Asymmetric Phase Shifts in the U.S. Industrial Production Cycles

Yongsung Chang[1] Sunoong Hwang[2]

[1]University of Rochester & Yonsei University

[2]Korea Institute for Industrial Economics and Trade

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Comovement of Industries

- The comovement of industries over the business cycle is a salient feature of market economies.
- Existing studies have focused on just correlation coefficients.
- Little is known about the comovement of phase shifts across industries, while the concentration of cyclical phases is a cornerstone of the classical definition of the cyclical comovement.

Business Cycles: Burns & Mitchell

A period in which **expansions** are **concentrated** is succeeded by another in which cyclical **peaks** are **concentrated**, by another in which **contractions** are **concentrated**, by another in which cyclical **troughs** are **concentrated**; and this round of events is repeated again and again.

Burns & Mitchell, *Measuring Business Cycles*, 1946, p.70.

What We Do

- Using quarterly industrial production (IP) indices disaggregated at the 4-digit NAICS level, we

  1. identify peaks and troughs in industry cycles
  2. quantify the degree of concentration of cyclical phases
  3. compare the concentration of the clusters of industry turning points between the NBER peak and trough dates
  4. investigate the sources of industry comovement using a panel probit model

Related Work

- **Empirical characterization of industry comovement**
  - Long & Plosser (1987), Christiano & Fitzgerald (1998), Hornstein (2000), Shea (2002), Conley & Dupor (2003), Foerster et al. (2011)
- **Sources of industry comovement**
  - Aggregate shocks : Lucas (1977), Dupor (1999)
  - Spillovers from input-output linkages : Long & Plosser (1983), Hornstein & Praschnik (1997), Horvath (2000), Carvalho (2010)
  - Empirical studies : Bartelsman et al. (1994), Shea (2002), Holly & Petrella (2011)

Related Work (Cont'd)

- **Asymmetric policy effects**
  - Monetary policy : Weise (1999), Lo & Piger (2005), Peersman & Smets (2005)
  - Fiscal policy : Christiano et al. (2011), Auerbach & Gorodnichenko (Forthcoming), Bachmann & Sims (2011), Woodford (2011)
- **Business cycle asymmetries**
  - First-moment properties of the aggregate business cycle: Neftçi (1984), Hamilton (1989), McQueen & Thorley (1993)
  - Cross-sectional properties: Higson et al (2002), Eisfeldt & Rampini (2006), Bachmann & Bayer (2009), Bloom et al (2010), Kehrig (2011)

Contents

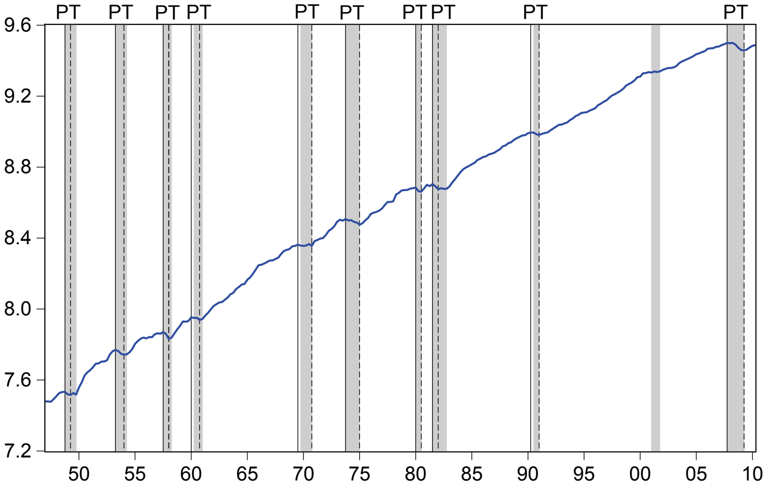
Dating Algorithm: Harding & Pagan (2002)

- We define turning points in the following way:
  - peak at t if $y_t = max\{y_{t-2}, y_{t-1}, y_t, y_{t+1}, y_{t+2}\}$
  - trough at t if $y_t = min\{y_{t-2}, y_{t-1}, y_t, y_{t+1}, y_{t+2}\}$
- Censoring rules:
  - Peaks and troughs alternate.
  - A phase has a minimum duration of 2 quarters.
  - A completed cycle has a minimum duration of 5 quarters.
- Applied to the **level** of industrial output (classical cycle)

Advantage and Disadvantage

- Intuitive and easily replicable
- Does not require a particular definition of trend components
- Consistent with the NBER's practice
- Consistent with many previous studies of business cycle features
- But may fail to detect a turning point in a series with a strong upward or downward trend

Business Cycle Dates: NBER vs Harding-Pagan



Data

- Disaggregated IP indices from the Board of Governors of the Federal Reserve System
- Quarterly and seasonally adjusted
- 1972:Q1–2010:Q2
- 74 manufacturing industries disaggregated by the NAICS codes (mostly at the 4-digit level)

Frequencies and Durations of Industry Cycles

Table 1. Industry Cycles, 1972:Q1–2010:Q2

	No. of cycles	Duration			
		Complete cycle	Expansion (A)	Contraction (B)	Duration asymmetry (A/B)
NBER cycle	5.0	27.4	23.8	3.8	6.2
Industry cycles					
Mean	10.3	14.2	8.7	5.3	1.8
Median	10.0	13.5	7.6	5.1	1.5
Max	16.0	34.0	31.3	8.9	10.4
Min	4.0	8.3	3.8	2.6	0.5
Std.	2.5	4.5	4.3	1.3	1.5

Note: Complete cycles are measured from trough to trough.

