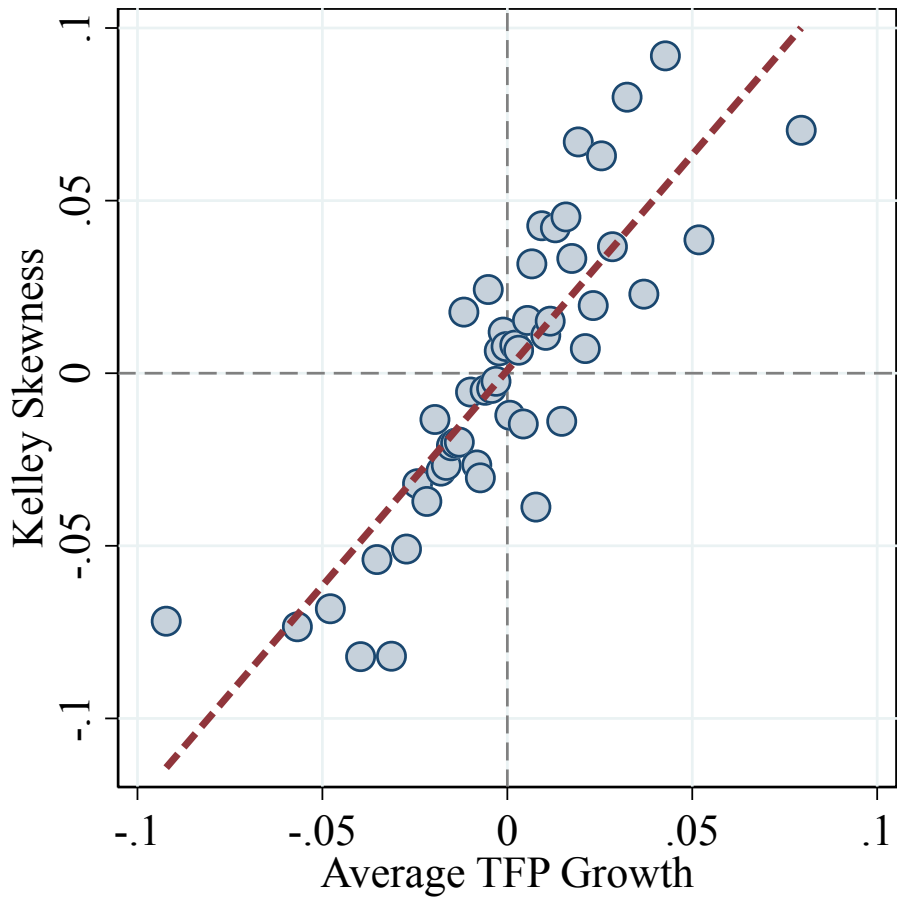


Skewness of Firm-Level TFP Shocks is Procyclical

(a) Cross Country

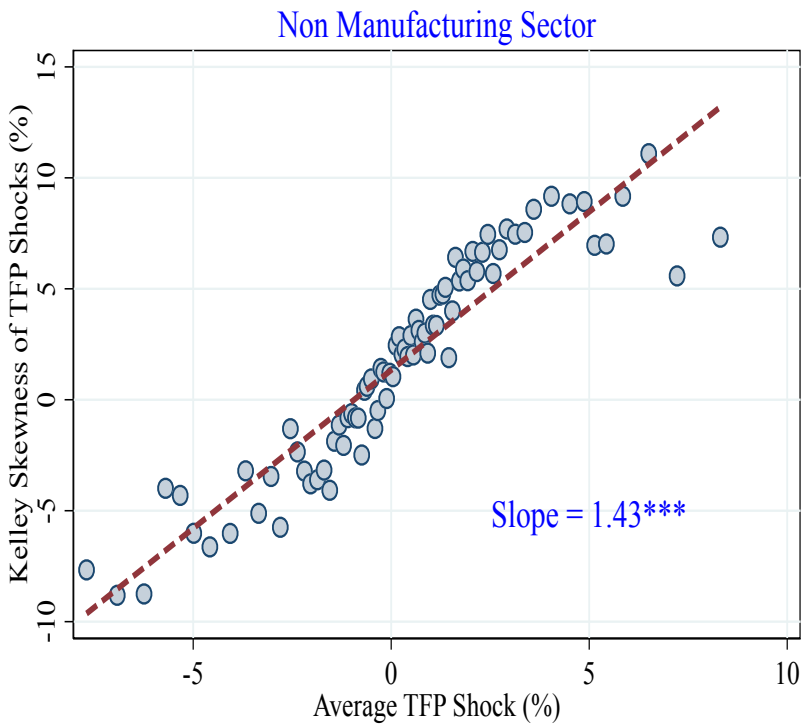


(b) US Manufacturing

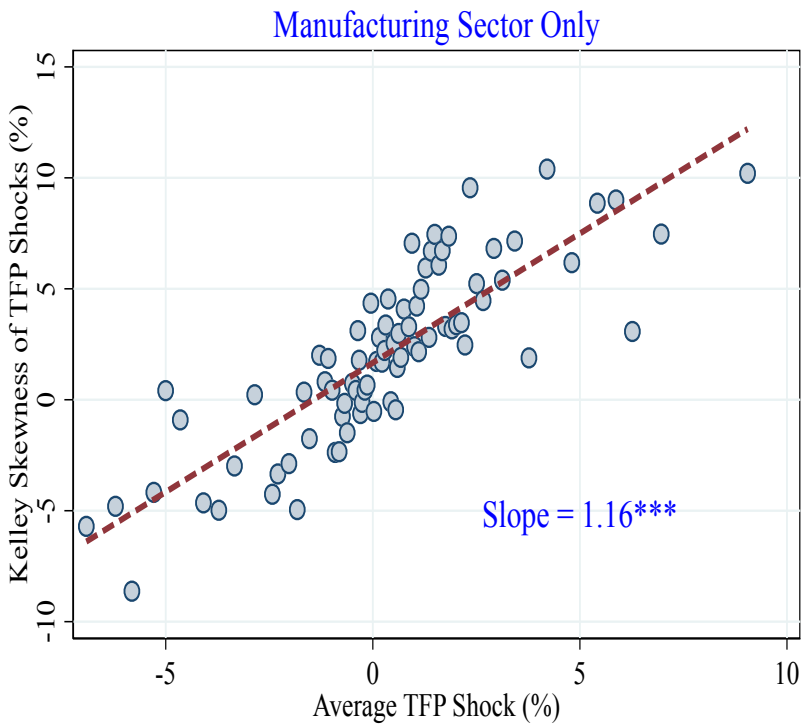


Cyclicality of Skewness Even Stronger Outside of Manufacturing

(a) BvD Amadeus: Non-Manufacturing



(b) BvD Amadeus: Manufacturing

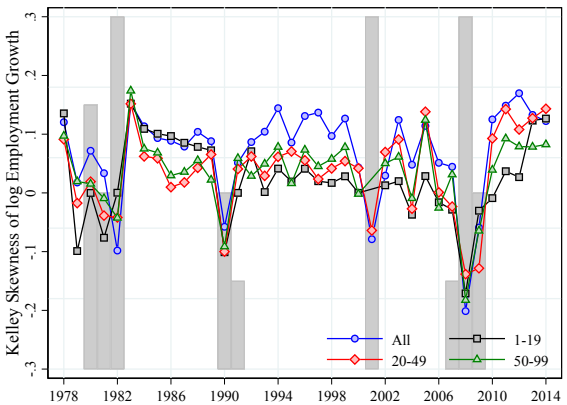


Road Map

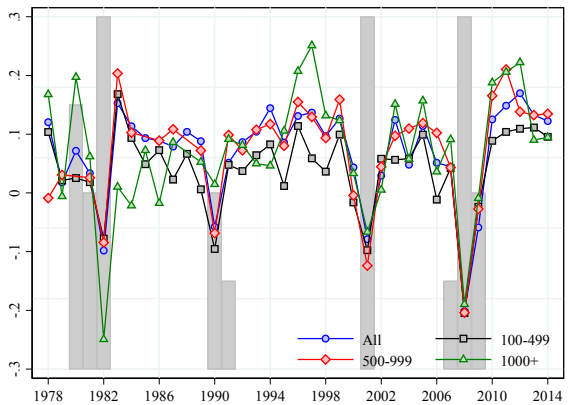
- Empirical Results
- **Robustness**
- Skewness During COVID-19
- VAR Results
- Model and Quantitative Results

Procyclical Skewness Robust Across Firm Characteristics (LBD)

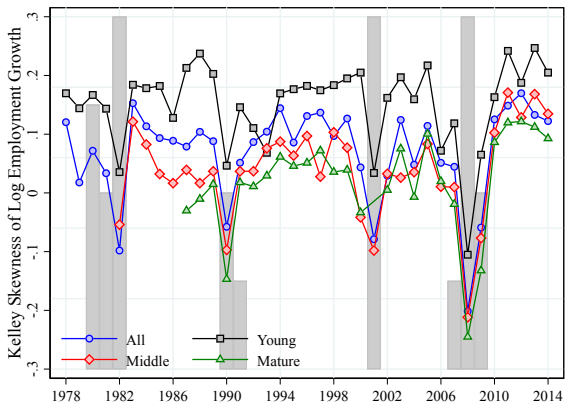
(a) Small Firms



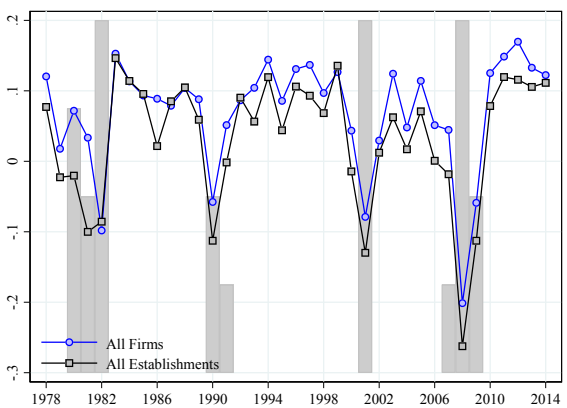
(b) Medium/Large Firms



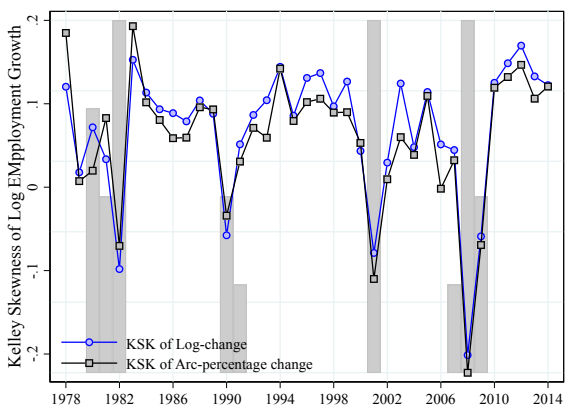
(c) Firm Age



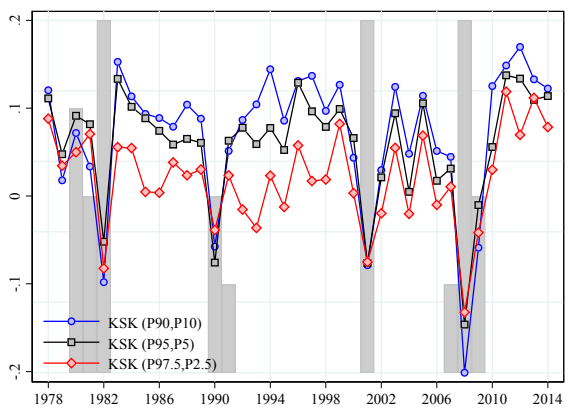
(d) Estab. & Firms



(e) Entry/Exit of Firms



(f) Other Skewness



Cyclicality of Skewness: Different Business Cycle Indicators

Table 1: Skewness of Firms Outcomes is Lower During Recessions & Rises in Expansions

