State Space Modeling for Mixed Frequency Time Series Applications

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Higher and Higher Frequency Time Series Becoming Available

- Particularly true in the finance sector
- Retail scanner and GPS data also collected at higher frequencies
- Higher frequency measures of network connections

Measurement of Other Relevant Factors Not (Always) Keeping Up

- Quarterly financial reports
- Monthly levels of (un)employment, payroll employment
- Household level membership

Growing Trend In Applications With Mixed Frequency Data

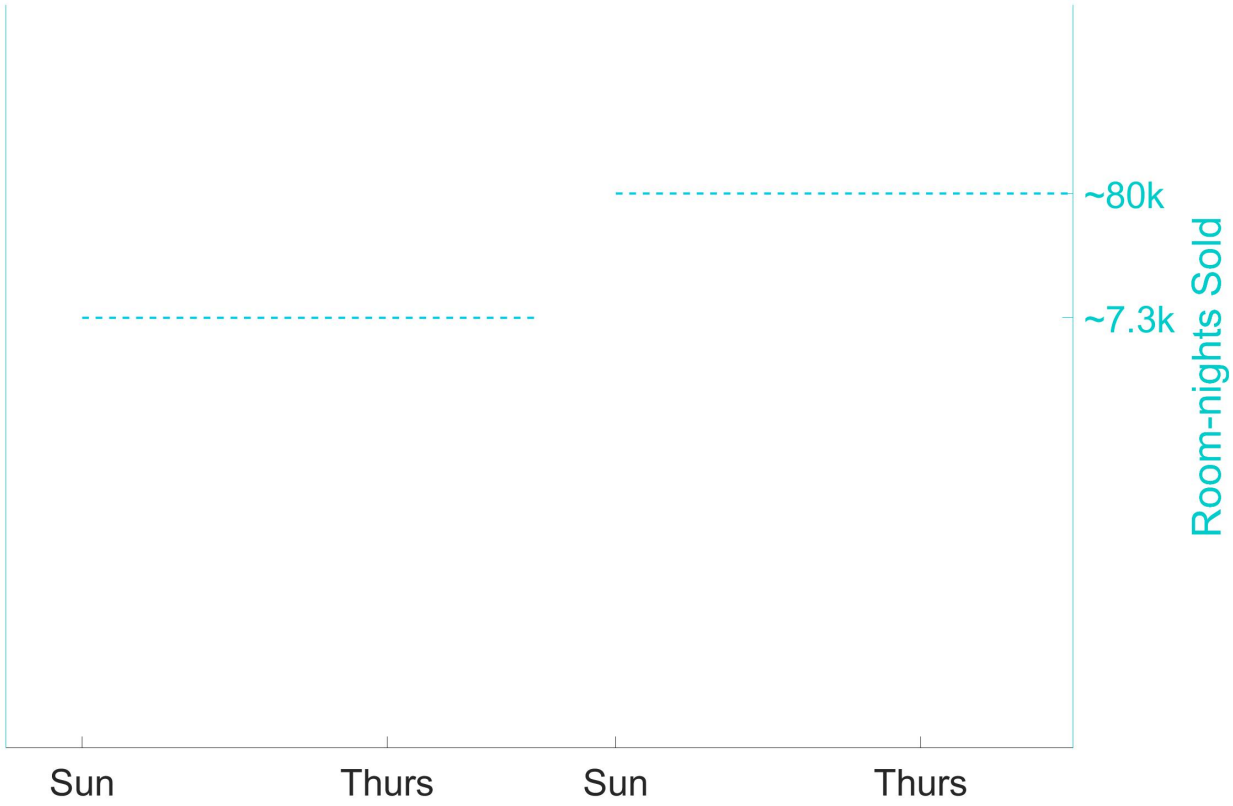
- Spans many types of industries and applications
- Spans many types of time series
- Spans many types of levels of cross-sectional aggregation

What is an Econometrician (Analyst) to do?

