When Is Sticky Information More Information?

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Observations and Motivating Questions

- Data provided by statistical agencies lag current conditions
  - e.g. manufacturing data are released with a one-month lag ...
  - are revised up to 3 months after initial release, ...
  - and further subject to an annual revision

- Even if obtained in real time, monthly manufacturing data is “noisy” $\Longrightarrow$ underlying business cycle conditions are partially masked

- Qualitative surveys also used to track business cycles.
  - e.g. the ISM monthly diffusion index of manufacturing production,
  - similar indices produced by several Federal Reserve Banks at a more regional level

Observations and Motivating Questions

- Carrying out timely qualitative surveys is costly...
- Diffusion indices constructed from simple trichotomous classifications
  - answers are limited to "up," "down," "the same,"
  - number of respondents can vary over time, need not be the same across surveys
  - individual responses are aggregated into proportions of respondents reporting "increases," "decreases," "no change,"
  - these proportions are aggregated into time series
- Can diffusion indices teach us about informational rigidities?
- Why have qualitative answers, converted in the way suggested by diffusion indices, proven useful in tracking activity in real time

Overview for this paper

- Use output data on 124 manufacturing sectors to construct an empirical framework comprising "hypothetical" survey respondents
- Each Respondent acts as a spokesperson for a firm whose output reflects aggregate and sector-specific considerations
- Methods used to construct diffusion indices are applied to hypothetical respondents to create a synthetic diffusion index - can then be compared with actual production index published by ISM
- 2 key assumptions:
  - respondents have "sticky" information as in Mankiw and Reis (2002, 2006)
  - Not all changes in output are reported as "up" or "down" $\Longrightarrow$ latent indifference thresholds, Pesaran and Weale (2006)

Overview for this paper

- Survey respondents update their expectations on average every 8 months...
- ... compared to 12 months in Carroll (2003), 12.5 months in Mankiw, Reis and Wolfers (2003), betwen 4 and 6 months in the firms of Mankiw and Reis (2006, 2009), around 6 to 7 months in Coibion and Gorodnichenko (2009)
- Informational rigidities help explain the widespread use of diffusion indices
  - survey answers based on expected output rather than actual production
  - "noisy" fluctuations are filtered out
  - diffusion indices are degenerate in an RBC environment
- Information on overall manufacturing is sectorally concentrated - surveying 15 sectors may work as well as 124 sectors

Key Steps

- Methods used to construct the ISM and other diffusion indices
- Differences between the ISM index and the underlying sectoral manufacturing production data
- Empirical framework aimed at reconciling these differences
- Review of findings
- Key features of the economic environment that make the ISM "work." Can we suggest guidelines for the construction of diffusion indices?

Diffusion Indices: The ISM Manufacturing Production Index

- The Institute for Supply Management (ISM) is a large trade association (40,000 management professionals)
- It compiles a monthly Manufacturing Report on Business based on questions asked of executives
- Respondents are asked about output changes this month relative to last month
- Answers are limited to "up," "down," and "same"
- ISM index is calculated by adding percentage of positive responses to half of the percentage of "same" responses

Diffusion Indices: The ISM Manufacturing Production Index

- Consider the U.S. Census Bureau classification of Manufacturing into M distinct sectors

- output of a firm i working in sector j at date t (x_t^{ij}), and its growth rate, (Δx_t^{ij})

- N respondents in each of these M manufacturing sectors are asked whether, relative to the previous month, their firm's output...
  - is "up" (u_t^{ij}),
  - "the same" (s_t^{ij}), or
  - "down" (d_t^{ij})

Diffusion Indices: The ISM Manufacturing Production Index

- ISM surveying process may be described as cataloging respondents' perception of changes in their firm's output between $t-1$ and t as:

$$
\begin{aligned}
&\text{if } \Delta x_t^{ij} > \tau, i \text{ reports "up"}; \ u_t^{ij}(\tau) = 1,\ s_t^{ij}(\tau) = d_t^{ij}(\tau) = 0,\\
&\text{if } -\tau \leq \Delta x_t^{ij} \leq \tau, i \text{ reports "same"}; \ s_t^{ij}(\tau) = 1,\ u_t^{ij}(\tau) = d_t^{ij}(\tau) = 0,\\
&\text{if } \Delta x_t^{ij} < -\tau, i \text{ reports "down"}; \ d_t^{ij}(\tau) = 1,\ u_t^{ij}(\tau) = s_t^{ij}(\tau) = 0.
\end{aligned}
$$

- Interval $[-\tau, \tau]$ defines an indifference region that represents respondents' latent perceptions of rises and falls in output.
  - Dependence made explicit: $u_t^{ij}(\tau)$, $s_t^{ij}(\tau)$, and $d_t^{ij}(\tau)$