Dependent Var:	Kelley Skewness of Log Growth of Firms Outcomes										
Sample:	United States			Cross-Industry				Cross-Country			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome:	Emp._t	Sales_t	Returns_t	$\text{Emp.}_{j,t}$	$\text{Sales}_{j,t}$	$\text{Returns}_{j,t}$	$\text{TFP}_{j,t}$	$\text{Emp.}_{k,t}$	$\text{Sales}_{k,t}$	$\text{Returns}_{k,t}$	$\text{TFP}_{j,k,t}$
$\Delta GDP_{k,t}$	0.061^{***}	0.053^{***}	0.021^{**}					0.056^{***}	0.032^{***}	0.024^{**}	
	(0.007)	(0.026)	(0.010)					(0.015)	(0.011)	(0.009)	
$\Delta Sales_{j,k,t}$				0.069^{***}	0.130^{***}	0.013^{**}	0.022^{***}				0.013^{***}
				(0.014)	(0.014)	(0.005)	(0.0104)				(0.003)
R^2	0.60	0.14	0.07	0.27	0.49	0.24	0.26	0.27	0.38	0.41	0.14
Obs.	43	48	184	1,045	1,046	4,133	457	701	720	2,428	2,278
Period	76-14	70-17	70-16	70-17	70-17	70-16	76-15	91-15	91-15	70-17	99-18
Freq.	Yr	Yr	Qtr	Yr	Yr	Qtr	Yr	Yr	Yr	Qtr	Yr
F.E.	—	—	—	Yr/Ind	Yr/Ind	Qtr/Ind	Yr/Ind	Yr/Ctry	Yr/Ctry	Qtr/Ctry	Yr/Ind/Ctry
Source	LBD	CSTAT	CSTAT	CSTAT	CSTAT	CSTAT	ASM	BvD	BvD	GCSTAT	Amadeus
Average	0.02	0.08	-.09	0.10	.08	-0.07	-0.00	0.11	0.05	-0.09	0.01
Recession	0.06	-0.09	-.14	-0.04	-0.12	-0.15	-0.03	-0.12	-0.10	-0.16	-0.03
Expansion	-0.08	0.16	.10	0.14	0.14	-0.00	0.03	0.13	0.06	-0.08	0.04
Sample	—	231K	650K	231K	231K	733K	—	357K	633K	5,800K	357K

Road Map

- Empirical Results
- Robustness
- **Skewness During COVID-19**
- VAR Results
- Model and Quantitative Results

Monthly SBU survey from Atlanta Fed, Chicago, and Stanford

SBU Survey of Business Uncertainty

FEDERAL RESERVE BANK of ATLANTA | CHICAGO BOOTH | Stanford University

Looking ahead, from now to four quarters from now, what approximate percentage sales revenue growth rate would you assign to each of the following scenarios?

The LOWEST percentage sales revenue growth rate would be about:	-2 %
A LOW percentage sales revenue growth rate would be about:	-1 %
A MIDDLE percentage sales revenue growth rate would be about:	0 %
A HIGH percentage sales revenue growth rate would be about:	1 %
The HIGHEST percentage sales revenue growth rate would be about:	2 %

SBU Survey of Business Uncertainty

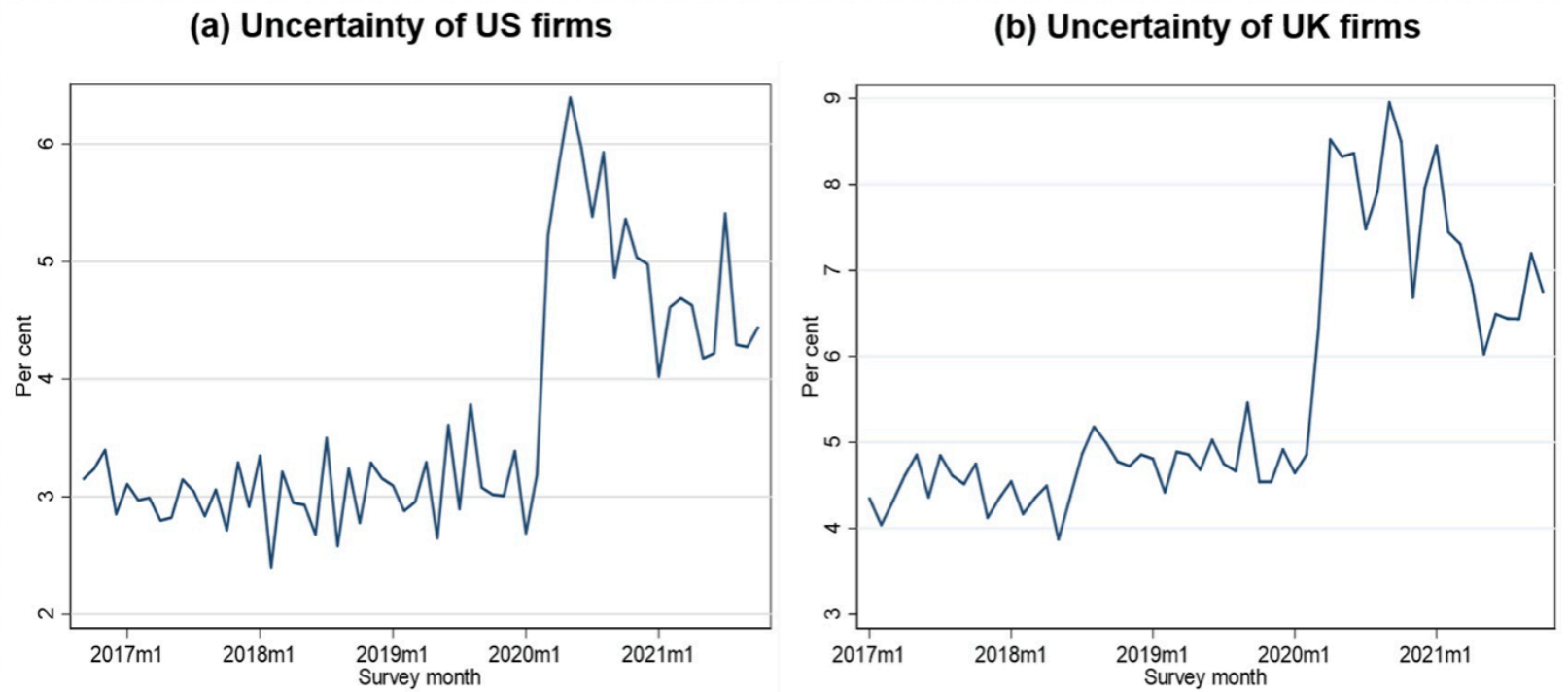
FEDERAL RESERVE BANK of ATLANTA | CHICAGO BOOTH | Stanford University

Please assign a percentage likelihood to the sales revenue growth rates you entered. (Values should sum to 100%)

LOWEST: The likelihood of realizing a **-2%** sales revenue growth rate would be:	15 %
LOW: The likelihood of realizing a **-1%** sales revenue growth rate would be:	25 %
MIDDLE: The likelihood of realizing a **0%** sales revenue growth rate would be:	30 %
HIGH: The likelihood of realizing a **1%** sales revenue growth rate would be:	25 %
HIGHEST: The likelihood of realizing a **2%** sales revenue growth rate would be:	5 %
Total	100 %

US and UK Firms' subjective sales uncertainty increased due to COVID...

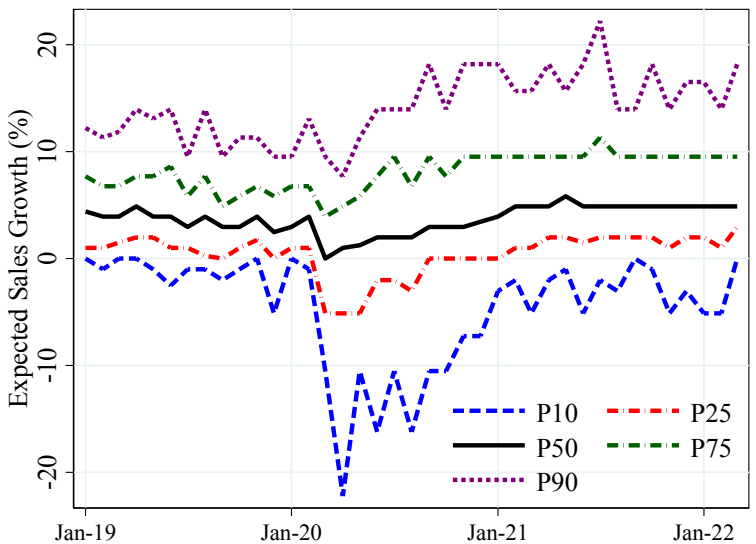
Figure 1 Subjective uncertainty about firm-level sales growth rates over the next four quarters



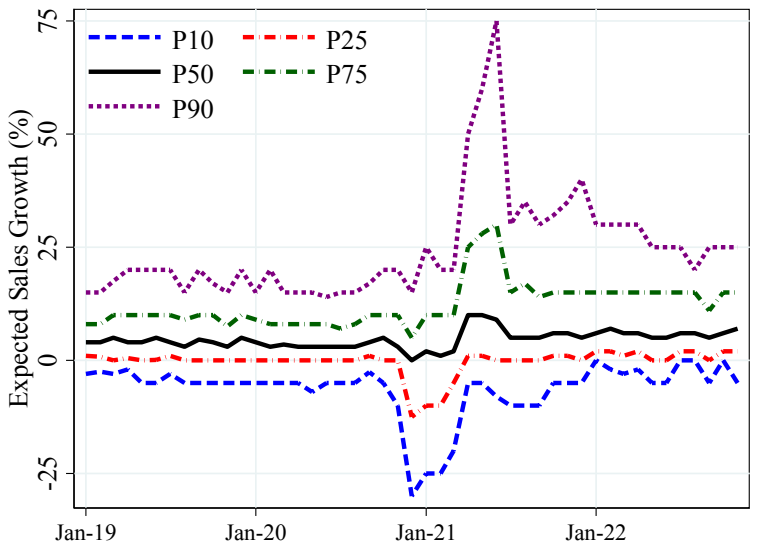
Notes: Subjective uncertainty about the growth rate of sales at a four-quarter look-ahead horizon. US and UK data through October 2021. See Altig et al (2020a) for more details. Data available at www.atlantafed.org/research/surveys/business-uncertainty and www.decisionmakerpanel.com.

...but all the increase due to left-tail risk...

(a) Expected: United States

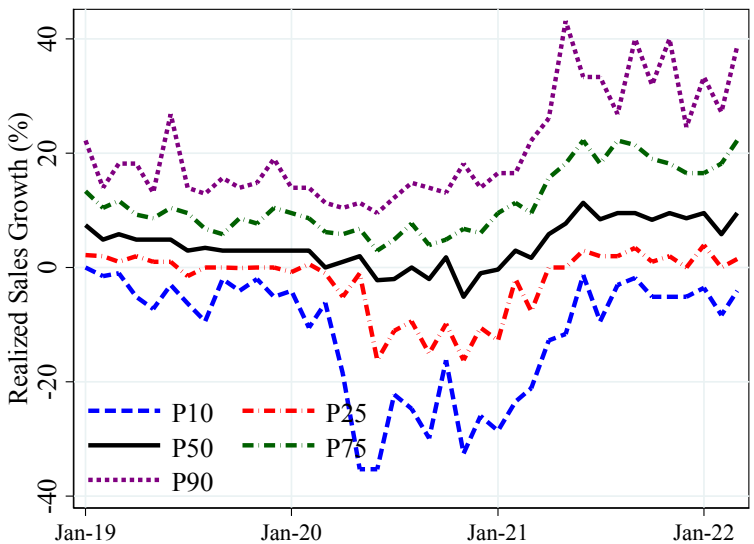


(b) Expected: United Kingdom

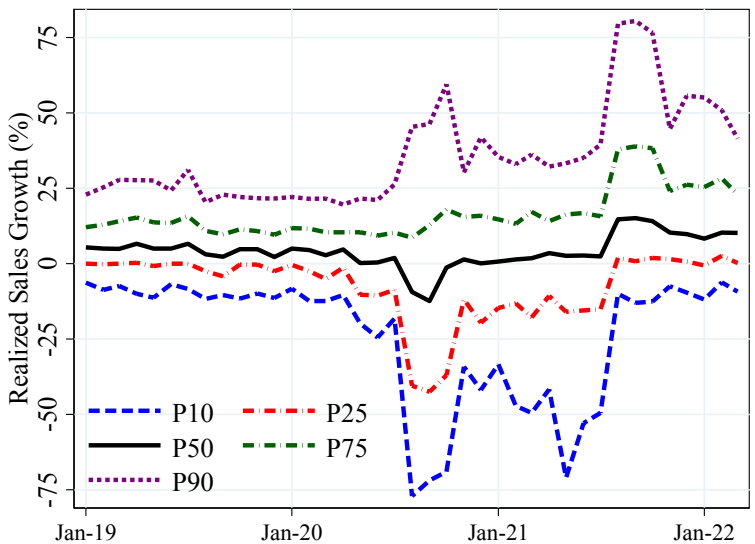


...and so were the realized growth rates..