- **More cycles than the aggregate economy**
- **Large cross-sectional differences**

Contents

Diffusion Index

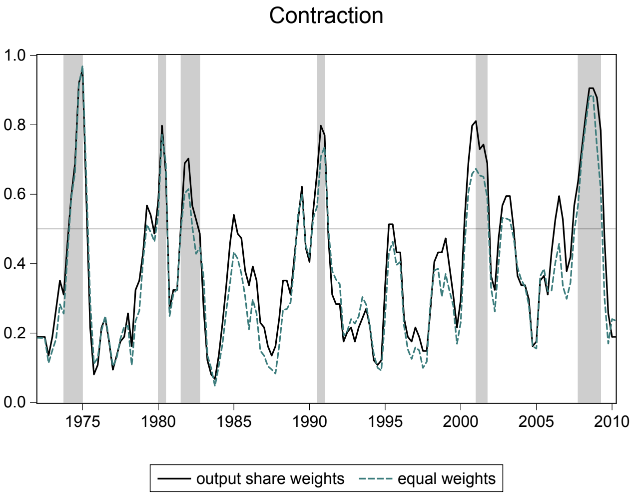
- The diffusion index is defined by

$$D_t = \sum_{i=1}^{N} \omega_{it} S_{it}, \quad t = 1, \ldots, T, \quad \sum_i \omega_{it} = 1$$

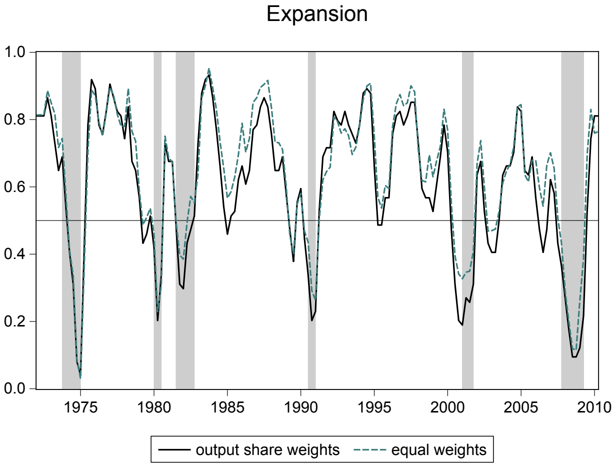
  - ω_{it} : Weight on industry i at time t (equal or output share)
  - S_{it} : Dummy variable taking 1 in contractions and 0 otherwise
  - N : Number of industries

- This index measures **the fraction of industries** sharing the same phase at a given point in time.

Diffusion Index for Contraction



Diffusion Index for Expansion



Concordance Index

- The concordance index is defined by

  1. Pairwise concordance between industries

  $$C_{ij} = T^{-1} \sum_{t=1}^{T} \left[S_{it} S_{jt} + (1 - S_{it})(1 - S_{jt}) \right]$$

  2. Concordance of industries with the aggregate economy

  $$C_{i,US} = T^{-1} \sum_{t=1}^{T} \left[S_{it} S_{US,t} + (1 - S_{it})(1 - S_{US,t}) \right]$$

- These indices measure **the fraction of time** that two cycles are in the same phase over the sample period.

Results of Concordance Indices

TABLE 2. CONCORDANCE INDICES

	Pairwise	NBER
Mean	0.607	0.674
Median	0.604	0.669
Max	0.864	0.883
Min	0.344	0.455
Std.	0.080	0.082

Note: 'Pairwise' measures the concordance between industries. 'NBER' measures the concordance of industries with the aggregate U.S. economy whose turning points are determined by the NBER.

Contents

Clustering Algorithm

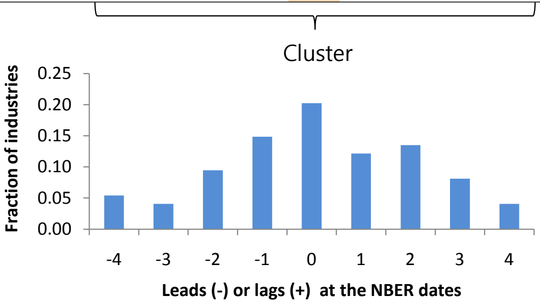
- A turning point cluster is defined as a set of industry turning points whose distances from given NBER turning points are less than $\bar{d}$.

- We choose $\bar{d} = 8$ following Harding & Pagan (2006).

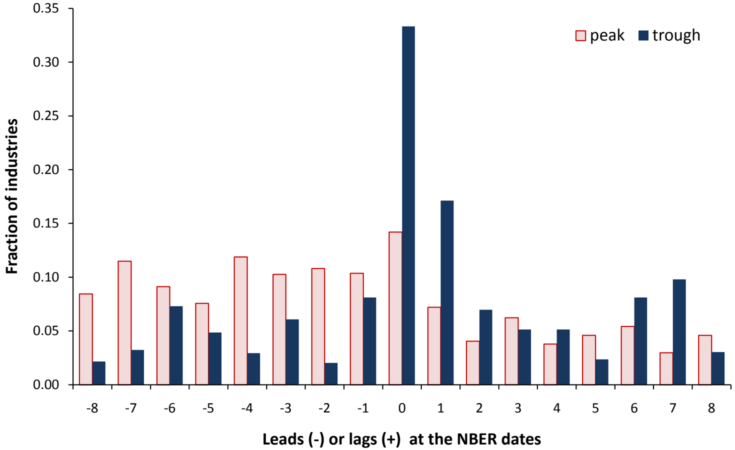
Clustering Algorithm: An Example

- If the aggregate economy experiences a peak at $t = 6$, $\bar{d}$ is set at 4, the number of industries is 74, and the industry turning points are identified as follows,