Diffusion Indices: The ISM Manufacturing Production Index

- Fraction of "optimists":

$$U_t = M^{-1}N^{-1}\sum_{j=1}^{M}\sum_{i=1}^{N} u_t^{ij}(\tau).$$

- Fraction of "pessimists":

$$D_t = M^{-1}N^{-1}\sum_{j=1}^{M}\sum_{i=1}^{N} d_t^{ij}(\tau),$$

- Fraction of "same" respondents:

$$S_t = M^{-1}N^{-1}\sum_{j=1}^{M}\sum_{i=1}^{N} s_t^{ij}(\tau)$$

Diffusion Indices: The ISM Manufacturing Production Index

- The ISM diffusion index at t is:

$$\begin{aligned}\mathcal{I}_t &= \left(U_t + \frac{1}{2}S_t\right) \times 100 \\ &= M^{-1}N^{-1}\sum_{j=1}^{M}\sum_{i=1}^{N}\left(u_t^{ij}(\tau) + \frac{1}{2}s_t^{ij}(\tau)\right) \times 100.\end{aligned}$$

  index values range between 0 to 100, above 50 interpreted as an expansion of economic activity

- The corresponding "balance statistic" is:

$$\begin{aligned}\mathcal{I}_t &= (U_t - D_t) \times 100 \\ &= M^{-1}N^{-1}\sum_{j=1}^{M}\sum_{i=1}^{N}\left(u_t^{ij}(\tau) - d_t^{ij}(\tau)\right) \times 100,\end{aligned}$$

  balance statistics range between -100 and 100, above 0 interpreted as an expansion of economic activity

Properties of Sectoral Data and the ISM index

- Monthly data on manufacturing production, 1972-2009, 124 NAICS sectors
- Growth rate of aggregate manufacturing output is:

$$\Delta x_t = \sum_{j=1}^{M} w_t^j \Delta x_t^j,$$

- where

$$\Delta x_t^j = \sum_{i} w_t^{ij} \Delta x_t^{ij},$$

- Sectoral weighting scheme relatively unimportant, Foerster, Sarte, Watson (2010)

$$\Delta x_t \approx M^{-1} \sum_{j=1}^{M} \Delta x_t^j = M^{-1} \sum_{j=1}^{M} \sum_{i} w_t^{ij} \Delta x_t^{ij}$$

Properties of Sectoral Data and the ISM index

- How do Δx_t and $\mathcal{I}_t$ compare?

- How do we reconcile the two series?


A. Aggregate Manufacturing Output Growth
percent (annual rate)
30
20
10
0
−10
−30
−50
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
year
B. ISM Manufacturing Production Index
index value
90
80
70
60
50
40
30
20
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
year

The Spectral Representation Theorem

- $$\Delta x_t = \mu + \int_0^{\pi} \alpha(\omega)\cos(\omega t)d\omega + \int_0^{\pi} \delta(\omega)\sin(\omega t)d\omega,$$

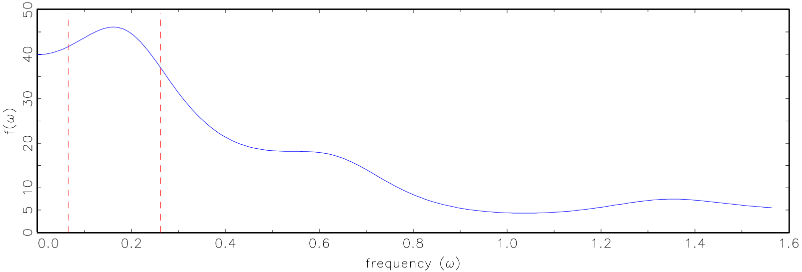
  where ω denotes a particular frequency and the weights $\alpha(\omega)$ and $\delta(\omega)$ are random variables with zero means.

- $$var(\Delta x_t) = 2\int_0^{\pi} f(\omega)d\omega,$$

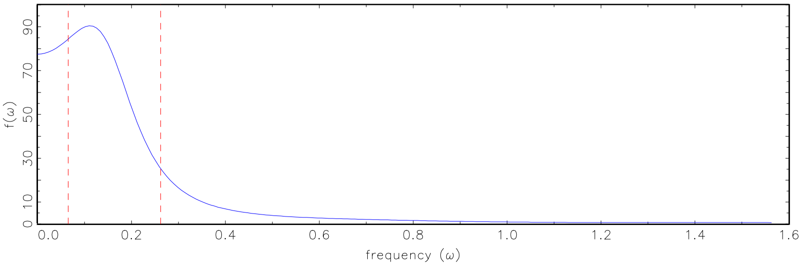
  where the power spectrum, $f(\omega)$, gives the extent of frequency ω's contribution to the total variance of the series. Each frequency, ω, is in turn associated with cycles of period $p = 2\pi/\omega$.

