Real-Time Nowcasting

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Economic and Financial Decision Making Over the Cycle

- Merger activity over the cycle
- Pricing and other competitive issues over the cycle
- Accounting behavior over the cycle
- Distress and bankruptcy over the cycle
- Labor/personnel decisions over the cycle
- Portfolio allocation over the cycle
- Risk management over the cycle
- Asset pricing over the cycle
Our Approach

- Guide real people, making real decisions, in real time
- Nowcasting, updated in real-time

We want:

- Real-time information (inputs and output)
- Based on many indicators
- Quantitative (cardinal), not 0-1 (ordinal)
Real-Time Interest is Percolating

- Conferences
- Centers
- Handbook chapters
- Policy
Underlying High-Frequency Dynamic Factor Structure

Economic activity factor:

\[ x_t = \phi x_{t-1} + \eta_t \]

\[ y^i_t = c^i + \beta^i x_t + \varepsilon^i_t \]

(Close Cousin: Stock and Watson, 1989)
Methodological Econometric Issues

- High-frequency, mixed-frequency, missing data (Close cousin: Mariano and Murasawa, 2003)
- Time-varying system matrices
- Modified filtering and likelihood evaluation
- Optimal extraction of latent macroeconomic activity
State Space Representation

\[ y_t = Z \alpha_t + \varepsilon_t \]

\[ \alpha_{t+1} = T \alpha_t + R \eta_t \]

\[ \varepsilon_t \sim (0, H), \quad \eta_t \sim (0, Q) \]
Kalman Filter Extraction of Latent Economic Activity

\[ a_{t|t} = a_t + P_t Z' F_t^{-1} v_t \]
\[ P_{t|t} = P_t - P_t Z' F_t^{-1} Z P_t' \]
\[ a_{t+1} = T a_{t|t} \]
\[ P_{t+1} = T P_{t|t} T' + R Q R' \]

where

\[ v_t = y_t - Z a_t \]
\[ F_t = Z P_t Z' + H \]

\[ a_{t|t} \equiv E(\alpha_t | \mathcal{Y}_t), \quad P_{t|t} = \text{var}(\alpha_t | \mathcal{Y}_t), \quad a_t \equiv E(\alpha_t | \mathcal{Y}_{t-1}), \]
\[ P_t = \text{var}(\alpha_t | \mathcal{Y}_{t-1}), \quad \mathcal{Y}_t \equiv \{y_1, ..., y_t\} \]
Filtering with Missing Data

All of $y_t$ missing (skip updating):

$$a_{t+1} = Ta_t$$
$$P_{t+1} = TP_t T' + RQR$$

Some of $y_t$ missing (update w/ modified measurement eqn.):

$$y_t^* = Z^* \alpha_t + \varepsilon_t^*$$
$$\varepsilon_t^* \sim N(0, H^*)$$

$$y_t^* = W_t y_t, \ Z^* = W_t Z, \ \varepsilon_t^* = W_t \varepsilon_t, \ H^* = W_t H W_t'$$
Likelihood Evaluation with Missing Data

\[ \ln L = \sum_{t=1}^{T} \ln l_t \]

where:

\[ \ln l_t = 0, \text{ if no elements of } y_t \text{ are observed} \]

\[ \ln l_t = -\frac{1}{2} \left( N^* \log 2\pi + \left( \log |F_t^*| + v_t^* F_t^{*-1} v_t^* \right) \right), \text{ otherwise} \]
Substantive Macroeconomic Issues

- What indicators, at what frequencies?
- How has real activity behaved historically?
- What happened to real activity during the Great Crisis of 2007-2009?
- Where is the economy now?
- What about inflation?
- What about the global economy?
Real Activity

- [ Initial unemployment claims (weekly) ]
- Payroll employment (monthly)
- Industrial production (monthly)
- Personal income less transfers (monthly)
- Manufacturing and trade sales (monthly)
- GDP (quarterly)
Coherence with NBER

Less noisy than individual indicators

“Great Moderation”

Recent episode
Real Activity Index During Recessions

1973-1975 Recession

1980 Recession

1981-1982 Recession

1990-1991 Recession

2001 Recession

2007-2009 Recession
2007-2009: Moderately Extreme Depth Severity

Recession Depth Severity

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<th>Year Range</th>
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2007-2009: Extreme Duration Severity

Recession Duration Severity
2007-2009: Highly Extreme Overall Severity

Overall Recession Severity
Real-time real activity index updates at:

Federal Reserve Bank of Philadelphia
Inflation

- All items CPI (monthly)
- Finished goods PPI (monthly)
- Standard and Poor’s GSCI Non-Energy Commodities Index (monthly)
- Spot price of West Texas intermediate crude oil (monthly)
- Hourly compensation in the non-farm business sector (quarterly)
- GDP deflator (quarterly)
Great inflation, Volcker containment

Increased volatility post-2000

Recent episode
Inflation Index, 2007-2009
Real Activity and Inflation Interaction

- Demand shocks: Real activity and inflation positively correlated
- Supply shocks: Real activity and inflation negatively correlated
- Usually positively correlated
- Negatively correlated during oil shocks
- Recent episode
Positive correlation

A Keynesian demand-driven recession
Going Global: An Extracted G-7 Factor
Comparative Behavior of Country Factors in Two Recessions

Country Factors around 1974

Country Factors around 2008
This time was not different, but it was certainly severe.
Several Authors/Papers/Teams...

Aruoba, Diebold and Scotti (2009, *J. Bus. and Econ. Stats.*)
“Real-Time Measurement of Business Conditions”

Aruoba, Diebold, et al. (2009-present, FRB Phila. RTDRC)
“Real-Time ADS Index” (website)

“Real-Time Macroeconomic Monitoring”

Aruoba, Diebold, Kose and Terrones (2011 NBER, in press)
“Globalization, the Business Cycle, and Macro Monitoring”
Extensions

- Richer component indicators
- Higher-frequency component indicators
- Regional aspects of the cycle