(a) Realized: United States

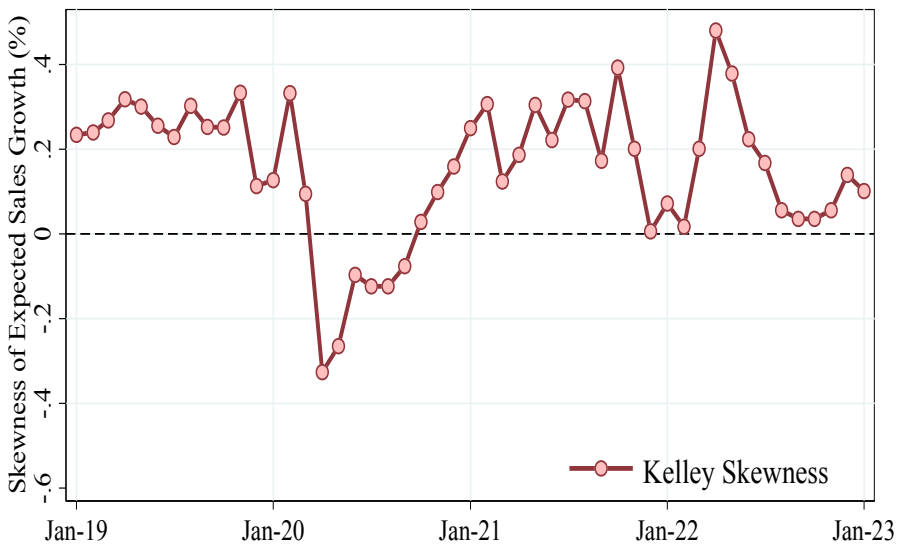


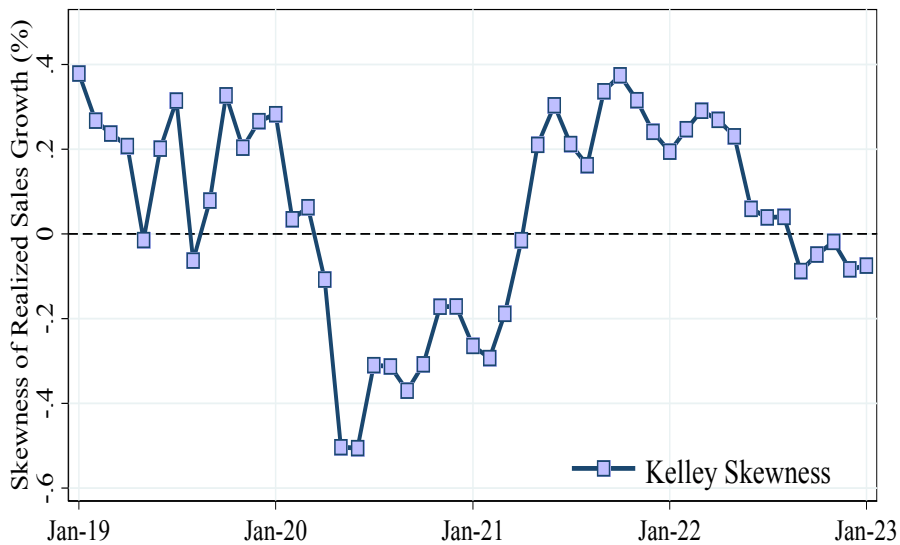
(b) Realized: United Kingdom



hence, COVID was (partly) a skewness shock..

Figure 9: COVID Skewness of Expected and Realized Sales Growth





Road Map

- Empirical Results
- Robustness
- Skewness During COVID-19
- VAR Results
- Model and Quantitative Results

The Impact of a Skewness Shock: VAR Evidence

Estimate range of VARs using monthly data for the United States

Variables and (Reverse) Order	
1. Log SP500	6. Investment (real GDP)
2. Volatility Measure	7. Employment (total nonfarm)
3. Skewness Measure	8. Wages (avg hourly earnings)
4. Real GDP	9. CPI for urban consumers
5. Real consumption expenditures	10. Fed Funds rate

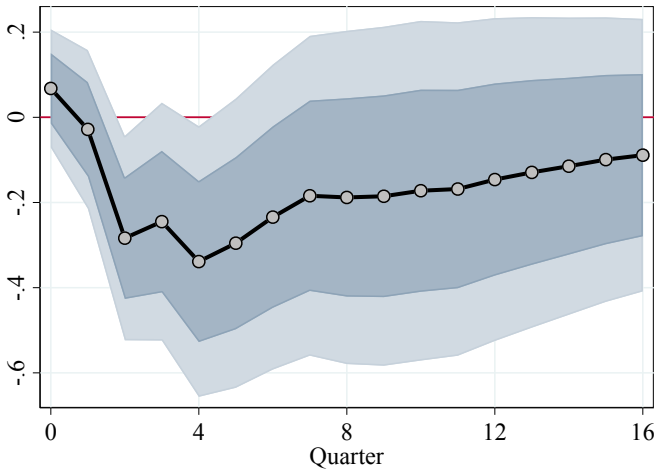
Volatility: measure of cross-sectional P90-P10 of stock (returnsp)

Skewness: measure of cross-sectional Kelley skewness of stock returns

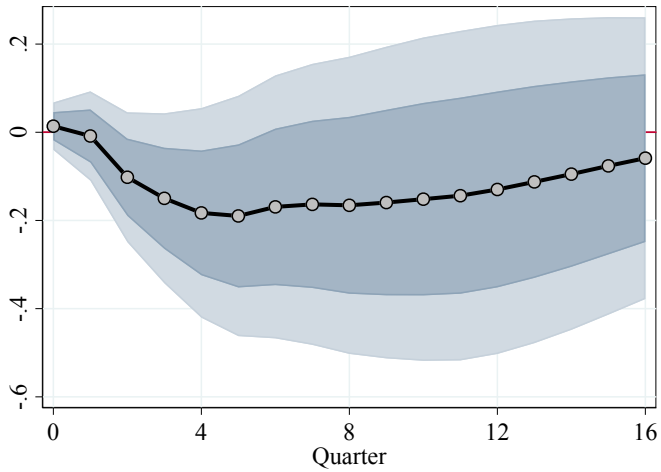
- All variables except 2, 3, and 10 are in logs and seasonally adjusted.
- Evaluate a one-standard-deviation decline in Kelley skewness.

Skewness Shock Predicts Persistent Drop in Aggregates

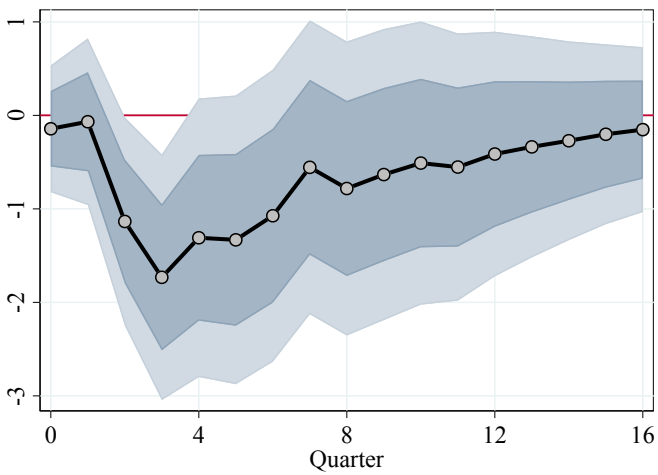
(a) Output



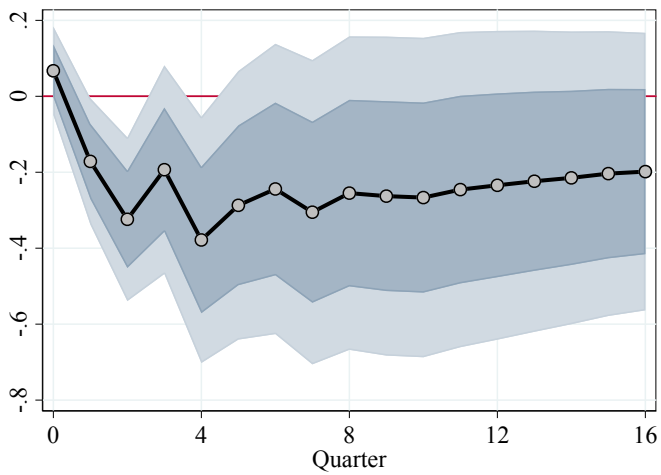
(b) Employment



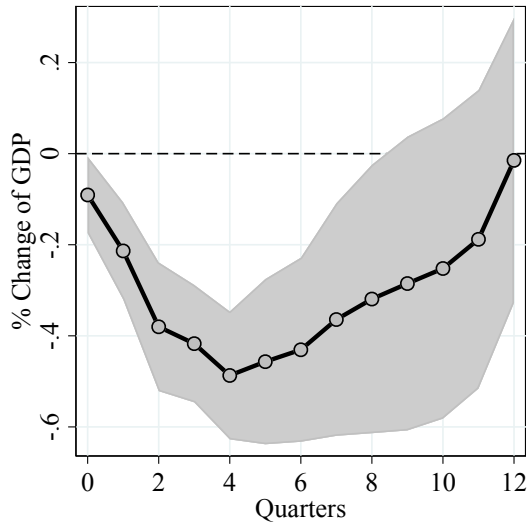
(c) Investment

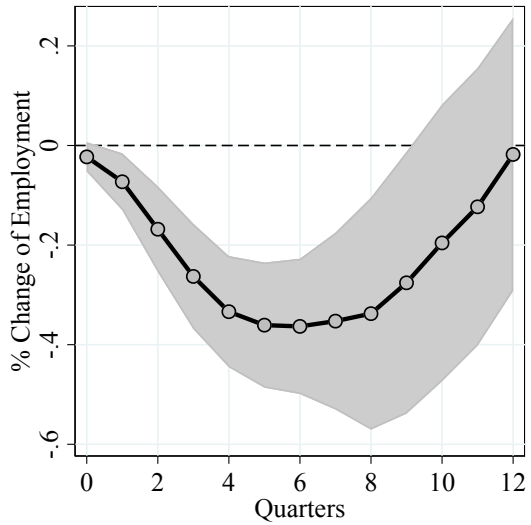


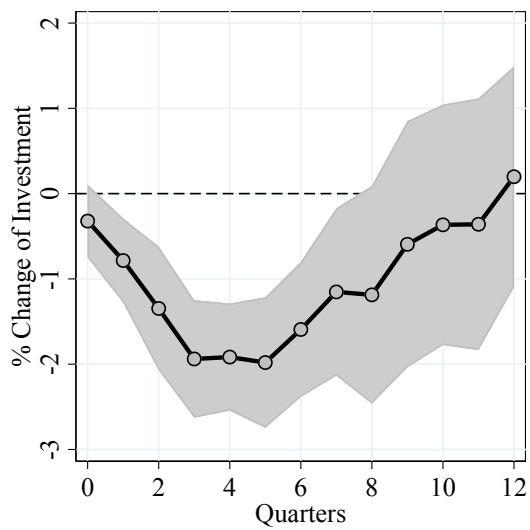
(d) Consumption

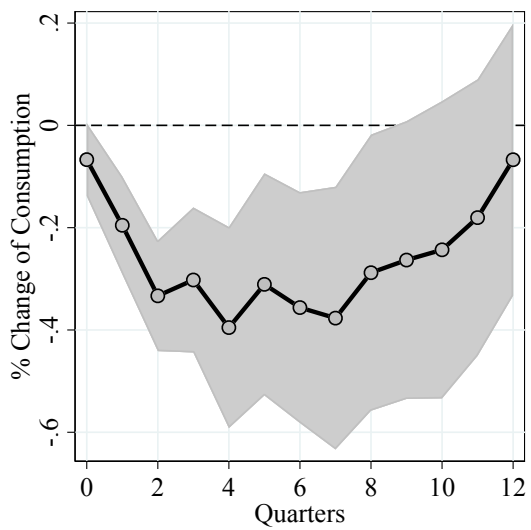


Macroeconomic Effect of Skewness Shock (Local Projection)