Time	1	2	3	4	5	6	7	8	9	10	11	12
Leads or lags	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
Number of industries	2	4	3	7	11	15	9	10	6	3	1	0
Fraction of industries	0.03	0.05	0.04	0.09	0.15	0.20	0.12	0.14	0.08	0.04	0.01	0.00

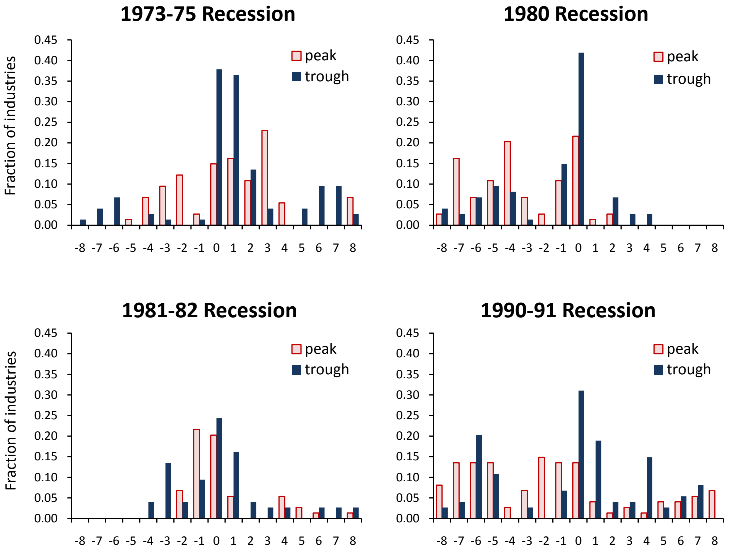


Distributions of Industry Turning Points, 1972:Q1-2010:Q2

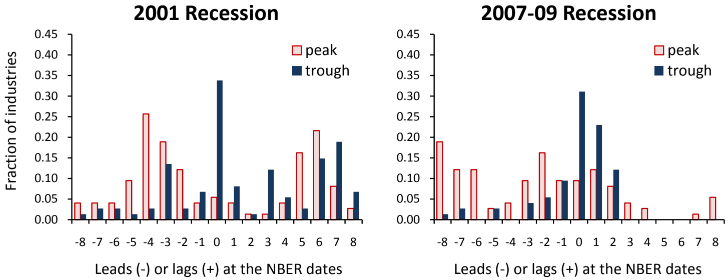


- **Troughs are much more concentrated than peaks.**

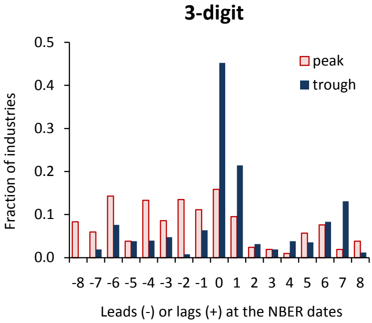
Each NBER Recession

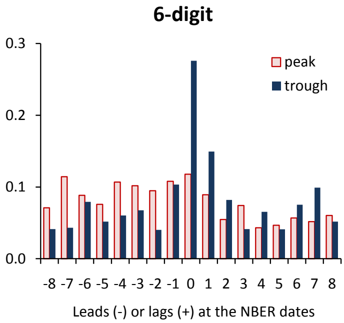


Each NBER Recession (Cont'd)

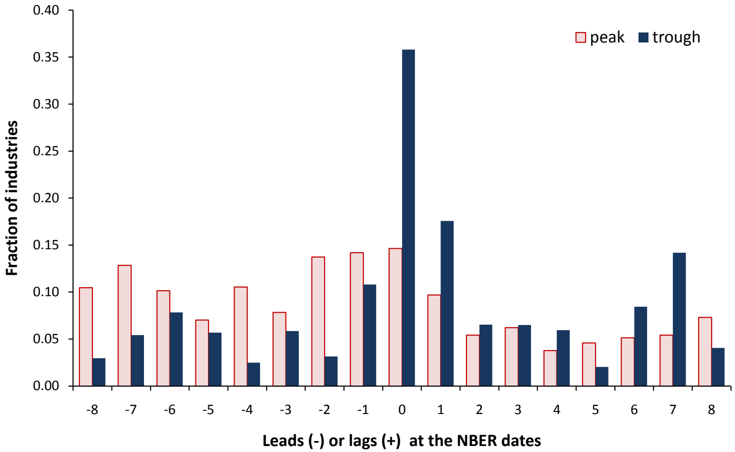


3- and 6-digit NAICS Industries





Detrended IP Series from the Hodrick-Prescott Filter



On Relation to Duration Asymmetry

- The above concentration asymmetry is not necessarily an artifact due to duration asymmetry (long expansions and short recessions).
- Consider the following multi-variate system with a common stochastic trend:

$$y_{it} = \gamma_i f_t + \epsilon_{it}, \quad (1)$$

$$f_t = \alpha + f_{t-1} + \eta_t, \quad (2)$$

where we assume $\gamma_i \sim N(\bar{\gamma}_i, \sigma^2_{\gamma_i})$, $\epsilon_{it} \sim i.i.d.N(0, \nu_i)$, $\nu_i \sim U(\bar{\nu}_i, \sigma^2_{\nu_i})$, and $\eta_t \sim i.i.d.N(0, 1)$.