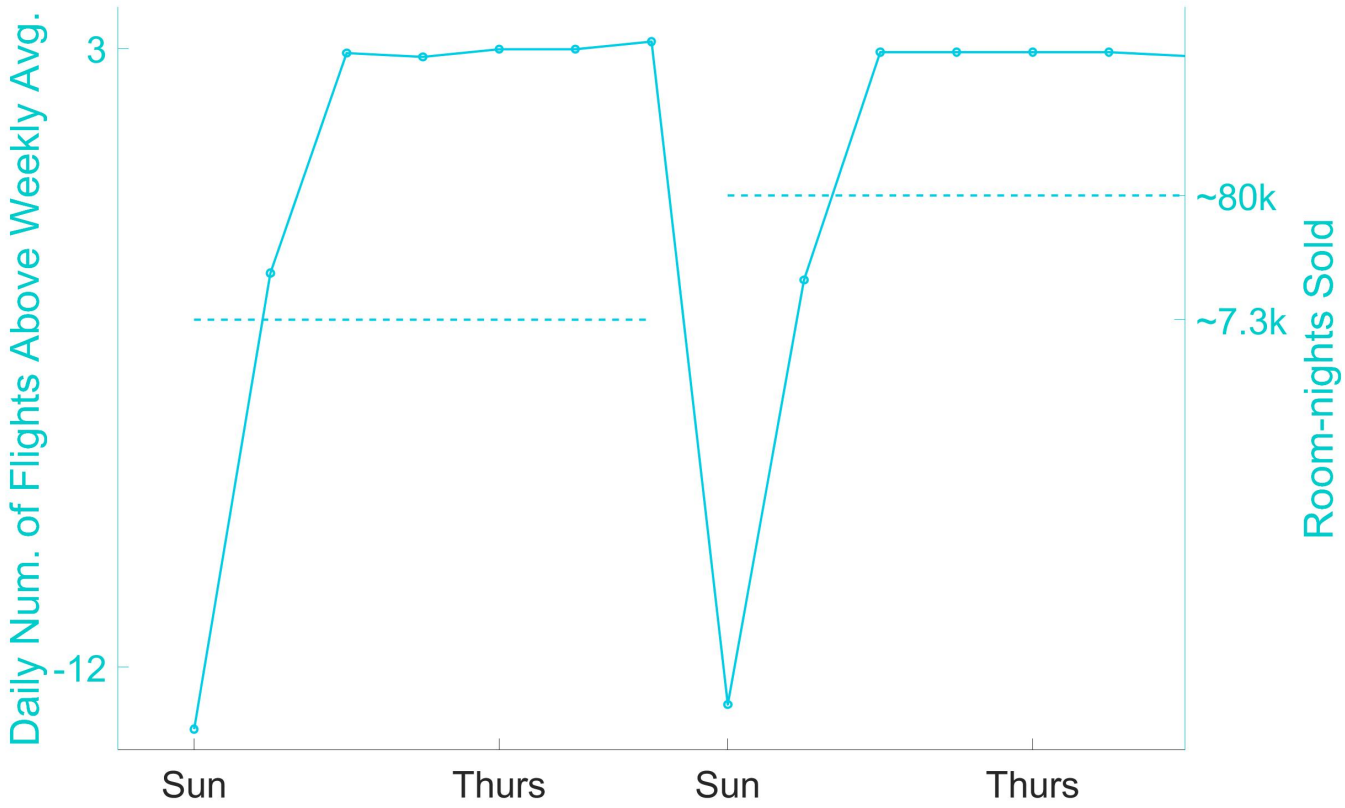
- Aggregate up higher frequency data to lowest common denominator?
- Interpolate lower frequency data at highest observed frequency?
- Throw your hands up and ask your RA for a "cleaner" dataset?