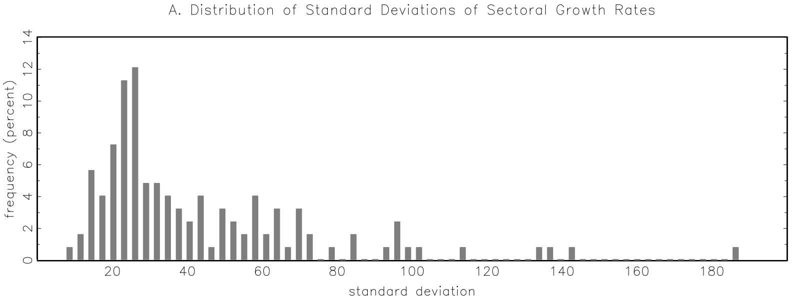
- Business cycle frequencies are defined as those associated with cycles of periods ranging from 24 to 96 months.

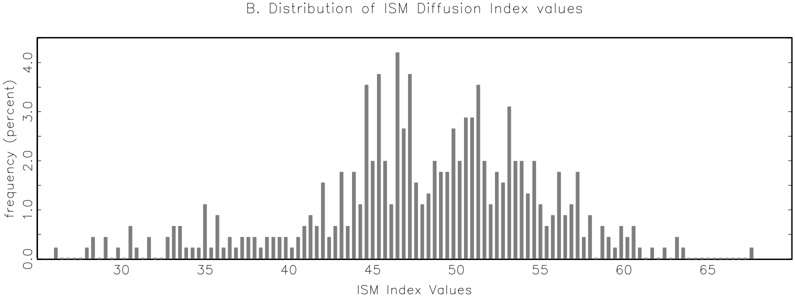
A. Spectrum of Manufacturing Output Growth



B. Spectrum of ISM Diffusion Index




A. Distribution of Standard Deviations of Sectoral Growth Rates
frequency (percent)
0 2 4 6 8 10 12 14
20 40 60 80 100 120 140 160 180
standard deviation


B. Distribution of ISM Diffusion Index values
frequency (percent)
0.0 1.0 2.0 3.0 4.0
30 35 40 45 50 55 60 65
ISM Index Values

Volatility of Output Growth and ISM Index

		1972-2009	
	Std. Dev.	Fraction of Variance in Business Cycles $2\ years \leq p \leq 8\ years$	Fraction of Variance at High Frequencies $p < 2\ years$
Output Growth	8.35	23.90	68.57
Diffusion Index	7.85	54.15	30.03

Autocorrelation and Cross-correlation Structure of Output Growth and the ISM index

	Autocorrelations (1972-2009)						
k	0	1	2	3	4	5	6
$\rho(\Delta x_t, \Delta x_{t-k})$	1.00	0.36	033	0.27	0.16	0.10	0.10
$\rho(\mathcal{I}_t, \mathcal{I}_{t-k})$	1.00	0.89	0.78	0.66	0.54	0.44	0.35
	Cross-Correlations (1972-2009)						
k	-3	-2	-1	0	1	2	3
$\rho(\Delta x_t, \mathcal{I}_{t+k})$	0.23	0.34	0.47	0.58	0.62	0.56	0.47

The Empirical Framework

- Ouput growth of firm i in industry j

$$\Delta x_t^{ij} = \Delta x_t^j + u_t^i,$$

where $E_{t-1}(u_t^i) = 0 \ \forall i$

- A spokesperson reports on changes in her firm's output, but is only infrequently apprised of the exact state of output growth

- At each date, a fraction $\alpha \in (0,1)$ of representatives (in each sector) is able to update its information set $\Longrightarrow \alpha$ of spokepersons have current information, $\alpha(1-\alpha)$ have one-period old information, $\alpha(1-\alpha)^2$ have two-period old information ... Mankiw an Reis (2002, 2006)

The Empirical Framework

- Survey designers ask a sample of N representatives in each of M sectors whether their firm's output increased, decreased, or stayed the same
- Informational rigidities $\Longrightarrow$ answers cannot always reflect firms' current output growth
- For respondents who do not have current information, answers reflect expected output growth conditional on most recent information

$$E_{t-k}(\Delta x_t^{ij}),$$

where $t-k$ is the date at which their information set was last updated.

The Empirical Framework

- Sectoral output changes are modeled as:

$$\begin{aligned} \Delta x_t^j &= \lambda^j F_t + e_t^j,\ j = 1, ..., M, \\ F_t &= \Phi(L) F_{t-1} + \eta_t, \end{aligned}$$

  F_t set of latent dynamic factors common to all manufacturing sectors, η_t common disturbance such that $E_{t-1}(\eta_t) = 0$, λ^j factor loading specific to sector j, and e_t^j sector-specific shock such that $E_{t-1}(e_t^j) = 0\ \forall j$

- DFMs help handle large data sets where both M and T are large - VAR with 124 sectors and 2 lags has 30752 coefficients and 7750 variance parameters

- Neoclassical multisector growth models, Long and Plosser (1983), Horvath (1998,2000), Dupor (1999), Carvalho (2007) etc. produce DFMs as reduced-form solutions for sectoral output growth