Road Map

- Empirical Results
- Robustness
- Skewness During COVID-19
- VAR Results
- **Model and Quantitative Results**

Outline of the Model

Small Open Economy with two groups of agents

- Risk averse entrepreneurs: produce, own the capital, rent labor, and consume
- Hand-to-mouth households: supply labor and consume

Outline of the Model

Small Open Economy with two groups of agents

- Risk averse entrepreneurs: produce, own the capital, rent labor, and consume
- Hand-to-mouth households: supply labor and consume

Entrepreneurs

- Idiosyncratic TFP shocks with time-varying risk: variance and skewness
- Capital adjustment costs
- Cannot borrow: self-financing firms
- Portfolio choice: can save in risk-free asset

Non linearities in the response of entrepreneurs

Production Technology and Adjustment Costs

- Entrepreneurs use capital and labor to produce a homogeneous good with function

$$y_j = Ae_j k_j^{\alpha} n_j^{\nu}$$

Production Technology and Adjustment Costs

- Entrepreneurs use capital and labor to produce a homogeneous good with function

$$y_j = A e_j k_j^{\alpha} n_j^{\nu}$$

- A is aggregate productivity and follows AR(1)

Production Technology and Adjustment Costs

- Entrepreneurs use capital and labor to produce a homogeneous good with function

$$y_j = A e_j k_j^{\alpha} n_j^{\nu}$$

- A is aggregate productivity and follows AR(1)
- e_j is idiosyncratic productivity with time-varying variance, σ^2, and time-varying skewness, γ

Production Technology and Adjustment Costs

- Entrepreneurs use capital and labor to produce a homogeneous good with function

$$y_j = A e_j k_j^{\alpha} n_j^{\nu}$$

- A is aggregate productivity and follows AR(1)
- e_j is idiosyncratic productivity with time-varying variance, σ^2, and time-varying skewness, γ
- Invest in capital, k_j, with capital adjustment costs

$$k_j' = (1-\delta)\, k_j + i_j$$

$$\phi\left(k_j', k_j\right) = \underbrace{\phi_1 \mathbb{I}_{|i_j|>0} y_j}_{\text{Disruption Cost}} + \underbrace{\phi_2 \left(i_j / k_{j,-1}\right)^2}_{\text{Quadratic Cost}} + \underbrace{(1-\phi_3)\left|i_j\right| \mathbb{I}_{i_j<0}}_{\text{Asymmetric Resale Cost}}$$

Production Technology and Adjustment Costs

- Entrepreneurs use capital and labor to produce a homogeneous good with function

$$y_j = A e_j k_j^{\alpha} n_j^{\nu}$$

- A is aggregate productivity and follows AR(1)
- e_j is idiosyncratic productivity with time-varying variance, σ^2, and time-varying skewness, γ
- Invest in capital, k_j, with capital adjustment costs

$$k_j' = (1-\delta)\, k_j + i_j$$

$$\phi\left(k_j', k_j\right) = \underbrace{\phi_1 \mathbb{I}_{|i_j|>0} y_j}_{\text{Disruption Cost}} + \underbrace{\phi_2 \left(i_j / k_{j,-1}\right)^2}_{\text{Quadratic Cost}} + \underbrace{(1-\phi_3)\left|i_j\right| \mathbb{I}_{i_j<0}}_{\text{Asymmetric Resale Cost}}$$

- Save in risk-free asset, a_j

Problem of the Entrepreneur

- Let $\Omega \equiv (A, \sigma_{-1}, \gamma_{-1}, \mu)$ be aggregate state, then entrepreneur j problem is

$$V(k_j, a_j, e_j; \Omega) = \max_{\substack{c_j, k_j', \\ a_j', n_j}} \left\{ \frac{c_j^{1-\xi}}{1-\xi} + \beta \mathbb{E} V(k_j, a_j, e_j; \Omega') \right\}$$

$$\text{s.t. } c_j + i_j + a_j' \leq y_j - w(\Omega) n_j - \phi\left(k_j', k_j\right) + (1 + r(\Omega)) a_j$$

$$i_j = k_j' - (1-\delta) k_j$$

$$k_j > 0, a_j \geq 0, n_j > 0$$

where $\mu \equiv \mu(e, k, a)$ is the distribution of entrepreneurs over idiosyncratic states

- Fixed r but $w = w(\Omega)$ solved in equilibrium

Idiosyncratic Shocks and Estimation

Idiosyncratic shocks

$$e_j = \rho_z e_{j,-1} + \eta_j^s \text{ with } \eta_j^s \sim F(\sigma_{-1}, \gamma_{-1})$$

- Assume two aggregate risk states, $s \in \{L, H\}$
  - *Low risk* $\longrightarrow$ low variance and positive skewness
  - *High risk* $\longrightarrow$ high variance and negative skewness

Idiosyncratic Shocks and Estimation

Idiosyncratic shocks

$$e_j = \rho_z e_{j,-1} + \eta_j^s \text{ with } \eta_j^s \sim F(\sigma_{-1}, \gamma_{-1})$$

- Assume two aggregate risk states, $s \in \{L, H\}$
  - *Low risk* $\longrightarrow$ low variance and positive skewness
  - *High risk* $\longrightarrow$ high variance and negative skewness
- Aggregate state follows first-order Markov process
- Conditional on $s \in \{H, L\}$, η is normal mixture

Idiosyncratic Shocks and Estimation

Idiosyncratic shocks

$$e_j = \rho_z e_{j,-1} + \eta_j^s \text{ with } \eta_j^s \sim F(\sigma_{-1}, \gamma_{-1})$$

- Assume two aggregate risk states, $s \in \{L, H\}$
  - *Low risk* $\longrightarrow$ low variance and positive skewness
  - *High risk* $\longrightarrow$ high variance and negative skewness
- Aggregate state follows first-order Markov process
- Conditional on $s \in \{H, L\}$, η is normal mixture

Parameterization

- Take some parameters from literature (e.g. prefs, technology, etc.)
- Estimate parameters of η to match moments of sales growth distribution in data

Impulse Response after a Risk Shock

Compare two cases

- Skewness shock $\gamma_H \to \gamma_L$ and σ_L constant
- Skewness + Variance shock $\sigma_L \to \sigma_H$ and $\gamma_H \to \gamma_L$

Impulse Response after a Risk Shock

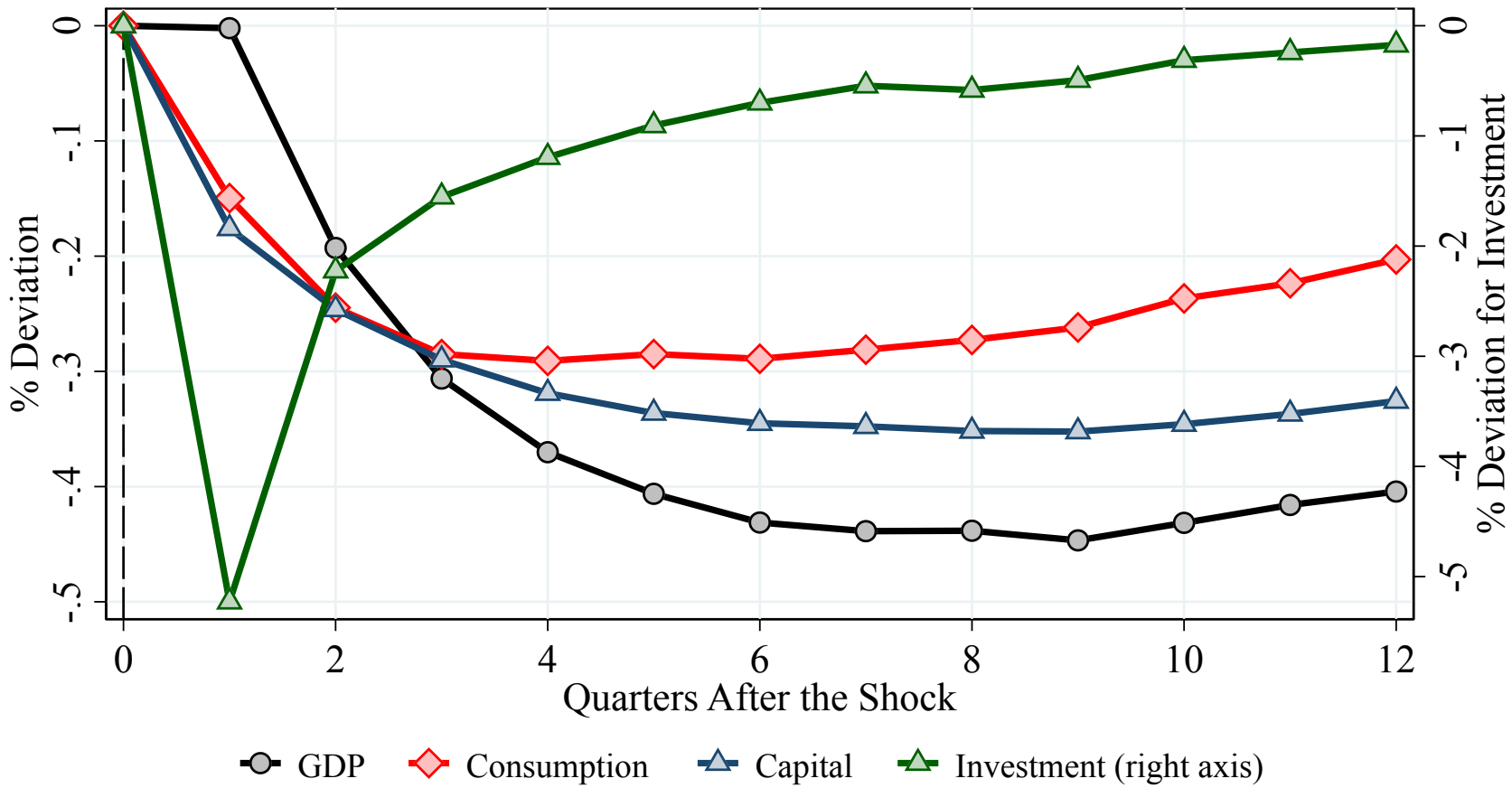
Compare two cases

- Skewness shock $\gamma_H \to \gamma_L$ and σ_L constant
- Skewness + Variance shock $\sigma_L \to \sigma_H$ and $\gamma_H \to \gamma_L$