Lowest Common Frequency: Aliasing Problem

High(er) Frequency Interpolation: How (Data) Rich Become Poor



High(er) Frequency Interpolation: How (Data) Rich Become Poor



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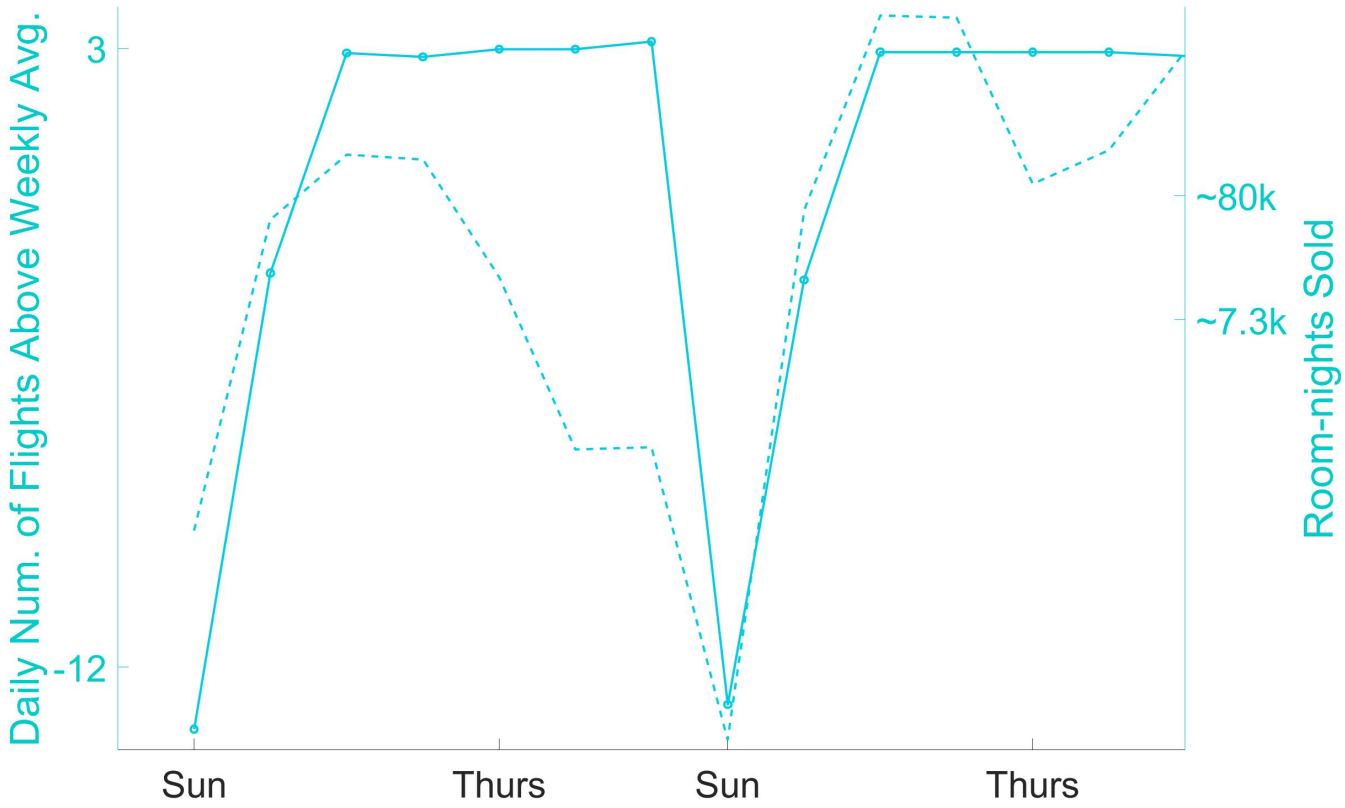


Take the Mixed Frequency Dimension Seriously

- Leverage all the high frequency information
- Think carefully about the temporal aggregation properties
- Keep the model as parsimonious as possible