The Empirical Framework

- e.g. Suppose $F_t = \phi F_{t-1} + \eta_t$, $\phi < 1$
- In each sector, for αN respondents,

$$E_t(\Delta x_t^{ij}) = \Delta x_t^{ij} = \lambda^j F_t + e_t^j + u_t^i$$

- For $\alpha(1-\alpha)N$ respondents,

$$E_{t-1}(\Delta x_t^{ij}) = \lambda^j \phi F_{t-1}$$

- More generally, for $\alpha(1-\alpha)^k N$ respondents,

$$E_{t-k}(\Delta x_t^{ij}) = \lambda^j \phi^k F_{t-k}, \quad j = 1, ..., M, \quad and \quad k = 1, 2, ...$$

The Empirical Framework

- Except for currently updated respondents, only fixed sector-specific characteristics and common shocks influence the construction of the diffusion index
- For majority of firms (if α is small), month-to-month shocks are not reflected in the diffusion index,

$$E_{t-k}(u_t^i) = 0 \quad and \quad E_{t-k}(e_t^j) = 0 \quad \forall i, \quad j \quad and \quad k = 1, 2, \ldots$$

- Past information will be reflected in the diffusion index through $\lambda^j \phi^k F_{t-k}$, with weights $\alpha(1-\alpha)^k$
- Δx_t^{ij} is unknown for currently updated firms. Assume

$$\Delta x_t^{ij} = \Delta x_t^j = \lambda^j F_t + e_t^j,$$

$\Longrightarrow$ currently informed respondents work for firms whose output mimics the sector in which they operate

A Synthetic ISM Diffusion Index

- A synthetic diffusion index can be created by recording, for each sector, differentially informed perceptions of changes in output according to the conditions:

$$\begin{aligned}
&\text{if } E_{t-k}(\Delta x_t^{ij}) > \tau,\ u_t^{kj}(\tau) = 1,\ s_t^{kj}(\tau) = d_t^{kj}(\tau) = 0,\ k = 0, 1, \ldots \\
&\text{if} - \tau \leq E_{t-k}(\Delta x_t^{ij}) \leq \tau\ ,\ s_t^{kj}(\tau) = 1,\ \ u_t^{kj}(\tau) = d_t^{kj}(\tau) = 0,\ k = 0, 1, \\
&\text{if } E_{t-k}(\Delta x_t^{ij}) < -\tau,\ d_t^{kj}(\tau) = 1,\ \ u_t^{kj}(\tau) = s_t^{kj}(\tau) = 0,\ k = 0, 1, \ldots,
\end{aligned}$$

- The proportions of "optimists" and "same" respondents are:

$$U_t(\alpha, \tau) = M^{-1} \sum_{j=1}^{M} \sum_{k=0}^{\infty} \alpha (1 - \alpha)^k u_t^{kj}(\tau)$$

$$S_t(\alpha, \tau) = M^{-1} \sum_{j=1}^{M} \sum_{k=0}^{\infty} \alpha (1 - \alpha)^k s_t^{kj}(\tau),$$

A Synthetic ISM Diffusion Index

- The synthetic ISM diffusion index then takes the form:

$$
\begin{aligned}
\widetilde{\mathcal{I}}_t(\alpha,\tau) &= \left(U_t(\alpha,\tau) + \frac{1}{2}S_t(\alpha,\tau)\right) \times 100 \\
& M^{-1}\sum_{j=1}^{M}\sum_{k=0}^{\infty} \alpha(1-\alpha)^k \left(u_t^{kj}(\tau) + \frac{1}{2}s_t^{kj}(\tau)\right) \times 100.
\end{aligned}
$$

- What degree of information stickiness, α, and indifference threshold, τ, best describe the actual ISM?

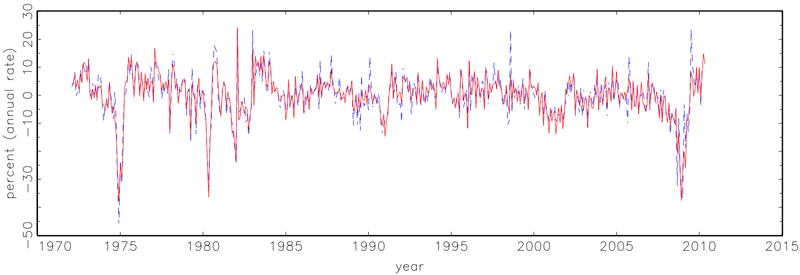
$$
\min_{\alpha,\ \tau}\ \mathcal{S}(\alpha,\tau) = T^{-1}\sum_{t=1}^{T}\left(\mathcal{I}_t - \widetilde{\mathcal{I}}_t(\alpha,\tau)\right)^2.
$$