Important: Aggregate productivity, A, constant throughout the simulation

Run 1,500 simulations and calculate mean change with respect to pre-shock period

Skewness Shock: Persistent Decline in Macro Aggregates

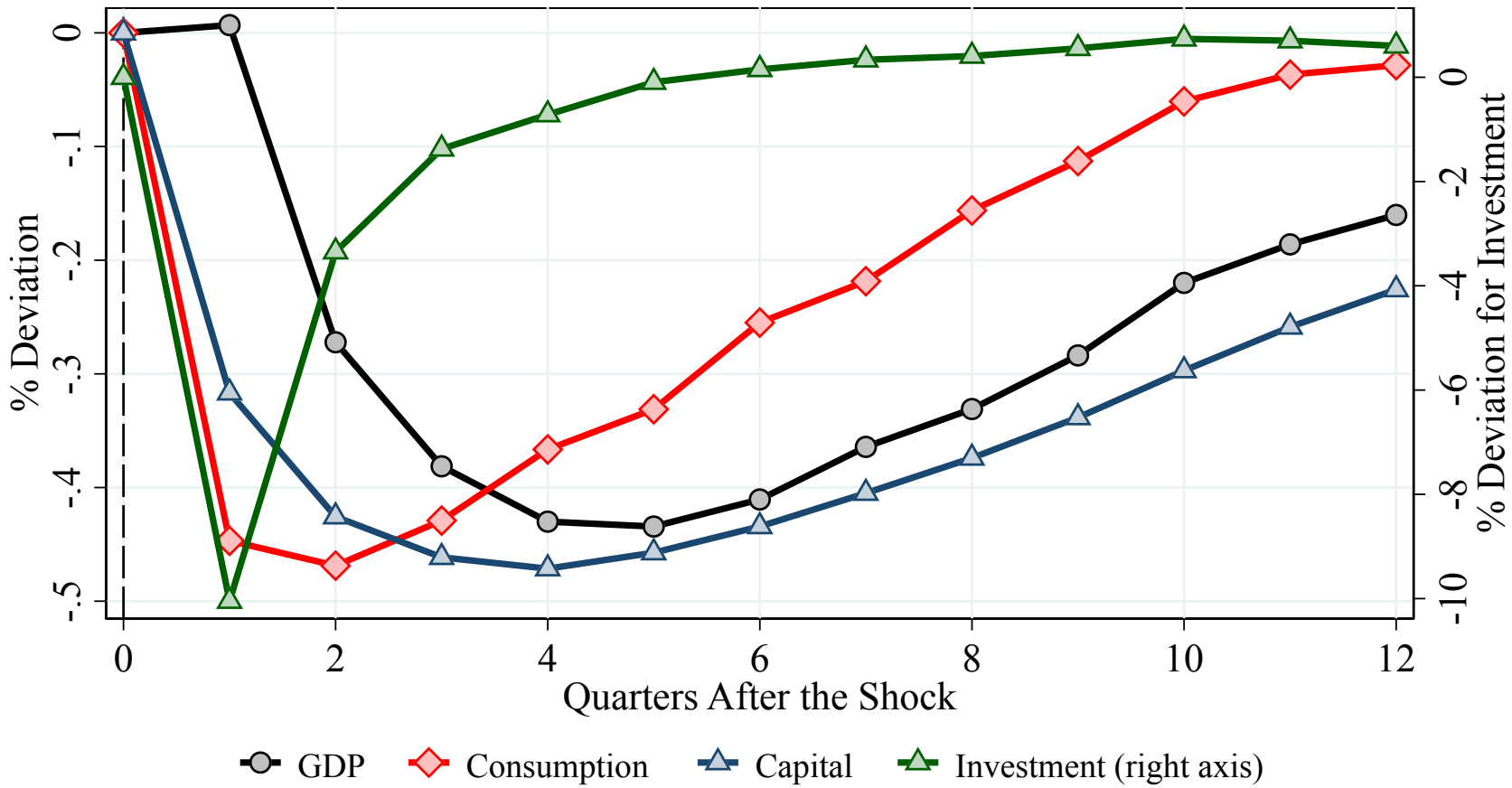


Response After a Skewness Shock

What is the mechanism?

- Pure real option effect from fixed adjustment costs
  - Similar to uncertainty shocks: firms freeze investment
- Risk aversion + safe asset: Precautionary savings but also flight to safety
  - Entrepreneurs move resources from risky capital to risk-free asset
- Muted Oi-Hartman-Abel effect
  - Uncertainty shock: same proportion of winners and losers
  - Firms like more variance: higher variance increases value of good projects
  - Skewness shocks loads increase of dispersion on big losers: micro disasters

Skewness + Variance Shock: Deeper drop in Macro Aggregates



Conclusions

Empirical Evidence

- We document procyclical skewness of growth rates of firms' outcomes
- Robust feature of business cycles: across industries, countries, firm size/age
- New data shows recent COVID shock also appears to be left-skewed
- VAR: skewness predicts persistent decline in aggregate economic activity

Quantitative Model

- Skewness shock generates persistent decline in macroeconomic activity
- Skewness shock generates 1.7% decline in output

Final Thoughts

- Putting these results together with findings on individual income dynamics:

  Skewness is procyclical for:

Final Thoughts

- Putting these results together with findings on individual income dynamics:

  Skewness is procyclical for:

  - Worker side:
    - annual earnings
    - wages
    - and hours;
    - for individuals and households
    - for full time job stayers, job changers, etc.

Final Thoughts

- Putting these results together with findings on individual income dynamics:

  Skewness is procyclical for:
  - Worker side:
    - annual earnings
    - wages
    - and hours;
    - for individuals and households
    - for full time job stayers, job changers, etc.
  - Firm side:
    - sales
    - employment
    - stock returns
    - TFP shocks.

Final Thoughts

- Putting these results together with findings on individual income dynamics:

  Skewness is procyclical for:
  - Worker side:
    - annual earnings
    - wages
    - and hours;
    - for individuals and households
    - for full time job stayers, job changers, etc.
  - Firm side:
    - sales
    - employment
    - stock returns
    - TFP shocks.

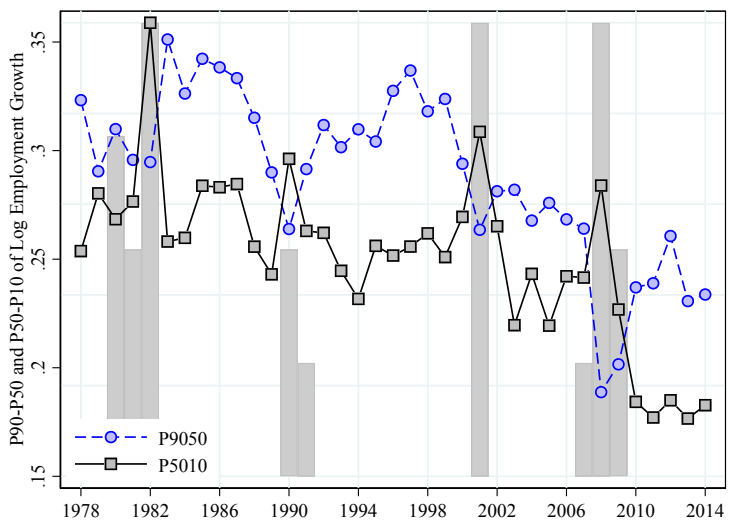
- Open Question: Is there a theory of business cycles here where the fundamental shock is to the tails?

Thanks!

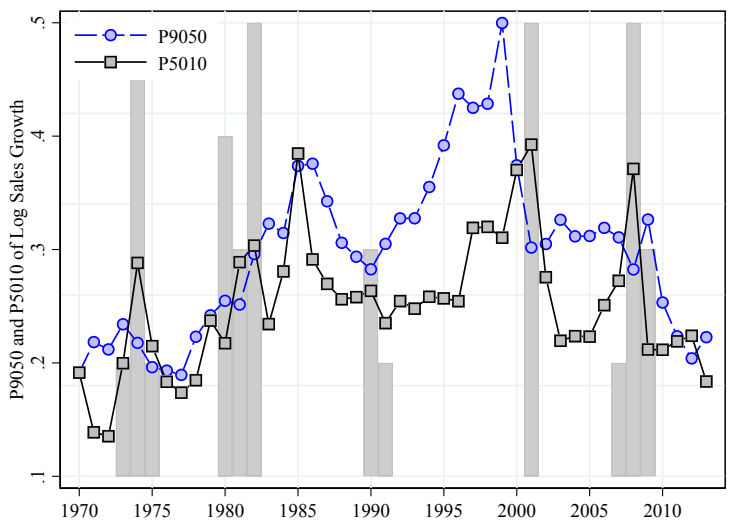
Upper and Lower Tails of Employment & Sales Growth

Figure 10: The Dispersion of Left Tail of Firm-Level Outcomes is Countercyclical

(a) Census LBD: Dispersion of Log Employment Growth



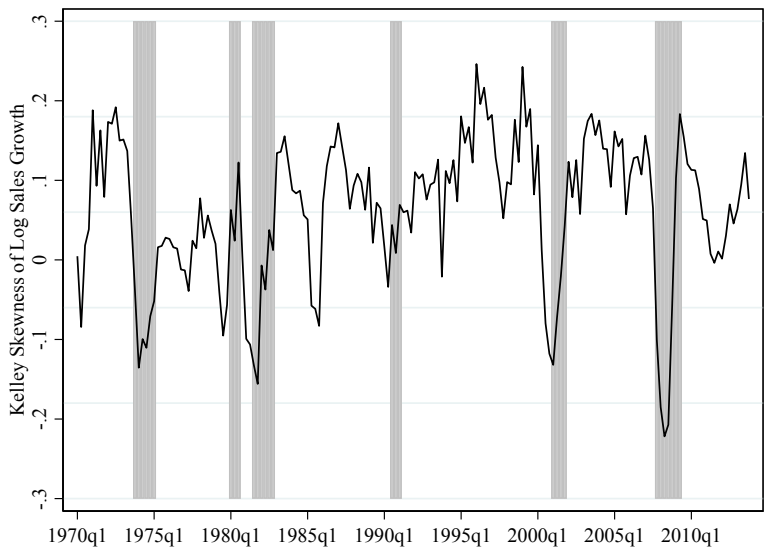
(b) Compustat: Dispersion of Log Sales Growth



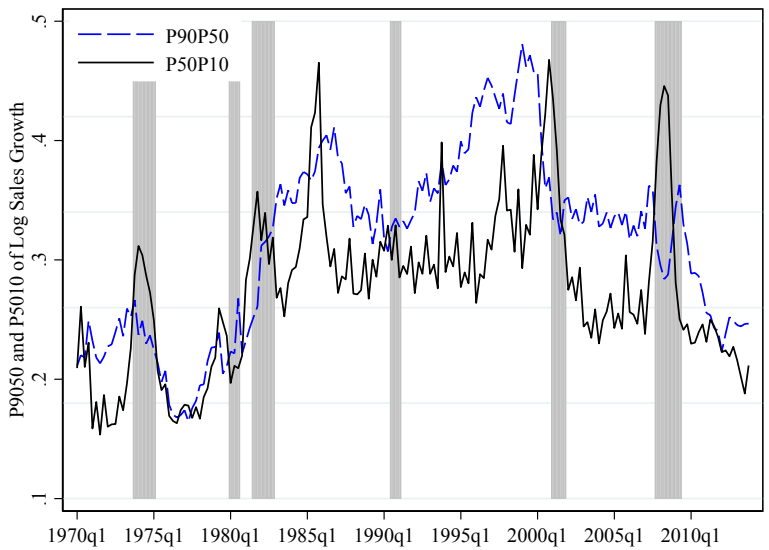
Right and Left Tail of Sales Growth, Time Series

Figure 11: The Skewness of Firm-Level Quarterly Log Sales Growth is Procyclical

(a) Compustat: Skewness of Log Sales Growth Distribution



(b) Compustat: Upper and Lower Tail Dispersion of Log Sales Growth

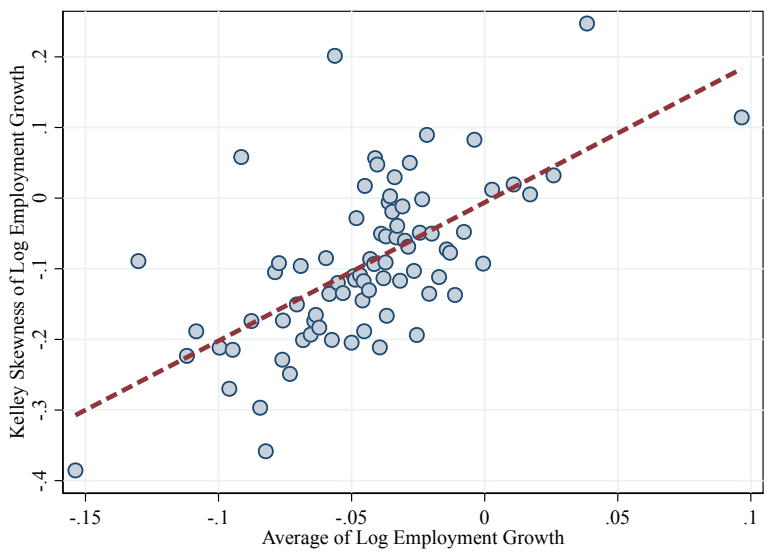


Note: The top panel of Figure shows the time series of the cross-sectional Kelley skewness of the distribution of the annual growth rate of quarterly sales for a sample of firms from Compustat. The bottom panel of Figure 11 shows the time series 90th-to-50th log percentiles differential and the 50th-to-10th log percentiles differential of the annual log quarterly sales growth for a sample of firms from Compustat. The shaded areas represent NBER recession quarters.