Leveraging the Flexibility of State Space Methods

$$y_t = Z_t \alpha_t + d_t + \epsilon_t \qquad \text{Observation Equation}$$

$$\alpha_t = T_t \alpha_{t-1} + c_t + R_t \eta_t \qquad \text{Transition Equation}$$

Some Additional Benefits of the State Space Approach

- Missing/irregular data becomes a different kind of "mixed frequency"
- Forecasting tasks are easily embedded into the framework
- Calculation of likelihood a natural by-product of Kalman filter

Some Methods That Have Benefited

- Dynamic factor models
- Vector autoregressions (VAR)
- Univariate structural time series

What Are the Necessary Packages in R

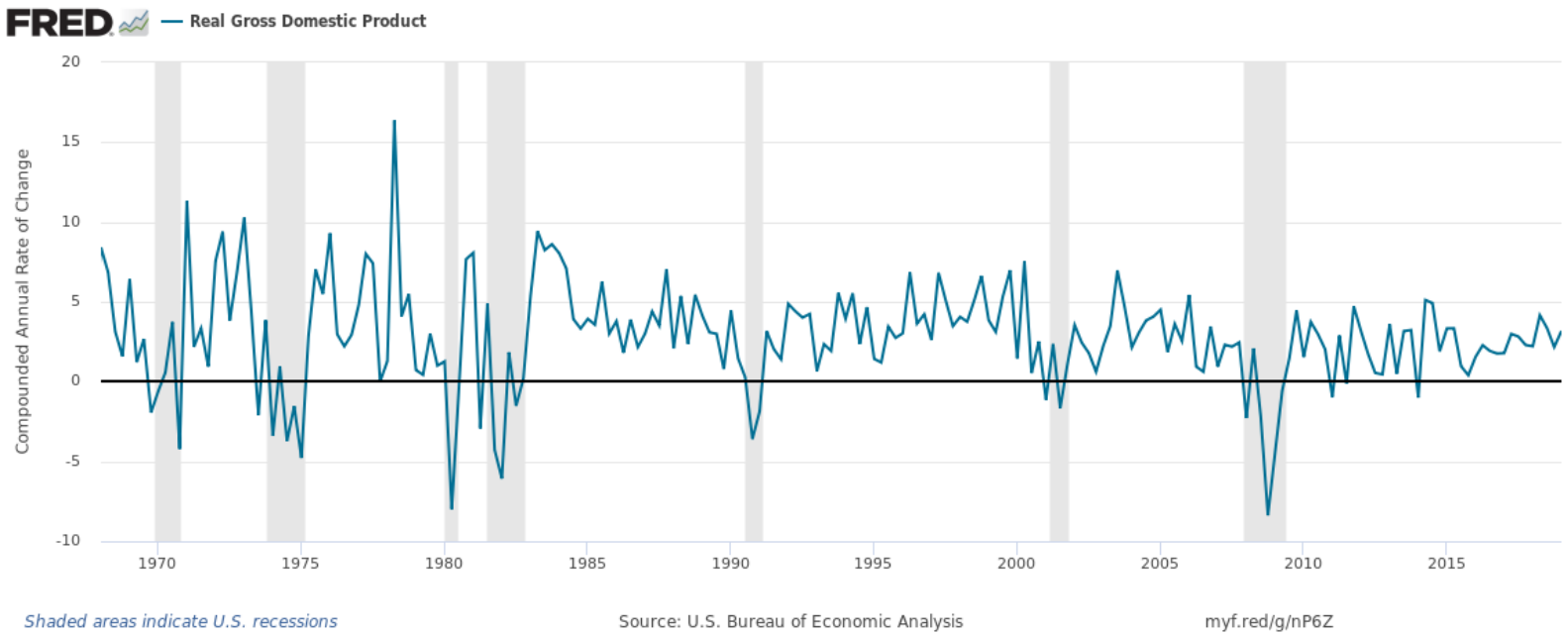
- **KFAS**
- **pomp**
- **dlmodler**

Coming in the future **MFSS**...