Estimation and Findings

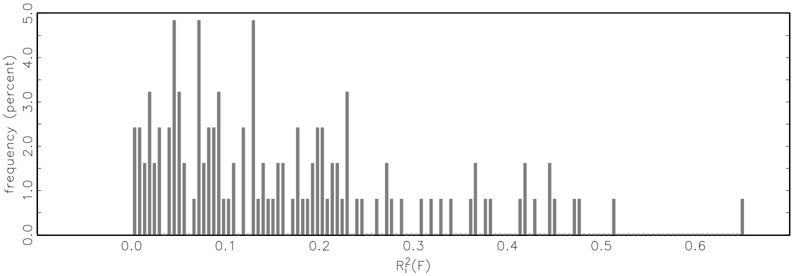
- Estimation proceeds in 2 steps: i) Estimate the DFM (i.e. the factors and factor loadings) using PC methods, ii) Use resulting DFM estimates to construct synthetic index and solve second stage minimization problem for α and τ
- Bai and Ng (2002) ICP1 and ICP2 estimators yield 2 factors in the full smaple (1972-2009)
- $$\Delta x_t = \mathbf{w}'\Lambda F_t + \mathbf{w}' e_t$$
- $$R^2(F) = \mathbf{w}'\Lambda\Sigma_{FF}\Lambda'\mathbf{w}/\sigma^2_{\Delta x}$$
- Distribution of $R_j^2(F)$

$$R_j^2(F) = \lambda^j \Sigma_{FF} \lambda^{j\prime}/\sigma^2_{\Delta x_j}$$

A. Manufacturing Output Growth (dashed), and Factor Component (solid)



B. Distribution of Sectoral $R_j^2(F)$



Estimation and Findings

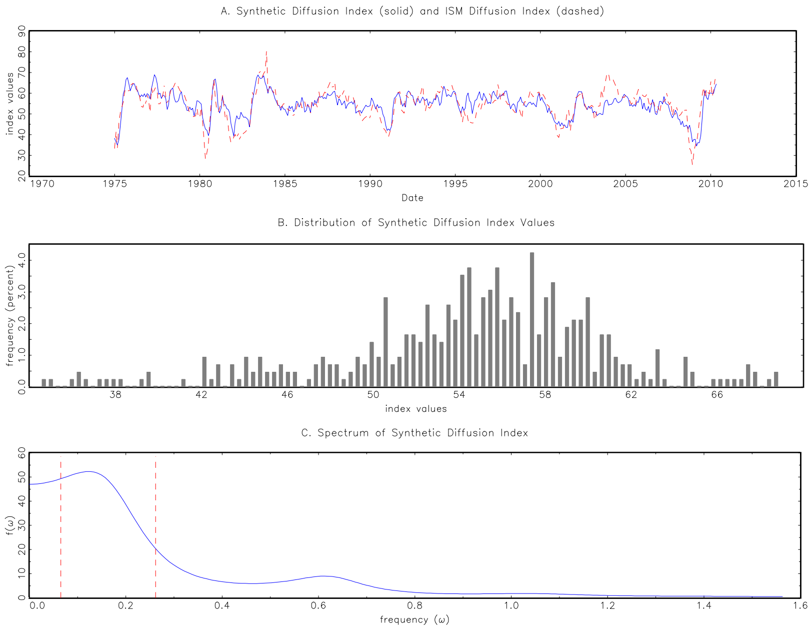
- The exercise yields $\alpha = 0.13$ and $\tau = 3.06$
- Respondents update their expectations every 8 months on average, and report output changes if they exceed 3 percent $\Longrightarrow$ somewhat stickier information than in previous work
- 12 months in Carroll (2003) - Michigan Survey of household's inflation expectations and Survey of Professional Forecasters
- 12.5 months in Mankiw, Reis and Wolfers (2003), betwen 4 and 6 months in Mankiw and Reis (2006, 2009) - Michigan and Livingston Surveys as well as calibrated stuctural models
- around 6 to 7 months in Coibion and Gorodnichenko - Same surveys but explore a range of alternative implications implied by Sticky Information frameworks

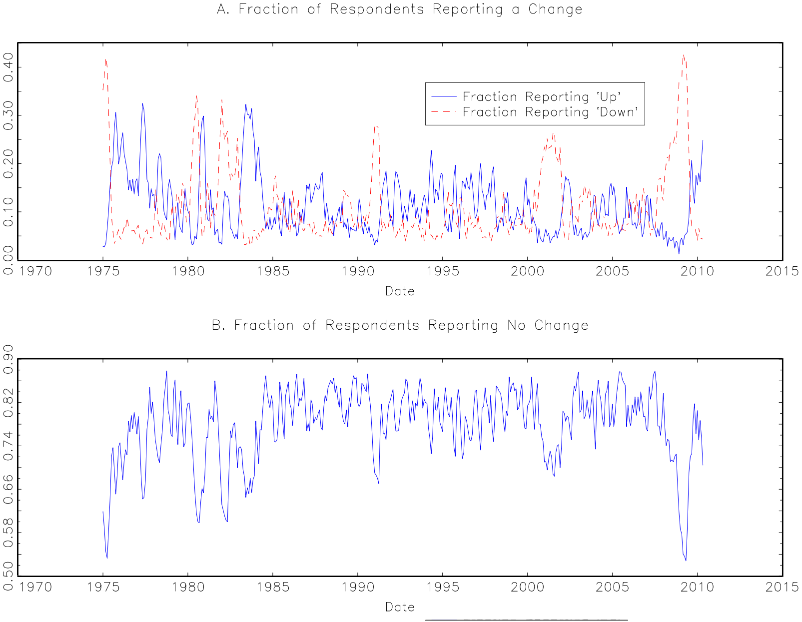
Volatility of the Manufacturing ISM Diffusion and Synthetic Diffusion Indices