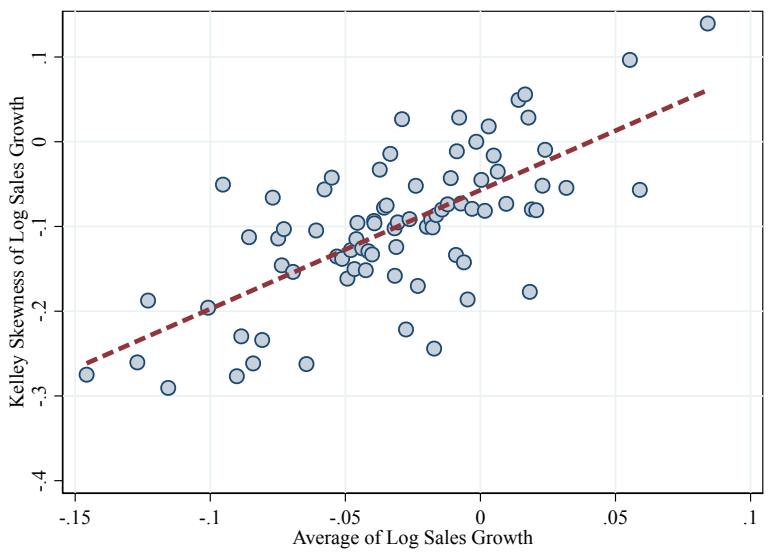
Skewness of Sales and Employment Growth: Cross-Country Data Including Private Firms

Figure 12: Skewness of Firm-Level Outcomes Including Private Firms is Procyclical

(a) BvD Amadeus: Log Employment Growth

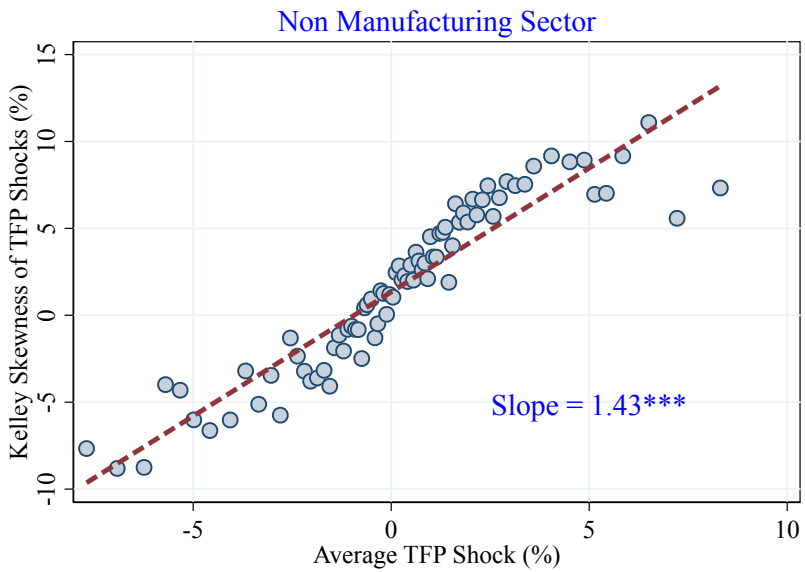


(b) BvD Amadeus: Log Sales Growth

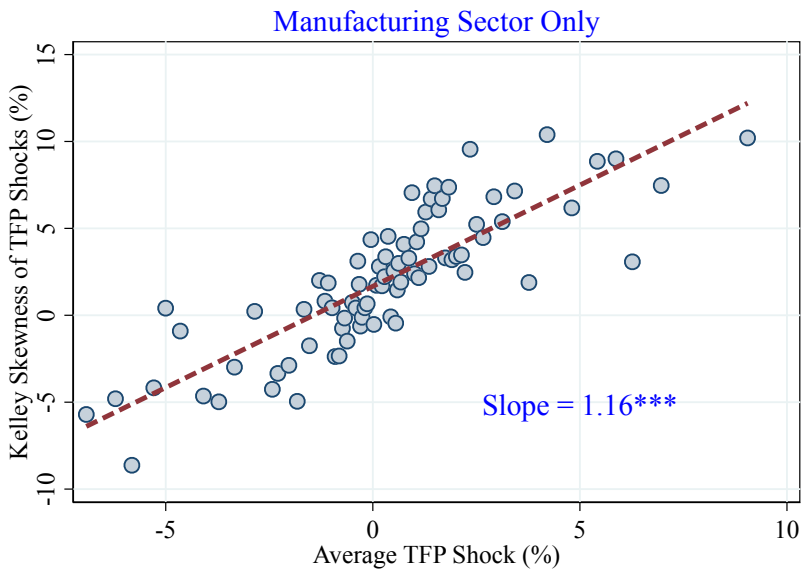


Cyclicality of Skewness Even Stronger Outside of Manufacturing

(c) BvD Amadeus: Non-Manufacturing



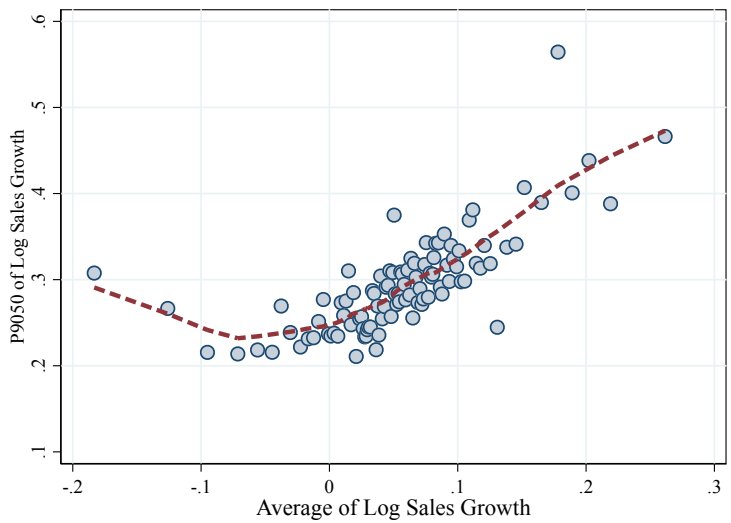
(d) BvD Amadeus: Manufacturing



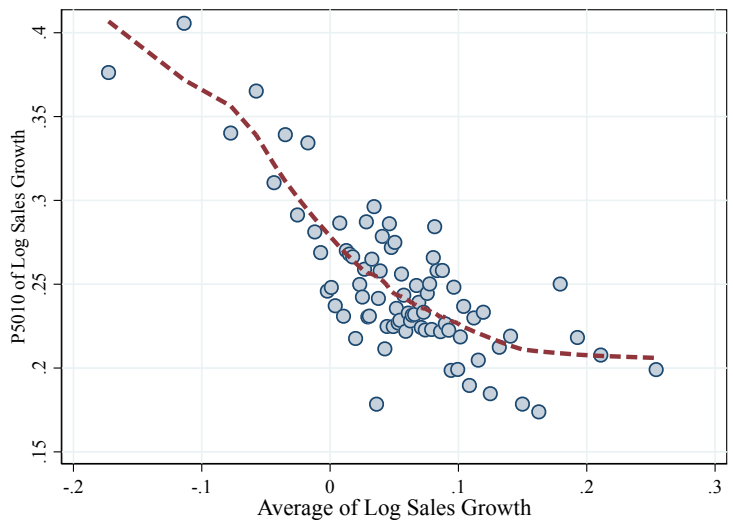
Right and Left Tail Moving Asymmetrically with the Industry Cycle