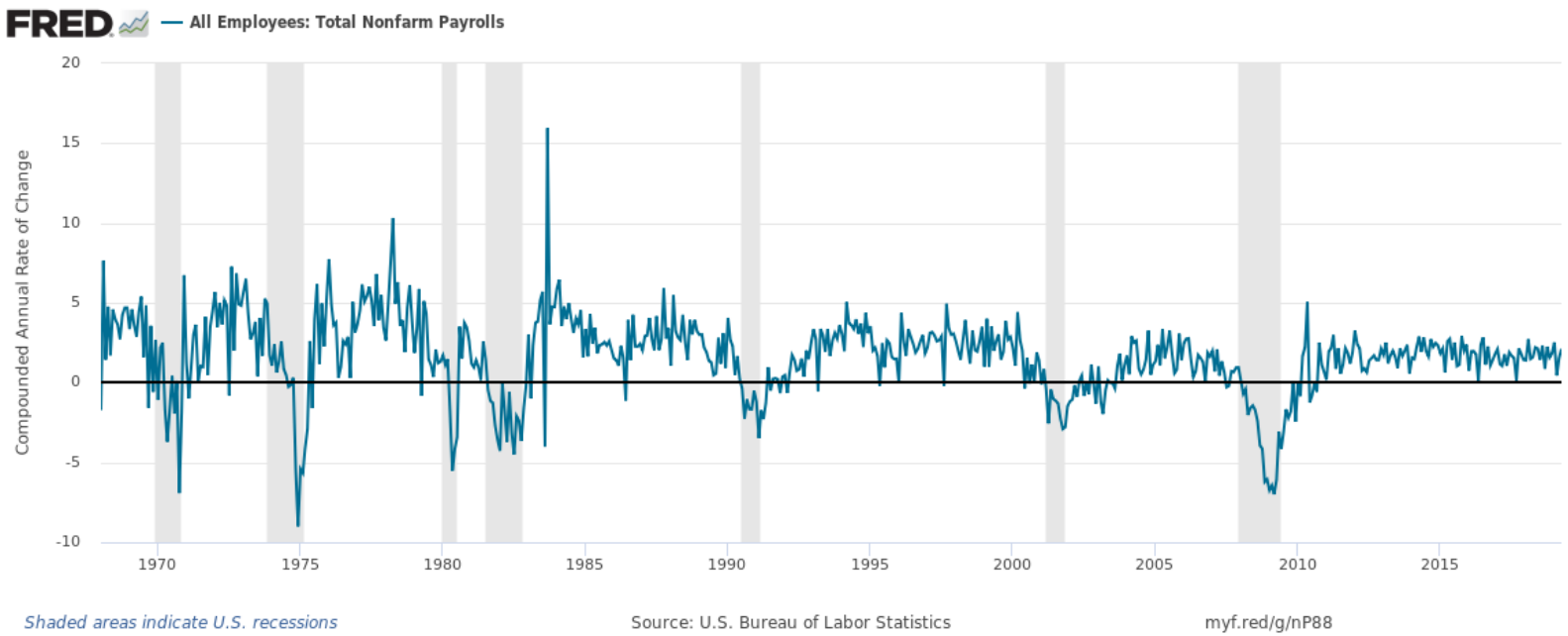
Measuring the Business Cycle: A Mixed Frequency Approach

- Most of the broader based measures still low frequency
- And, subject to long publication delays
- Abundance of more timely monthly indicators of economic activity