		1972-2009	
	Std. Dev.	Fraction of Variance in Business Cycles $2 \text{ years} \leq p \leq 8 \text{ years}$	Fraction of Variance at High Frequencies $p < 2 \text{ years}$
Diffusion Index	7.85	54.15	30.03
Pseudo Index	6.08	50.8	31.74

Autocorrelation and Cross-correlation Structure of the ISM Diffusion and Synthetic Diffusion indices

	Autocorrelations (1972-2009)						
k	0	1	2	3	4	5	6
$\rho(\mathcal{I}_t, \mathcal{I}_{t-k})$	1.00	0.89	0.78	0.66	0.54	0.44	0.35
$\rho(\widetilde{\mathcal{I}}_t, \widetilde{\mathcal{I}}_{t-k})$	1.00	0.90	0.76	0.61	0.47	0.36	0.28
	Cross-Correlations (1972-2009)						
k	-3	-2	-1	0	1	2	3
$\rho(\Delta x_t, \mathcal{I}_{t+k})$	0.23	0.34	0.47	0.58	0.62	0.56	0.47
$\rho(\Delta x_t, \widetilde{\mathcal{I}}_{t+k})$	0.22	0.31	0.40	0.59	0.73	0.67	0.58


A. Synthetic Diffusion Index (solid) and ISM Diffusion Index (dashed)
index values
Date
1970 1975 1980 1985 1990 1995 2000 2005 2010 2015
20 30 40 50 60 70 80 90
B. Distribution of Synthetic Diffusion Index Values
frequency (percent)
index values
38 42 46 50 54 58 62 66
0.0 1.0 2.0 3.0 4.0
C. Spectrum of Synthetic Diffusion Index
f(ω)
frequency (ω)
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6
0 10 20 30 40 50 60



A. Fraction of Respondents Reporting a Change
Fraction Reporting 'Up'
Fraction Reporting 'Down'
0.00
0.10
0.20
0.30
0.40
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date
B. Fraction of Respondents Reporting No Change
0.50
0.58
0.66
0.74
0.82
0.90
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date

Anatomy of the ISM Diffusion Index

- How does the degree of information stickiness affect the behavior of the ISM diffusion index?
- How important is sectoral heterogeneity in helping the diffusion index track business cycles?
- Is it possible to more efficiently construct a diffusion index by steering the underlying survey's efforts towards key sectors?
- What implications does the Great Moderation have for the estimated degree of information stickiness and the types of sectors that are most informative in the index?

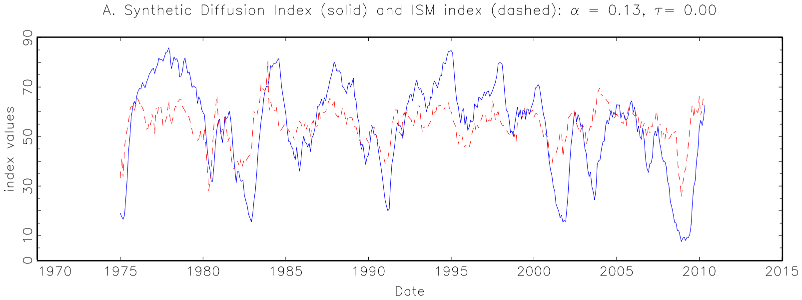
Fully Informed Survey Respondents

- What happens when $\tau = 0$?
- What happens when $\alpha = 1$? When all respondents are always fully updated, the diffusion index reflects

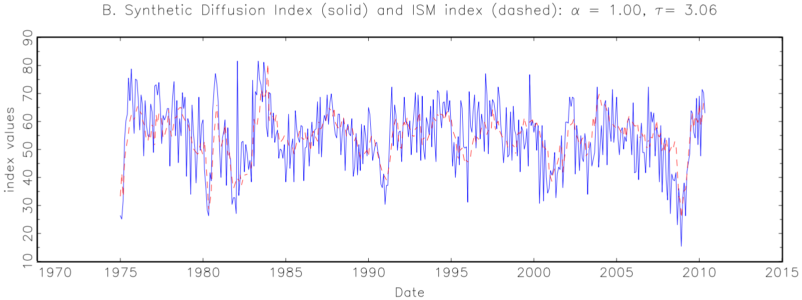
$$\begin{aligned}
&\text{if } \Delta x_t^j > \tau, \text{ then } u_t^j(\tau) = 1,\ s_t^j(\tau) = d_t^j(\tau) = 0 \\
&\text{if} - \tau \leq \Delta x_t^j \leq \tau \text{ , then } s_t^j(\tau) = 1,\ u_t^j(\tau) = d_t^j(\tau) = 0, \\
&\text{if } \Delta x_t^j < -\tau, \text{ then } d_t^j(\tau) = 1,\ u_t^j(\tau) = s_t^j(\tau) = 0,
\end{aligned}$$