On Relation to Duration Asymmetry (Cont'd)

- We estimate parameters of the model using the indirect inference method in order to match the model to the data, especially wrt duration asymmetries.

- The mean of duration asymmetries in our multi-variate model is 2.25, close to that (1.85) in the data.

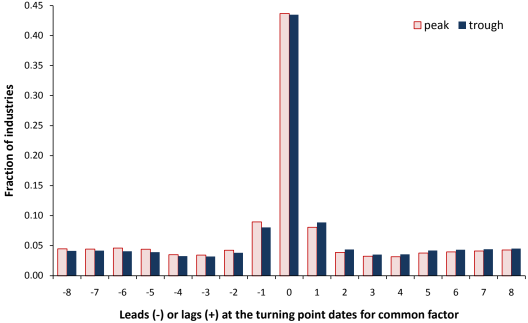
TABLE 3. ACTUAL AND SIMULATED MOMENTS

		Actual moments		Simulated moments
Duration of a complete cycle	Mean	14.22	(0.63)	13.63
	Std.	4.53	(1.22)	2.15
Duration asymmetry	Mean	1.85	(0.18)	2.25
	Std.	1.47	(0.28)	0.62
Amplitude asymmetry	Mean	-1.82	(0.10)	-2.43
	Std.	2.04	(0.16)	0.62
Pairwise concordance	Mean	0.61	(0.01)	0.72
	Std.	0.08	(0.01)	0.13

Note: The actual moments are estimated from IP series disaggregated at the 4-digit NAICS level. The simulated moments are calculated from a simulated data panel using the common stochastic trend model (5)-(7) and the parameter estimates reported in Table A.1. The values in parentheses are bootstrapped standard errors.

On Relation to Duration Asymmetry (Cont'd)

- Armed with this model we generate an artificial data set, and perform the same cluster analysis with peaks and troughs in the individual series.
- In the resulting turning point distributions, averaged over 1000 simulations, the shapes of peak and trough clusters are almost identical.



Uncovering Leading Industries

- **Leading industry:** An industry whose turning points came earlier than the NBER turning points (maximum lead $= 8$ quarters).
- **Coincident industry:** An industry whose turning points coincide with the NBER turning points.
- **Lagging industry:** An industry whose turning points came later than the NBER turning points (maximum lag $= 8$ quarters).
- **Acyclical industry:** An industry that does not experience a cyclical turning point during the time period spanned by the cluster.

Asymmetric Persistence of Groups

TABLE 4. TRANSITION PROBABILITY

	Current			
Previous	Leading	Coincident	Lagging	Acyclical
(A) For Peaks				
Leading	0.613	0.131	0.157	0.100
Coincident	0.554	0.089	0.179	0.179
Lagging	0.547	0.187	0.107	0.160
Acyclical	0.500	0.167	0.146	0.188
(B) For Troughs				
Leading	0.300	0.338	0.263	0.100
Coincident	0.256	0.336	0.296	0.112
Lagging	0.185	0.346	0.346	0.123
Acyclical	0.371	0.171	0.286	0.171

Note: The ijth element indicates the probability of moving from group i at the previous NBER peak (trough) to group j at the current NBER peak (trough).

Asymmetric Composition of Leading Industries

- We examine the numbers of industries that have led, lagged, and coincided with the U.S. business cycle on more than 3 occasions over the past 6 NBER peak and trough dates, respectively (50% or higher).
- For the NBER peak dates, 30 of the 74 industries are defined as leading.
  - No industry is defined as coincident, and 2 industries are defined as lagging.
- For the NBER trough dates, the number of leading industries is reduced to 3.
  - By contrast, those of coincident and lagging industries increase to 10 and 12, respectively.