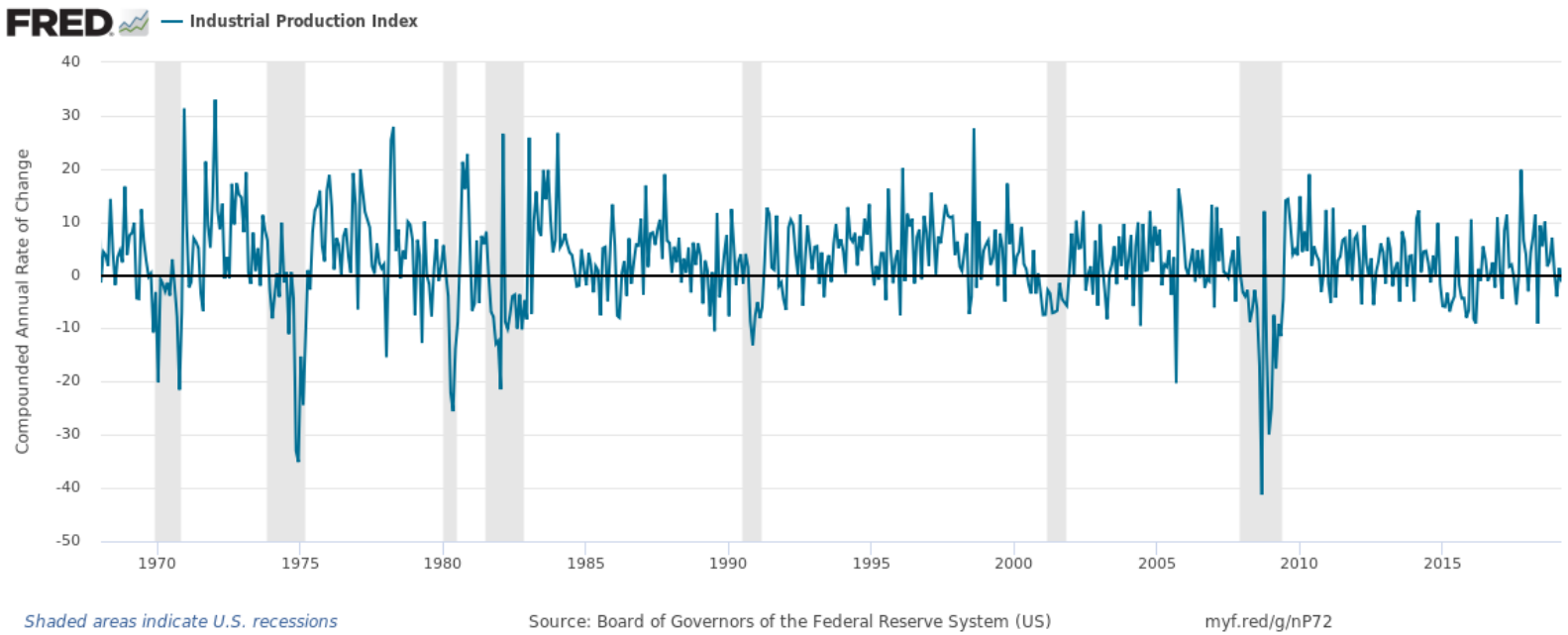
Real Gross Domestic Product



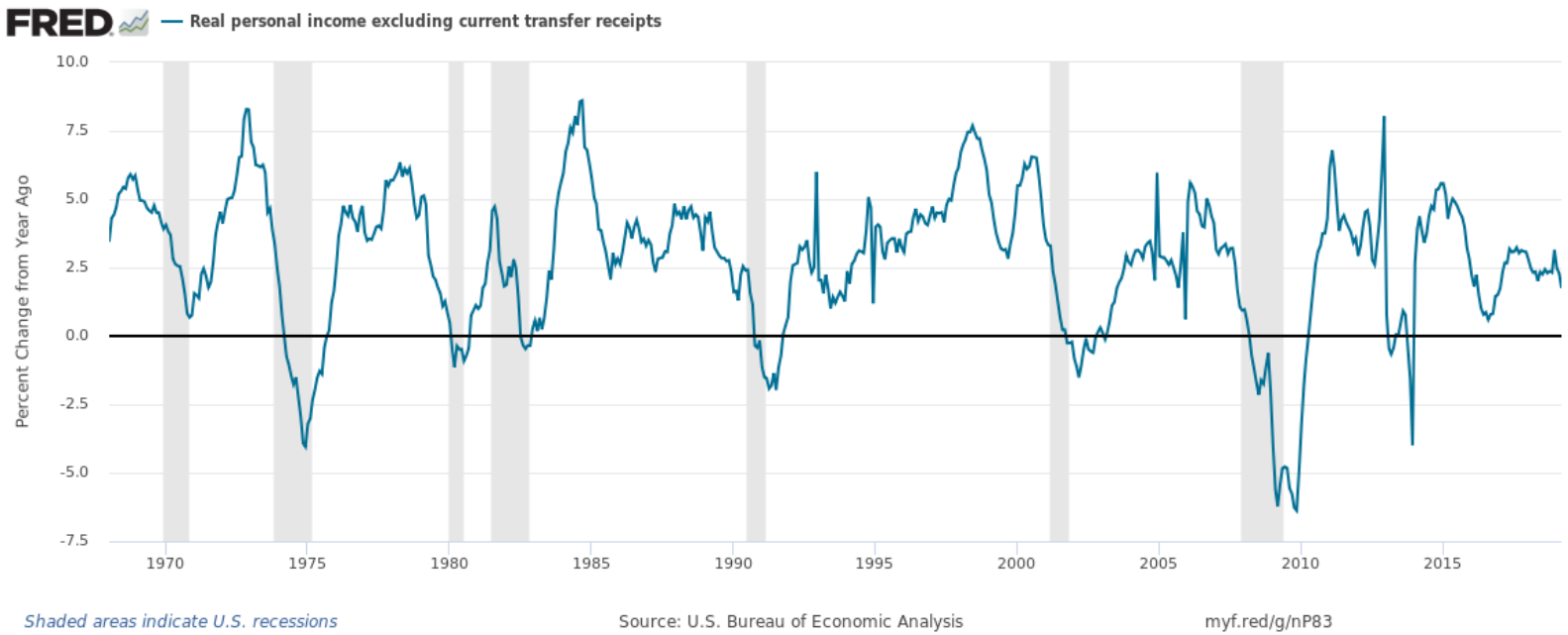
Payroll Employment



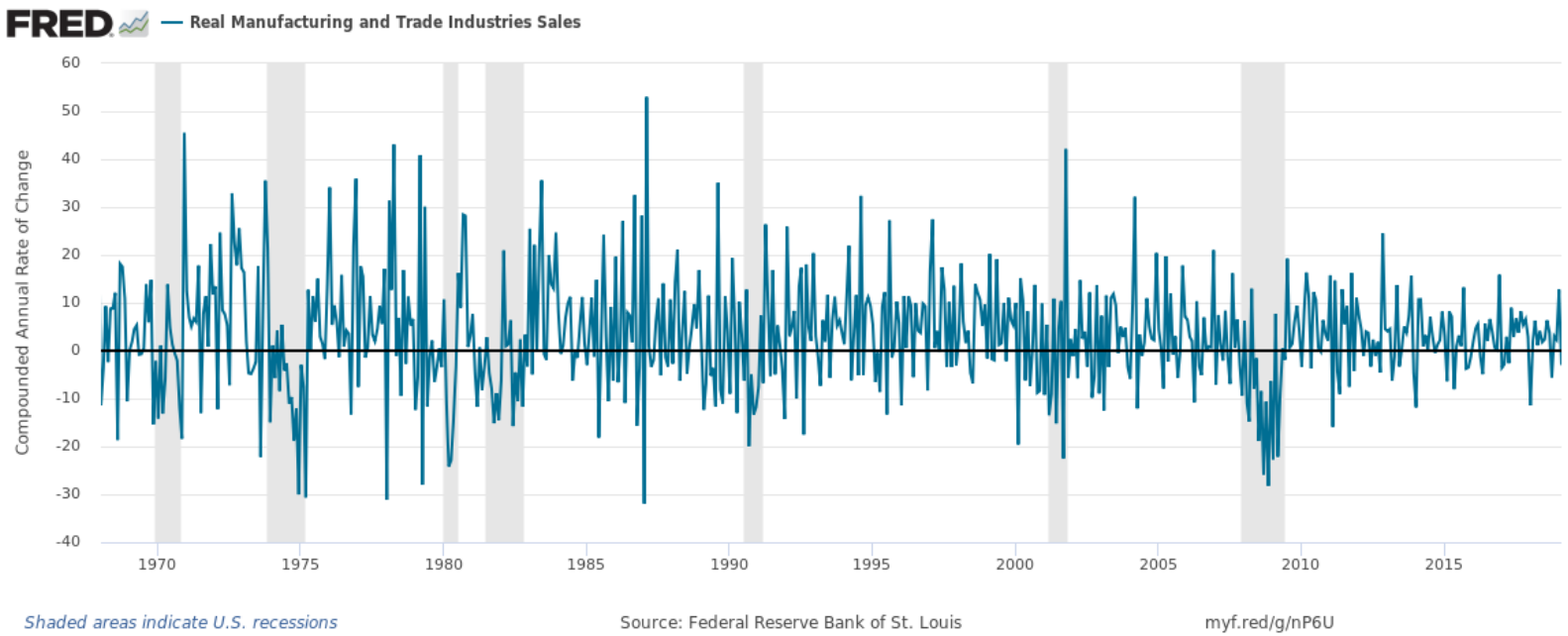
Industrial Production