Figure 13: Right- and Left-Tail Dispersion and Industry Cycle

(a) Compustat: Right-Tail Dispersion of Log Sales Growth

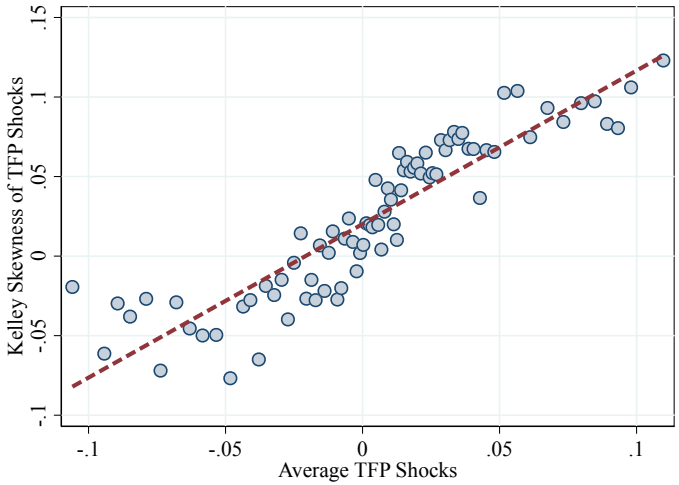


(b) Compustat: Left-Tail Dispersion of Log Sales Growth

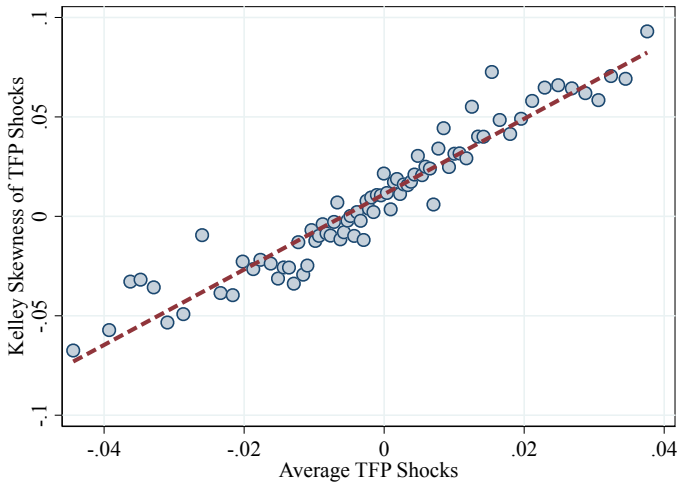


Robustness: Firm-Level TFP Shocks Estimated 4 Different Ways

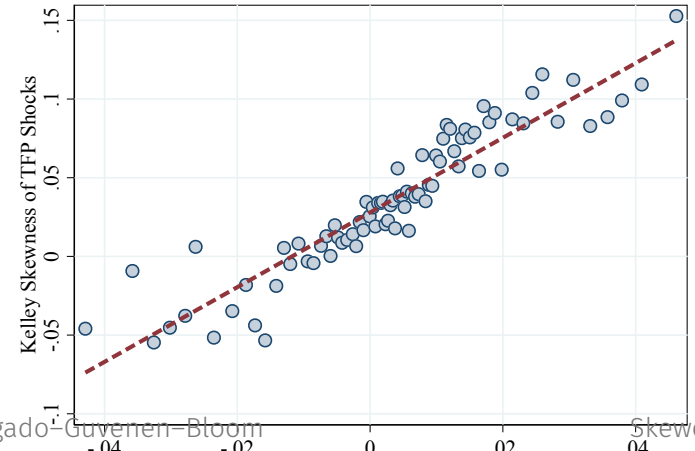
(c) Factor Shares



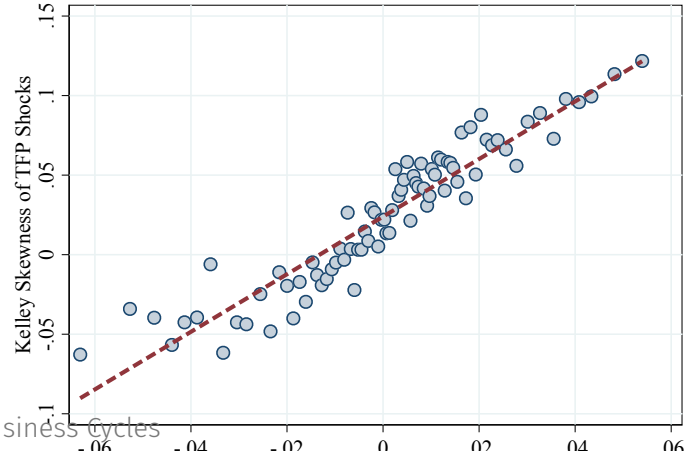
(d) Panel Regression



(e) Olley and Pakes



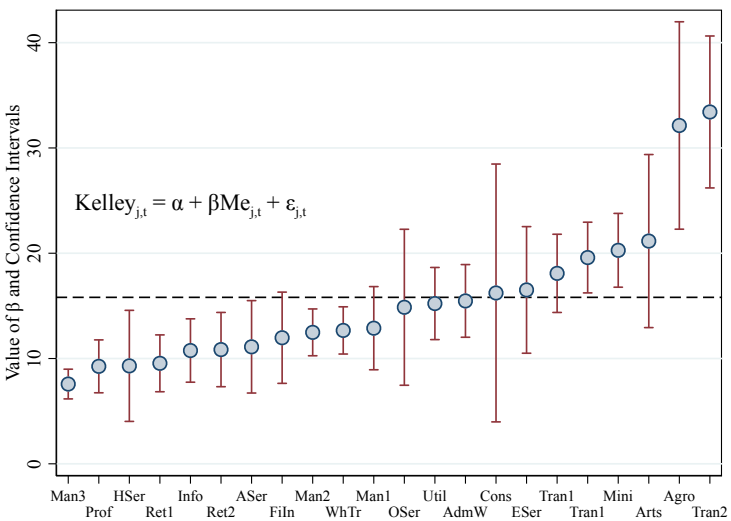
(f) Labor Productivity



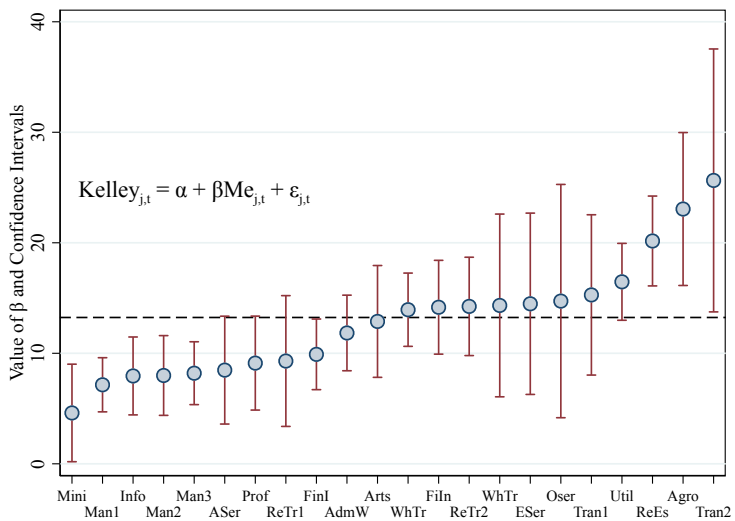
Within-Industry Skewness of Employment Growth also Procyclical

Figure 14: The Skewness of Firm-Level Outcomes is Procyclical Within Industry

(a) Compustat: Log Employment Growth



(b) Compustat: Log Sales Growth



Firm-Level TFP Shocks Comove Positively with Sales Growth

Table 2: Regressing Firm-Level TFP Shocks on Sales Growth

	(1)	(2)	(3)	(4)
Estimation Method:	Factor Shares	Panel Regression	Olley and Pakes	Labor Productivity
Ave. Sales Growth	1.21***	1.10***	1.18***	1.256***
	(0.40)	(0.31)	(0.40)	(0.37)
R^2	0.18	0.14	0.31	0.17
N	3,873	3,873	3,873	3,873

Regressing Skewness of TFP Shocks at Country Level

Table 3: Skewness of Firms' Shocks is Procyclical at the Country Level

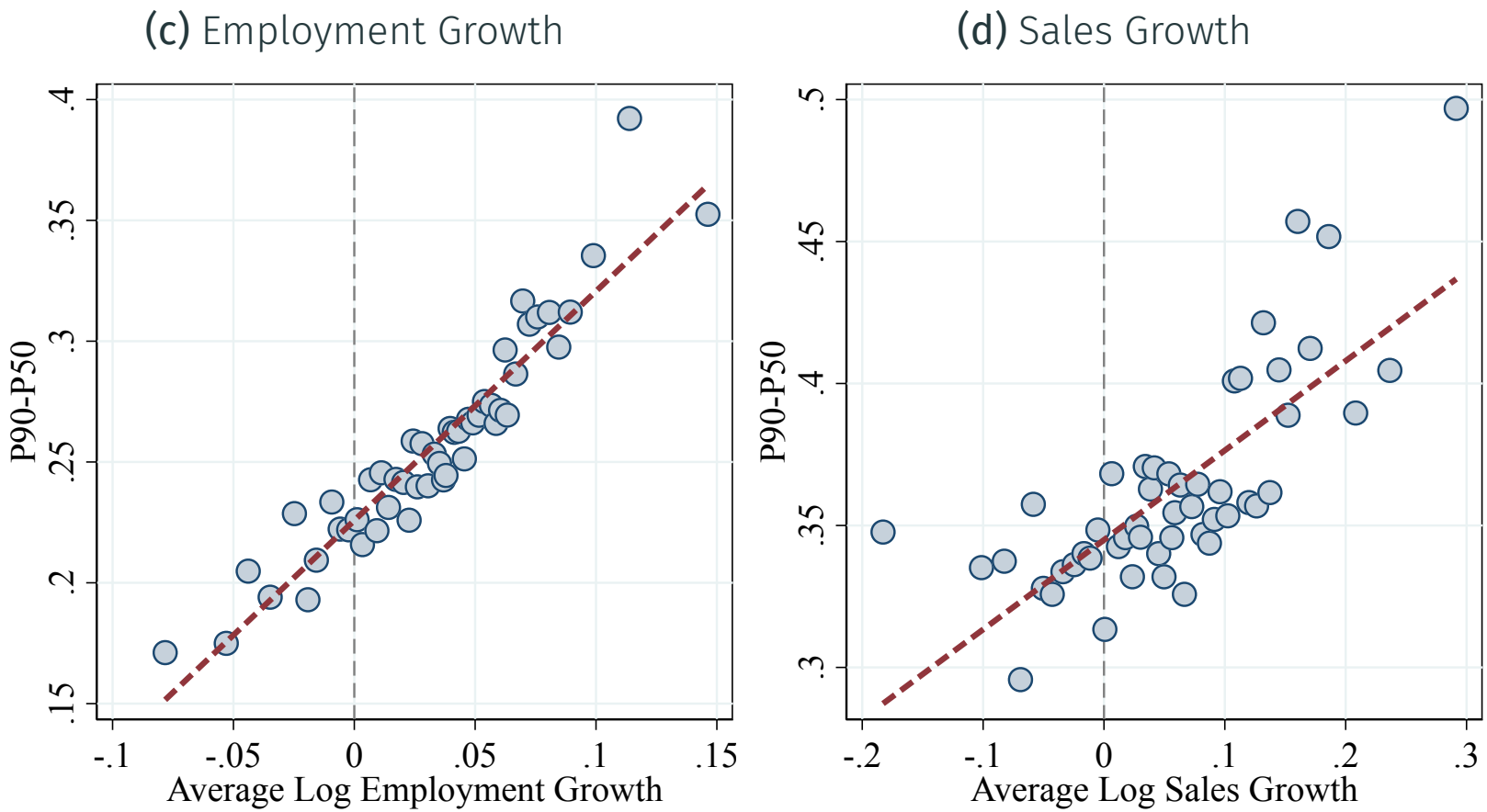
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ISO	DEU	DNK	ESP	FIN	FRA	GBR	GRC	HUN	IRL
Sales Growth	5.27***	4.47***	1.69***	2.27***	3.24***	2.25***	1.27***	0.87***	1.70***
	(0.70)	(1.02)	(0.32)	(0.14)	(0.45)	(0.14)	(0.24)	(0.24)	(0.19)
R^2	0.66	0.63	0.60	0.64	0.56	0.74	0.47	0.76	0.66
N	208	73	392	245	334	275	179	271	186

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
ISO	ISL	ITA	NLD	NOR	POL	PRT	SWE	UKR
Sales Growth	2.56***	1.29***	2.12***	2.04***	1.87***	1.74***	2.86***	1.56***
	(0.31)	(0.19)	(0.21)	(0.35)	(0.36)	(0.17)	(0.228)	(0.209)
R^2	0.84	0.55	0.72	0.51	0.52	0.61	0.65	0.55
N	102	306	152	208	264	234	228	229