and

$$\widetilde{\mathcal{I}}_t(1, \tau) = M^{-1} \sum_{j=1}^{M} \left(u_t^j(\tau) + \frac{1}{2} s_t^j(\tau) \right) \times 100,$$



A. Synthetic Diffusion Index (solid) and ISM index (dashed): α = 0.13, τ= 0.00
index values
0
10
30
50
70
90
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date



B. Synthetic Diffusion Index (solid) and ISM index (dashed): α = 1.00, τ= 3.06
index values
10
20
30
40
50
60
70
80
90
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date

Volatility of Manufacturing Output Growth and the Synthetic Diffusion Index with Fully Informed Respondents, $\alpha = 1$

		1972-2009	
	Std. Dev.	Fraction of Variance in Business Cycles $2\ years \leq p \leq 8\ years$	Fraction of Variance at High Frequencies $p < 2\ years$
Output Growth	8.35	23.90	68.57
Pseudo Index	11.74	28.13	61.80

Autocorrelations of Manufacturing Output Growth and the Synthetic Diffusion Index with Fully Informed Respondents, $\alpha = 1$

	Autocorrelations (1972-2009)						
k	0	1	2	3	4	5	6
$\rho(\Delta x_t, \Delta x_{t-k})$	1.00	0.36	033	0.27	0.16	0.10	0.10
$\rho(\widetilde{\mathcal{I}}_t, \widetilde{\mathcal{I}}_{t-k})$	1.00	0.39	0.40	0.42	0.22	0.18	0.20

Sectoral Heterogeneity

- What is the importance of sectoral heterogeneity in the construction of meaningful diffusion indices?

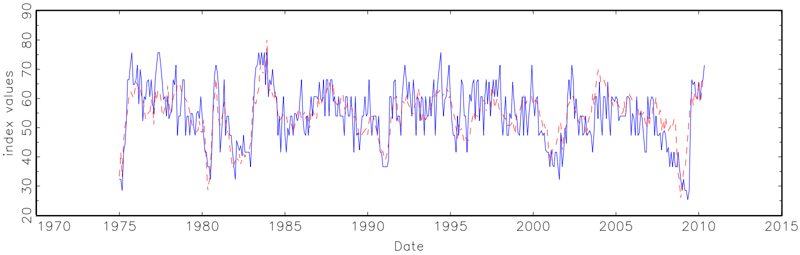
- There are (at least) two dimensions: heterogeneity in production and heterogeneity in information sets

- $$E_{t-k}(\Delta x_t^{ij}) = \overline{\lambda}\phi^k F_{t-k} \ \forall i, j \text{ and } k = 1, 2, \ldots$$

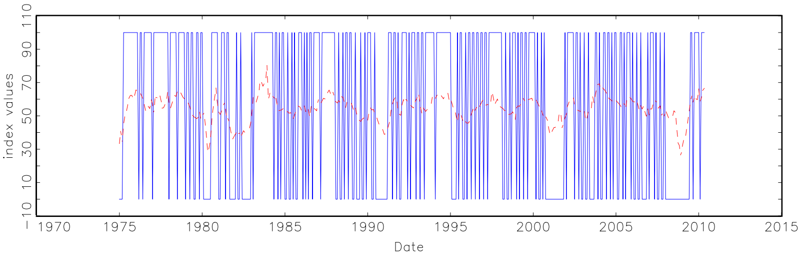
  where $\overline{\lambda} = M^{-1} \sum_{j=1}^{M} \lambda^j$