Leading, Coincident, and Lagging Industries at the NBER Peak Dates

TABLE 5. LEADING, COINCIDENT, AND LAGGING INDUSTRIES AT THE NBER PEAK DATES

Code	Dur.	Industry title	Prob.	Leads (-) or lags (+)	
				Mean	Std.
Leading industries					
3322	D	Cutlery and handtool	1.00	-3.00	1.41
3361	D	Motor vehicle	1.00	-3.00	1.79
3371	D	Furniture and kitchen cabinet	1.00	-1.83	1.17
3325	D	Hardware	0.83	-4.40	2.07
3362	D	Motor vehicle body and trailer	0.83	-4.40	2.70
3255	ND	Paint, coating, and adhesive	0.83	-3.80	2.68
3212	D	Veneer, plywood, and engineered wood product	0.83	-3.60	2.07
3219	D	Other wood product	0.83	-3.40	1.95
3221	ND	Pulp, paper, and paperboard mills	0.83	-3.40	2.30
3352	D	Household appliance	0.83	-3.00	2.35
3274	D	Lime and gypsum product	0.83	-3.00	2.92
3252	ND	Resin, synth. rubber, fibers, and filaments	0.83	-2.80	1.64
3253	ND	Pestic., fertil., and agric. chemical	0.83	-2.60	2.07
3351	D	Electric lighting equipment	0.83	-2.40	1.34
3372A9	D	Office and other furniture	0.83	-2.20	1.30
3315	D	Foundries	0.67	-4.75	2.87
3211	D	Sawmills and wood preservation	0.67	-4.50	2.08
3363	D	Motor vehicle parts	0.67	-4.50	2.08
3122	ND	Tobacco	0.67	-4.25	3.77
3334	D	Ventilat., heat., air-cond., and refrig. equip.	0.67	-4.00	2.16
3149	ND	Other textile product mills	0.67	-4.00	2.45
3118	ND	Bakeries and tortilla	0.67	-4.00	2.94
3133	ND	Textile and fabr. finishing and fabr. coating mills	0.67	-3.75	1.26
3343	D	Audio and video equipment	0.67	-3.75	1.71
3131	ND	Fiber, yarn, and thread mills	0.67	-3.75	2.36
3353	D	Electrical equipment	0.67	-3.75	2.36
3273	D	Cement and concrete product	0.67	-3.25	1.50
3329	D	Other fabricated metal product	0.67	-3.25	3.30
3279	D	Other nonmetallic mineral product	0.67	-3.00	2.12
3141	ND	Textile furnishings mills	0.67	-2.25	0.50
Lagging industries					
3113	ND	Sugar and confectionery product	0.67	1.50	1.00
3345	D	Navig., measur., electromed., and contr. instr.	0.67	2.50	1.29

Note: 'D' and 'ND' stand for durables and nondurables, respectively. 'Prob.' denotes the unconditional probability of being classified in a group at a NBER peak. 'Mean' and 'Std.' are the conditional mean and standard deviation of leads or lags at the NBER peaks, given that the industry belongs to the specified group.

Leading, Coincident, and Lagging Industries at the NBER Trough Dates

Table 6. Leading, Coincident, and Lagging Industries at the NBER Trough Dates

Code	Dur.	Industry title	Prob.	Leads (-) or lags (+)	
				Mean	Std.
Leading industries					
3391	D	Medical equipment and supplies	0.67	-3.50	3.32
3113	ND	Sugar and confectionery product	0.67	-3.20	2.28
3211	D	Sawmills and wood preservation	0.67	-3.00	2.45
Coincident industries					
3149	ND	Other textile product mills	0.83	0.00	0.00
3325	D	Hardware	0.83	0.00	0.00
3311A2	D	Iron and steel products	0.83	0.00	0.00
3132	ND	Fabric mills	0.67	0.00	0.00
3133	ND	Textile and fabr. finishing and fabr. coating mills	0.67	0.00	0.00
3327	D	Machine shop; screw, nut, and bolt	0.67	0.00	0.00
3371	D	Furniture and kitchen cabinet	0.67	0.00	0.00
3261	ND	Plastics product	0.67	0.00	0.00
3272	D	Glass and glass product	0.67	0.00	0.00
3315	D	Foundries	0.67	0.00	0.00
Lagging industries					
3333A9	D	Commercial and service industry machinery	0.83	1.80	1.30
3336	D	Engine, turbine, and power trans. equipment	0.83	2.40	2.61
3118	ND	Bakeries and tortilla	0.83	2.40	2.61
3353	D	Electrical equipment	0.83	2.80	2.39
3256	ND	Soap, cleaning compound, and toilet preparation	0.83	3.00	2.55
3345	D	Navig., measur., electromed., and contr. instr.	0.67	2.25	1.50
3321	D	Forging and stamping	0.67	2.75	0.96
3331	D	Agriculture, construction, and mining machinery	0.67	2.75	2.06
3122	ND	Tobacco	0.67	3.00	1.41
3111	ND	Animal food	0.67	3.00	1.41
3335	D	Metalworking machinery	0.67	3.20	2.77
3365	D	Railroad rolling stock	0.67	4.50	2.38

Note: See footnote of Table 5.

On Relation to Sharpness Asymmetry

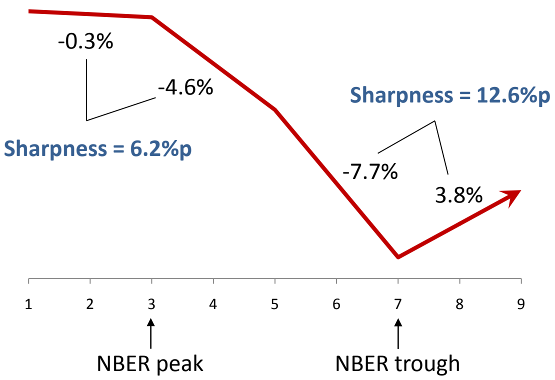
- Our finding of a higher concentration of troughs is in contrast to the conventional notion of a 'sudden stop and slow recovery' dating back to Keynes (1936, p.314):

  > *"The substitution of a downward for an upward tendency often takes place suddenly and violently, whereas there is, as a rule, no such sharp turning point when an upward is substituted for a downward tendency."*

- It is instead consistent with 'round' peaks and 'sharp' troughs, as documented by McQueen & Thorley (1993).