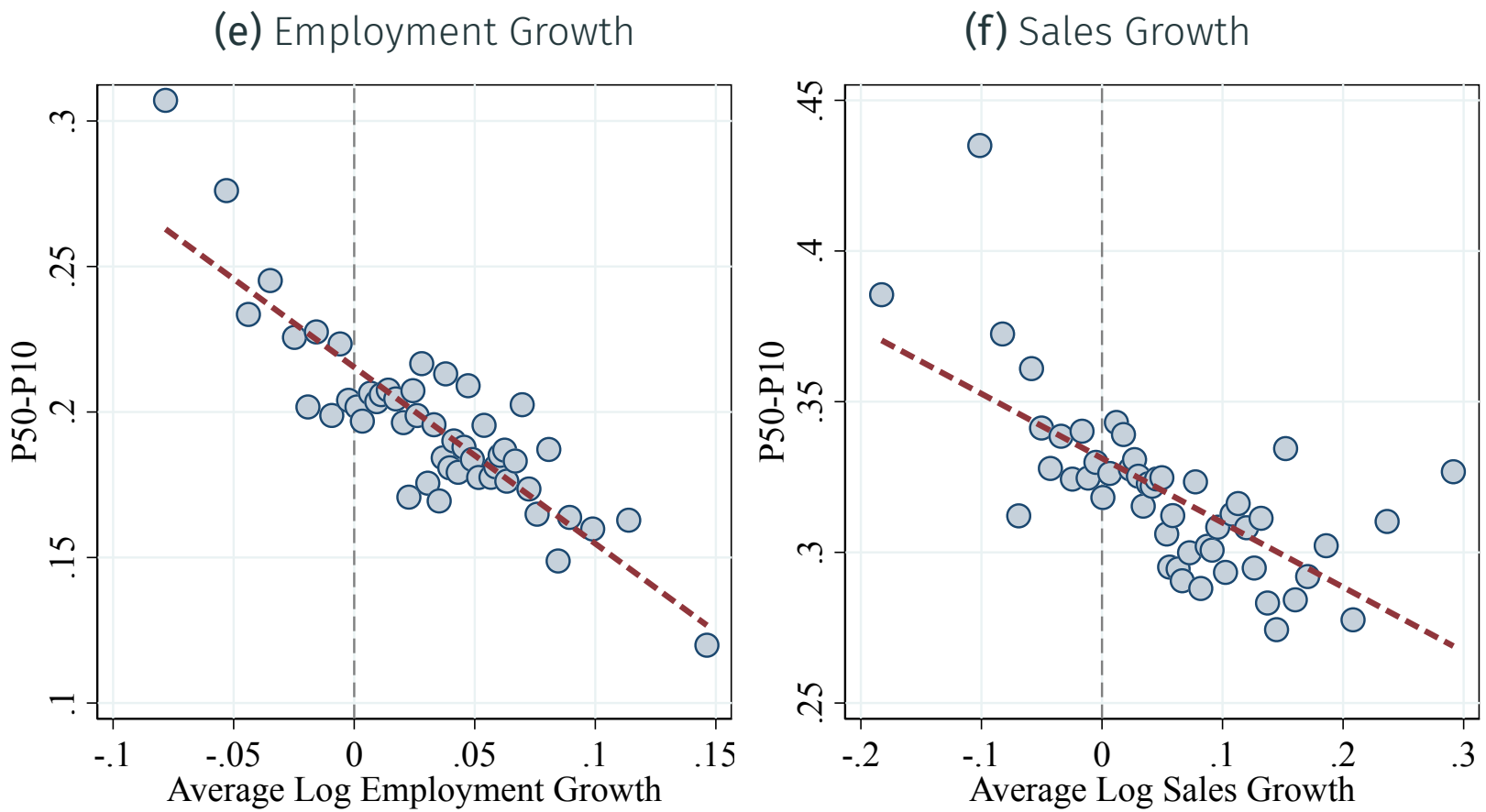
Related Literature

- Micro & Macro Skewness
  - Earnings: Guvenen et al. (2014, 2019), Busch et al. (2020), Harmenberg & Sievertsen (2017), Mckay (2014), Schmidt (2016), Hubmer (2016)
  - Firms: Ilut et al. (2018), Decker et al. (2015), Kehrig (2011)
  - Stocks: Harvey & Siddique (2000), Oh & Wachter (2018), Ferreira (2018), Dew-Becker et al. (2020), Dew-Becker & Giglio (2020)
  - Macro skewness: McKay & Reis (2008), Acemoglu (1999), Van Nieuwerburgh & Veldkamp (2006), Jovanovic (2006)
- Uncertainty Shock:
  - Arellano et al. (2018), Fernadez-Villaverde et al. (2011), Schaal (2017), Bachmann et al. (2013), Bachmann & Bayer (2014), Gilchrist et al. (2014), Jurado et al. (2015), Leduc & Liu (2016), Basu & Bundick (2017), Berger et al. (2017), Kozeniauskas et al. (2018), Bloom et al. (2018), Bhattarai et al. (2019)
- Disaster Risks
  - Rietz (1988), Barro (2006), Barro and Ursua (2011), Gabaix (2008, 2012), Gourio (2008, 2012, 2013), Wachter (2013), Kilic & Wachter (2015), Kozlowski et al. (2018, 2016), Venkateswaran et al. (2015), Jordà et al. (2020).

P9050 in a Panel of 44 Countries

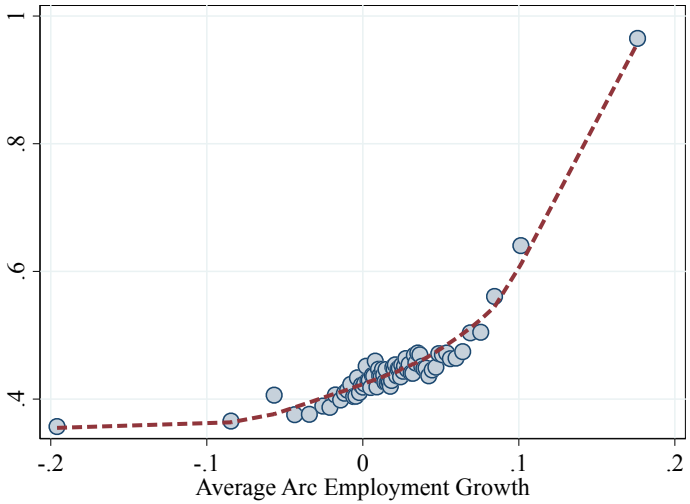


P50-10 in a Panel of 44 Countries

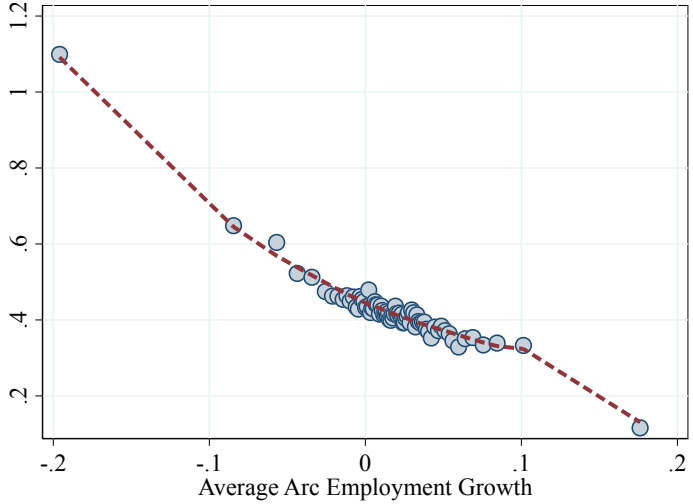


P9050 and P5010 USA Industries LBD and LBD+R

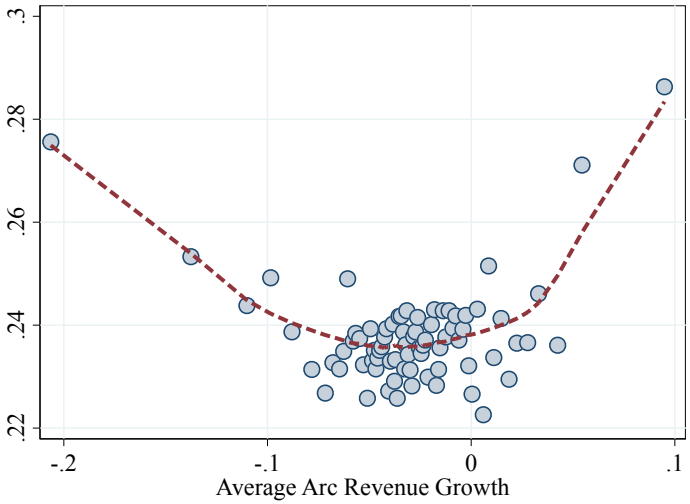
(g) Employment: P90-50



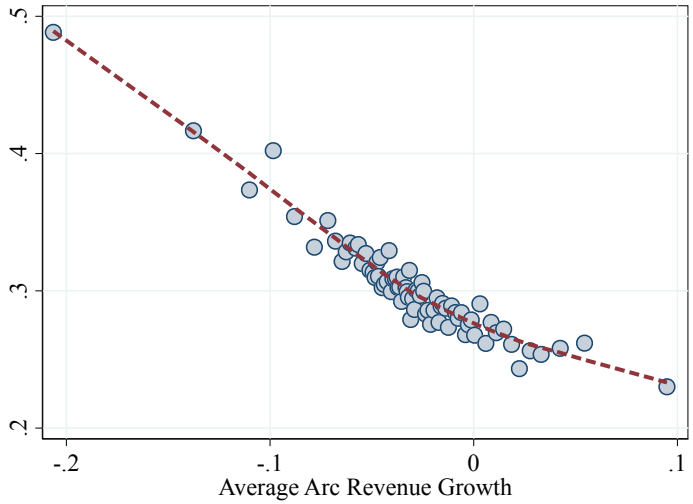
(h) Employment: P50-10



(i) Sales: P90-50

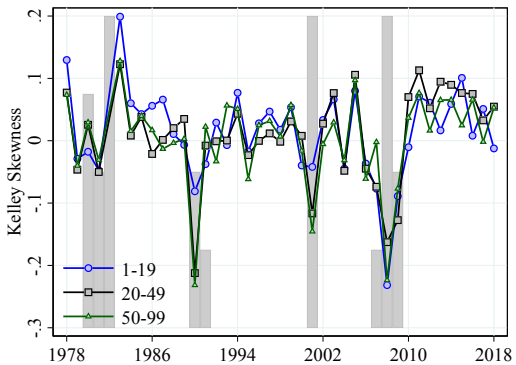


(j) Sales: P50-10

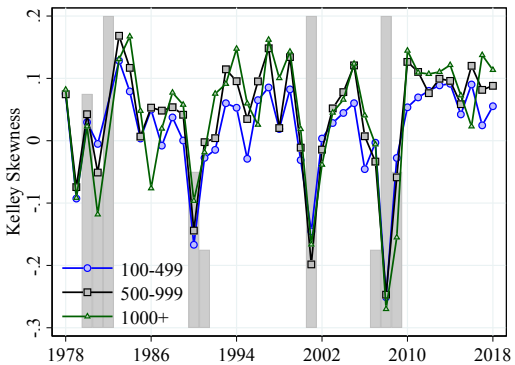


Procyclical Skewness Robust Across Firm Characteristics (LBD, LBD+R)

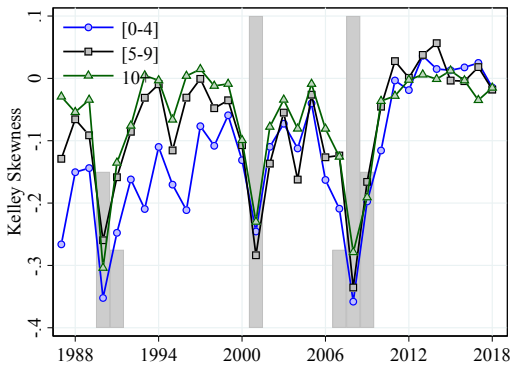
(k) EMP: Small Firms



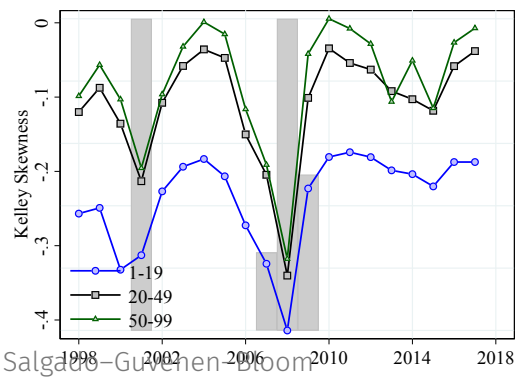
(l) EMP: Medium/Large Firms



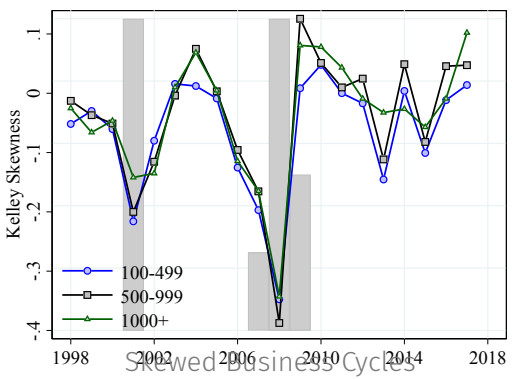
(m) EMP: Firm Age



(n) Sales: Small Firms



(o) Sales: Medium/Large Firms



(p) Sales: Firm Age