- $$\overline{\lambda} F_t = M^{-1} \sum_{j=1}^{M} \Delta x_t^j$$

A. Synthetic Diffusion Index with Homogenous Sectors, $\alpha = 0.13$, $\tau = 3.06$ (solid) and ISM index (dashed)



B. Synthetic Diffusion Index with Homogenous Sectors, $\alpha = 1.00$, $\tau = 0.00$ (solid) and ISM index (dashed)

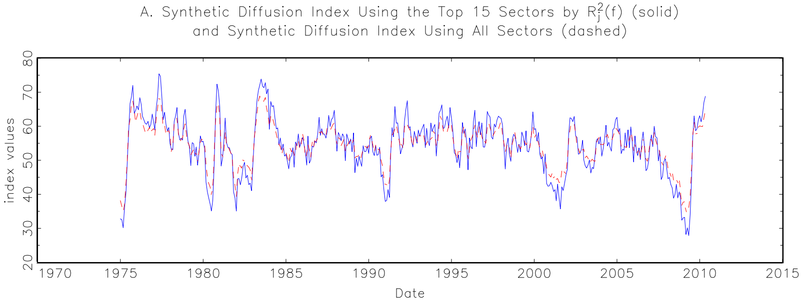


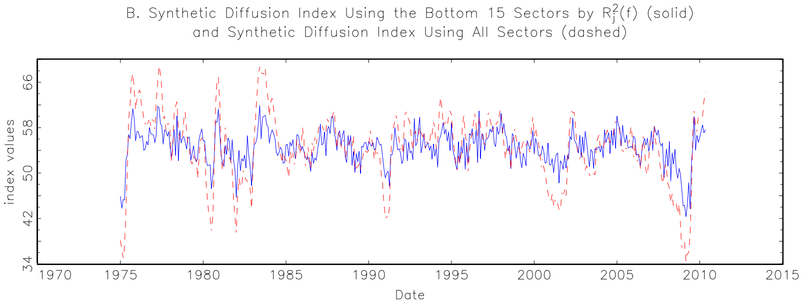
Most Informative Sectors Ranked According to $R_j^2(F)$

Sector	$R_j^2(F)$	Weight
1. Plastic Products	0.65	1.36
2. Household and Institutional Furniture	0.52	1.22
3. Metal Vales Except Balls and Roller Bearings	0.49	0.62
4. Architectural and Structural Metal Products	0.47	0.86
5. Commercial and Service Industry Machinery	0.45	0.17
6. Other Miscellaneous Manufacturing	0.45	0.51
7. Reconstituted Wood Products	0.45	0.23
8. Fabricated Metals: Forging and Stamping	0.45	0.76
9. Foundries	0.43	2.40
10. Fabricated Metals: Spring and Wire	0.43	3.04
11. Sawmills and Wood Preservation	0.42	0.08
12. Metalworking Machinery	0.41	0.05
13. Coating, Engraving, and Allied Activities	0.39	0.08
14. Textile Furnishings Mills	0.37	0.21
15. Other Electrical Equipment	0.37	0.15

Least Informative Sectors Ranked According to $R_j^2(F)$

Sector	$R_j^2(F)$	Weight
1. Aircraft and Parts	0.00	0.42
2. Guided Missile and Space Vehicles	0.00	0.77
3. Fluid Milk	0.00	0.55
4. Coffee and Tea	0.01	1.03
5. Dry, Condensed, and Evaporated Dairy Products	0.01	0.38
6. Primary Smelting/Refining of Nonferrous Metals	0.01	0.01
7. Farm Machinery and Equipment	0.01	0.17
8. Animal Food	0.01	0.16
9. Seafood Product Preparation and Packaging	0.01	0.11
10. Heavy Duty Trucks	0.01	0.88
11. Wineries and Distilleries	0.01	0.45
12. Soft Drinks and Ice	0.02	0.14
13. Copper and Nonferrous Metal Rolling	0.02	1.23
14. Grain and Oilseed Milling	0.02	0.18
15. Mining and Oil and Gas Field Machinery	0.02	0.98


A. Synthetic Diffusion Index Using the Top 15 Sectors by $R_j^2(f)$ (solid)
and Synthetic Diffusion Index Using All Sectors (dashed)
index values
20
30
40
50
60
70
80
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date


B. Synthetic Diffusion Index Using the Bottom 15 Sectors by $R_j^2(f)$ (solid)
and Synthetic Diffusion Index Using All Sectors (dashed)
index values
34
42
50
58
66
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Date

The Great Moderation

- Carroll (2003) is in part based on inflation expectations from the Michigan Survey, mostly covering the Great Moderation period (1981-2000) - expectations updated on average every 12 months

- Exercise yields $\alpha = 0.09$ over the period 1972-1983 $\Longrightarrow$ expectations are updated on average every 11 months

- Exercise yields $\alpha = 0.22$ over the period 1984-2010 $\Longrightarrow$ expectations are updated on average every 5 months

- Intuition: Output growth volatility falls after 1984 while ISM variability is roughly unchanged $\Longrightarrow$ less smoothing of output growth needed after 1984 $\Longrightarrow$ lesser need for information stickiness after 1984

Conclusions

- Survey answers underlying the ISM diffusion index reflect informational rigidities
- Informational rigidities paradoxically helps filter out high frequency (or noisy) fluctuations in survey answers $\Longrightarrow$ resulting index better able to isolate variations at business cycle frequencies
- Diffusion indices would be degenerate in an RBC environment - Heterogeneity in information lags may be more important than heterogeneity in production
- Information regarding the state of aggregate manufacturing is sectorally concentrated $\Longrightarrow$ suggests steering surveys towards key sectors and ignoring others