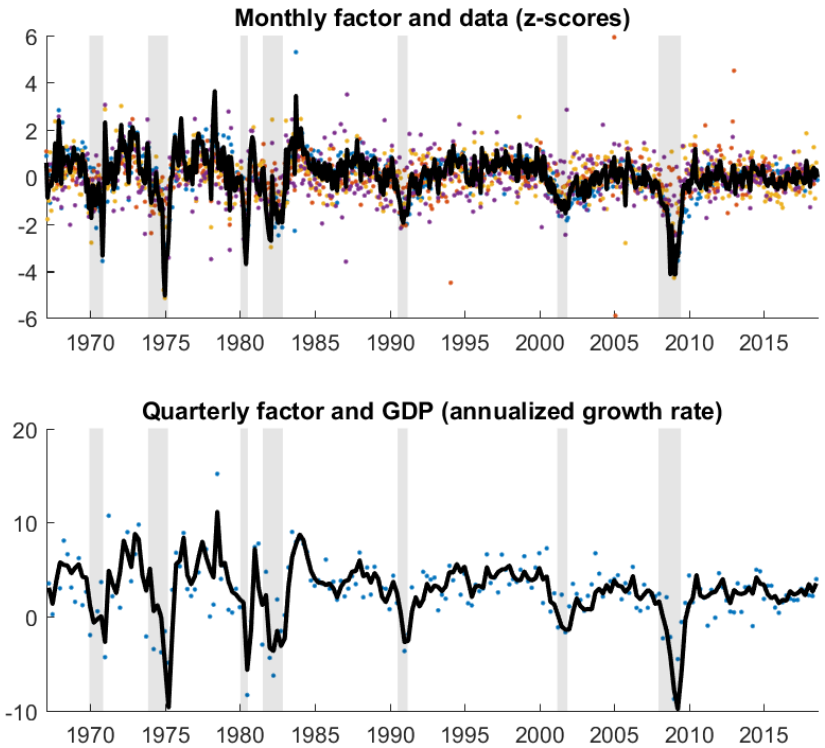
Real Personal Income Less Transfers



Real Manufacturing and Trade Industries Sales



A Mixed Frequency Indicator of the Business Cycle



Going Forward State Space Methods Offer Advantageous Approach

- Flexible framework that accommodates all mixed frequency needs
- Most of the traditional R packages readily amendable to this approach
- Offers more sophisticated inference and identification possibilities