Round Peak and Sharp Trough

Growth Rates of Log IP During 2 Quarters Around the NBER Turning Points : Cross-industry Mean for Total Manufacturing



Sharpness Asymmetry for Each Group of Industries

Table 7. Sharpness Asymmetry for Each Group of Industries

	Peaks			Troughs			Sharpness asymmetry
	$D_{P,-2}$	$D_{P,+2}$	S_P	$D_{T,-2}$	$D_{T,+2}$	S_T	$(S_T - S_P)$
Total	-0.003	-0.046	0.062	-0.077	0.038	0.126	0.065*
Coincident	0.034	-0.063	0.097	-0.120	0.089	0.209	0.112*
Others	-0.009	-0.043	0.056	-0.056	0.012	0.085	0.029*
Leading	-0.029	-0.068	0.059	-0.020	0.055	0.096	0.037*
Lagging	0.034	0.013	0.049	-0.083	-0.018	0.083	0.035*
Acyclical	0.003	-0.031	0.056	-0.035	0.024	0.070	0.013

Note: For peaks, $D_{P,-2}$ and $D_{P,+2}$ indicate the mean changes in the log IP during the two quarters ending in the NBER peak dates and those during the two quarters following the NBER peak dates. S_P measures the mean sharpness of the log IP at the NBER peak date, defined as the absolute difference between $D_{P,-2}$ and $D_{P,+2}$. For troughs, $D_{T,-2}$, $D_{T,+2}$, and S_T are defined in a similar way. Sharpness asymmetry is measured by the difference between S_T and S_P. Asterisk indicates that the Welch t-test rejects the null of no sharpness asymmetry at the 5% level or less.

- **All groups except for acyclical industries exhibit significant sharpness asymmetry, and the most profound asymmetry is found in coincident industries.**

Decomposition of Sharpness Asymmetry

$$S_T - S_P = \underbrace{\sum_{g=1}^{2}(w_{g,T} - w_{g,P}) \times \frac{1}{2}(S_{g,P} + S_{g,T})}_{\text{Composition effect}} + \underbrace{\sum_{g=1}^{2}(S_{g,T} - S_{g,P}) \times \frac{1}{2}(w_{g,P} + w_{g,T})}_{\text{Individual asymmetry}}$$

where

- $g = 1$: coincident industries, $g = 2$: others
- P : NBER peaks, T : NBER troughs
- w : fraction of industries
- S : sharpness at the NBER turning point dates

Decomposition of Sharpness Asymmetry

Table 8. Decomposition of Sharpness Asymmetry

NBER recessions	$S_T - S_P$	Composition effect (%)		Individual asymmetry (%)	
1973–75	0.151	0.030	(19.5)	0.122	(80.5)
1980	0.045	0.010	(22.5)	0.035	(77.5)
1981–82	0.028	0.003	(9.2)	0.026	(90.8)
1990–91	0.029	0.014	(48.5)	0.015	(51.5)
2001	0.022	0.017	(74.6)	0.006	(25.4)
2007–09	0.112	0.022	(19.3)	0.090	(80.7)
Mean	0.065	0.016	(24.3)	0.049	(75.7)

Note: The second column shows sharpness asymmetry at the aggregate level, estimated for each NBER recession. 'Composition effect' corresponds to the sharpness asymmetry due to changes in the fraction of coincident and other industries. 'Individual asymmetry' corresponds to the sharpness asymmetry attributed to the changes in sharpness for each group of industries between NBER troughs and peaks. The values in parentheses are the share of sharpness asymmetry (in percentage terms) explained by each source.

- **The concentration asymmetry accounts for 24.3% of the aggregate-level sharpness asymmetry.**

Contents

Empirical Model

- For the occurrence of a peak, the empirical model is

$$d_{it} = \mathbb{1}(X_{it}'\beta + u_{it} > 0), \quad \text{for } i = 1, \ldots, N \text{ and } t = 1, \ldots, T,$$

  - d_{it} : 1 if industry i is at a peak at time t and otherwise 0
  - $\mathbb{1}(\cdot)$: indicator function
  - X_{it} : a vector of observable covariates
  - β : a vector of index coefficients
  - u_{it} : residual term

Empirical Model (Cont'd)

- We assume that

$$u_{it} = \tau_i + \epsilon_{it},$$

  - τ_i : industry-specific time-invariant component that captures unobserved heterogeneity in the mean duration of expansion phases
  - ϵ_{it} : idiosyncratic disturbance that changes across t as well as i
  - Both τ_i and ϵ_{it} are assumed to be independent from X_{it}.
  - $\tau_i \sim N(0, \sigma_\tau^2)$ and $\epsilon_{it} \sim$ i.i.d.$N(0, 1)$
  - This assumption allows for a random effects approach.

Empirical Model (Cont'd)

- The conditional likelihood is

$$L = \prod_{i=1}^{N} \left\{ \int_{-\infty}^{\infty} \left[\prod_{t=1}^{T} \text{Prob}\left(d_{it} | X_{it}, \tau_{it}, s_{it}; \beta\right) \right] \phi(\tau_i | \sigma_\tau^2) d\tau_i \right\},$$

  - $$\begin{aligned} \text{Prob}(d_{it}|X_{it}, \tau_{it}, s_{it}; \beta) &= \Phi(X_{it}'\beta + \tau_i)^{d_{it}}[1 - \Phi(X_{it}'\beta + \tau_i)]^{1-d_{it}} && \text{if } s_{it} = 0 \\ &= 1 && \text{if } s_{it} = 1 \end{aligned}$$
  - s_{it} equals 1 where a peak *cannot* occur because of the censoring rule.
  - $\Phi(\cdot)$ and $\phi(\cdot)$ are the c.d.f. and p.d.f. of the standard normal distribution.

- We use a 12-point Gauss-Hermite quadrature to approximate the integral over τ_i (Butler & Moffitt, 1982).

Differences from Previous Studies

This study	Previous studies
• Discrete event variables	• Continuous variables like the growth rates of IP indices (Bartelsman et al. 1994; Shea, 2002; Holly & Petrella, 2011)
• The end of the cyclical phases (peaks and troughs)	• Cyclical phases per se (Estrella & Mishkin, 1998; Harding & Pagan, 2011)
• Panel data model	• Aggregate-level time-series model (Estrella & Mishkin, 1998; Harding & Pagan, 2011)

Spillover Effects from Input-Output Linkages

- Two groups of explanatory variables are considered.
- The first group consists of the weighted averages of spillover effects from other industries' phase shifts, constructed as

$$Z_{i,t-p} = \sum_{j \neq i} \omega_{ij} d_{j,t-p}$$

  - $d_{j,t-p}$: 1 if industry j experiences a phase shift at time $t-p$
  - w_{ij} : the importance of industry j for industry i

- Two types of spillover effects are considered.
  - Upstream : From output users (demand-side)
  - Downstream : From input suppliers (supply-side)

Spillover Effects from Input-Output Linkages (Cont'd)

- Let m_{ij} be the value of commodity (in producers' prices) produced by industry i and used in industry j. This value is obtained from the 1997 Benchmark Input-Output table.
- In the upstream propagation,

$$\omega_{ij} = \frac{m_{ij}}{\sum_{j \neq i} m_{ij}}$$

- In the downstream propagation,

$$\omega_{ij} = \frac{m_{ji}}{\sum_{j \neq i} m_{ji}}$$

Aggregate Macroeconomic Shocks

- We consider three different macroeconomic shocks.
    1. Monetary policy shocks: Romer & Romer (2004)
    2. Government spending shocks: Ramey (2011)
    3. Oil price shocks: Hamilton (2003)
- Due to data limitation for monetary policy shocks, the model is estimated over the period 1972:Q1-1996:Q4.
- We include 8 lags for both the inter-industry spillover variables and the macroeconomic shocks.
- All explanatory variables are normalized to unit variance after setting the mean to zero.

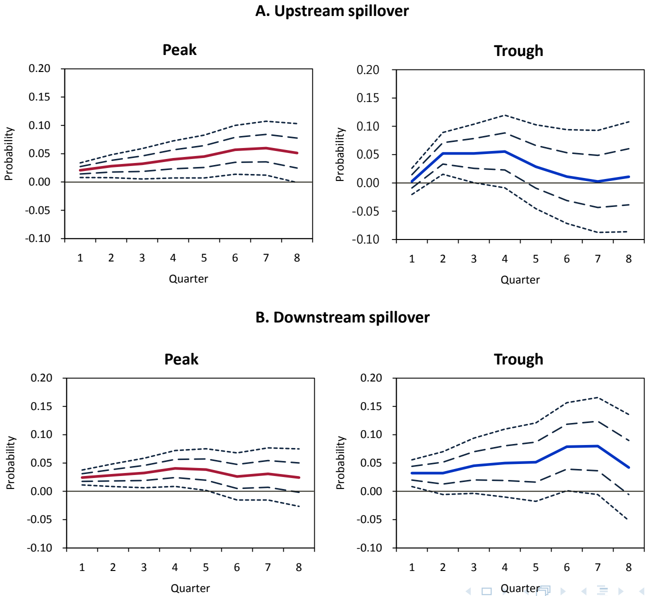
Average Marginal Effects

- Our discussion of the estimation results is based on the average marginal effects (AME), given by

$$\frac{1}{N}\sum_{i=1}^{N}\left\{\frac{1}{T_i}\sum_{t=1}^{T_i}\left[\frac{\partial\,\text{Prob}\left(d_{it}=1|X_{it},\tau_i,s_{it};\beta\right)}{\partial\,X_{it}}\right]\right\},$$

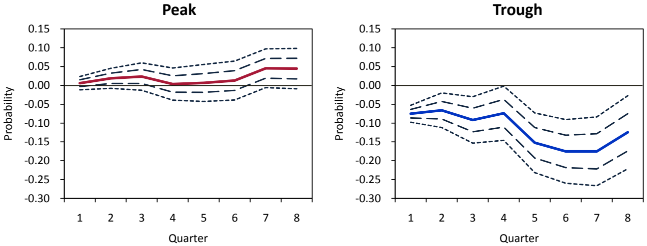
  - T_i : the size of the effective sample in which $s_{it}=0$ (not censored) for given i

The Cumulative Marginal Effects of a One-standard-deviation Increase in the Explanatory Variables on the Probabilities of Industry Phase Shifts

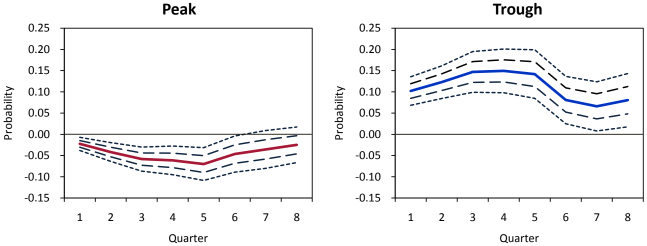


The Cumulative Marginal Effects of a One-standard-deviation Increase in the Explanatory Variables on the Probabilities of Industry Phase Shifts

C. Monetary policy shock



D. Government spending shock



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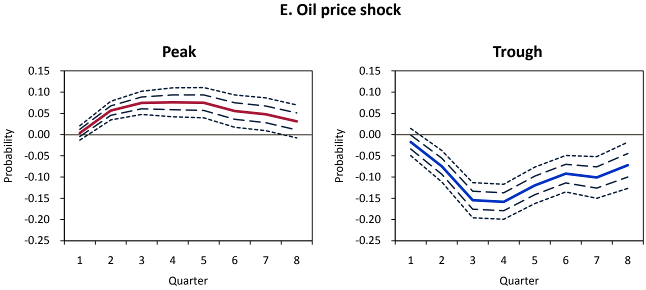


Summary of Findings

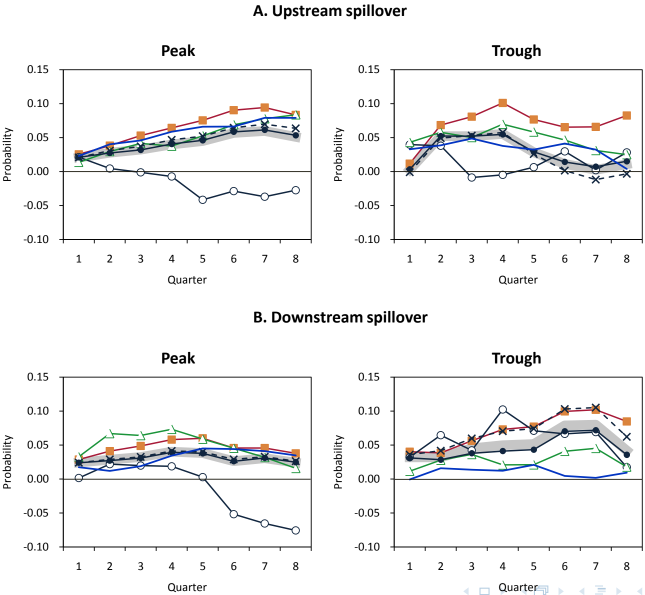
- Occurrences of phase shifts across industries strongly support the spillovers through input-output linkages, a core aspect of multi-sector models.
- The standard common macroeconomic shocks, such as exogenous changes in the federal funds rate, government spending, and oil prices, are all significant drivers of phase shifts at the industry level.
- Both monetary and fiscal policy shocks are more effective in recessions.

Robustness

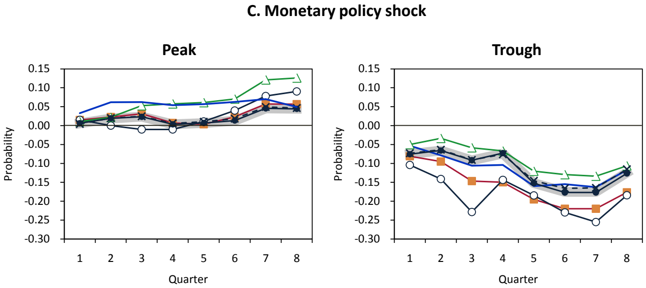
- We find that the results are quite robust to alternative data and model specifications.

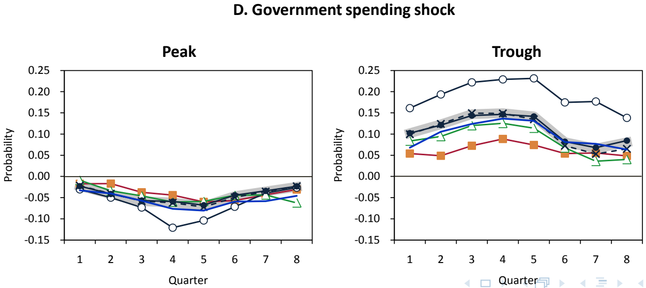
Baseline	Alternative
• Nominal oil price shocks (Hamilton, 2003)	• Real oil price shocks due to oil supply disruptions (Kilian, 2008)
• 4-digit NAICS	• 3-digit NAICS
• Series in levels	• Detrended series
• No serial correlation in the errors	• AR(1) specification
• Random effects model	• Fixed effects model
• 1997 IO table	• 1977 IO table

Results of Various Sensitivity Exercises

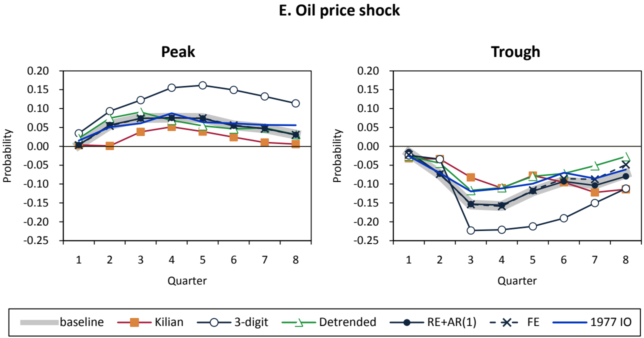


Results of Various Sensitivity Exercises (Cont'd)





Results of Various Sensitivity Exercises (Cont'd)



Contents

Summary

- Cyclical phase shifts of industries are highly concentrated around the aggregate turning points.
- In contrast to the conventional notion of a 'sudden stop and slow recovery,' troughs are much more concentrated than peaks.
- Occurrences of phase shifts across industries support the spillovers through input-output linkages.
- The common macroeconomic shocks, such as exogenous changes in the federal funds rate, government spending, and oil prices, are significant drivers of industrial phase shifts.
- Both monetary and fiscal policy shocks are more effective in recessions than in expansions.