MACROECONOMETRIC FORECASTING IN UNCERTAIN TIMES

Pandemic & recovery; Uncertainty is pervasive

Emphasis on forecast uncertainty

Focus on statistically-based model forecasts

Presentation outline

- Why is economic forecasting so difficult?
- Criteria for good forecasts – it’s not all about accuracy
- Forecast uncertainty – the shame of economic forecasters
- Coping with structural change – the forecaster’s nightmare

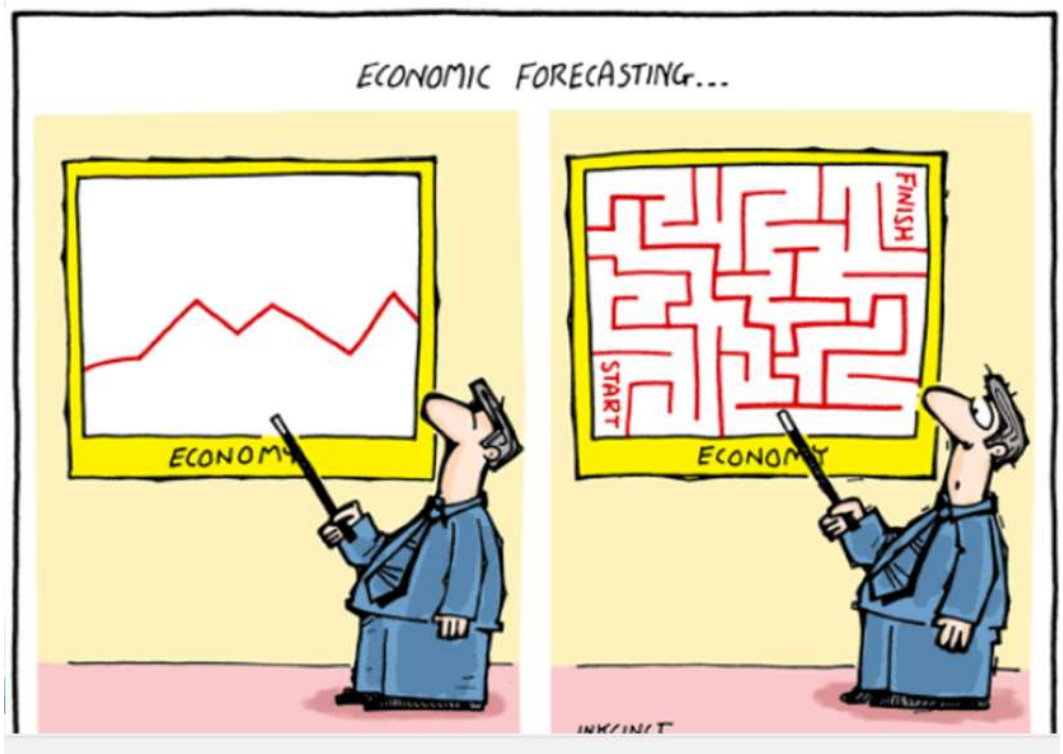
Difficulty of economic forecasting: the record from Survey of Professional Forecasters

- November 2007 – housing foreclosures had doubled; Countrywide on verge of bankruptcy
  - Mean forecast of GDP growth for 2008 was 2.4%. Actual outcome was output drop of 3.3%
  - Consensus probability of 2008 recession was 3%.
- Record since 1968 of forecasts of GDP growth for coming year made in fourth quarter:
  - 95% prediction interval was +/- 4.6%
  - Example, given a point forecast of 2% growth, the actual outcome could be between a 2.6% contraction and a 6.6% expansion

The challenges of economic forecasting

- Data are unreliable – average revision of GDP growth is 1.7%
  - Shaky base for predictions
- Unpredictable structural change
- Correlations trick us into imputing causality
  - Search for strong historical correlations will not produce good forecasts
- Few immutable economic laws in macroeconomics
- Economies are non-linear dynamic systems subject to the Butterfly Effect of Chaos theory

The challenges of economic forecasting: yesterday vs. today



What are characteristics of good forecasting methodology?

1. Accuracy
2. Full use of available information
3. Transparency
4. Internal consistency
5. Econometric criteria
6. Provide information on uncertainty

Evaluating forecasts: Accuracy

- Ideally based on forecasts into a holdout sample, or a retrospective evaluation after forecast period has passed.
- Most common criteria:
  - Root mean squared error $\sqrt{\sum_{t=T+1}^{T+h} (y_t - y_t)^2 / h}$
    - Large or small?
    - Compare with standard deviation of forecasted variable
  - Mean absolute percent error $100 \sum_{t=T+1}^{T+h} \left| \frac{y_t - y_t}{y_t} \right| / h$
    - What if y_t is close to zero?
  - Visual inspection
    - Does forecast capture immediate trend, turning points?

Use of available information. Encompassing Tests & Forecast Combinations

- Compare forecast accuracy of several alternative forecasts of the same variable, e.g. GDP growth
  - Does one of these forecasts (called “best”) dominate the others, such that the others do not improve forecast accuracy?
  - Consider combining different forecasts that may be based on different information sets.
    - Simple combinations such as means or medians
    - Weighted means based on inverse of MSEs
  - Illustrate with forecasts over Great Recession

Why did economists fail to predict the Great Recession of 2008-09?

- Anatomy of forecast failure
  - During period of the Great Moderation (1986-2006) economists' real GDP growth forecasts came within 1.3 percentage points 70% of the time.
    - In 2007 typical forecast was for continuation of moderate steady growth
    - Failure to recognize overvaluation in housing market
    - Lack of understanding of rapidly growing financial instruments and the feedback loops between financial sector and real economy. Real business cycle models.
  - November 2007 Survey of Professional Forecasters:
    - Only 3% chance of 2008 recession.
    - Mean of forecasts called for 2.4% growth in real GDP in 2008

  "The only function of economic forecasting is to make astrology look respectable" - John Kenneth Galbraith

Could we have known a recession was coming?

Early signals of problems in housing market & financial sector

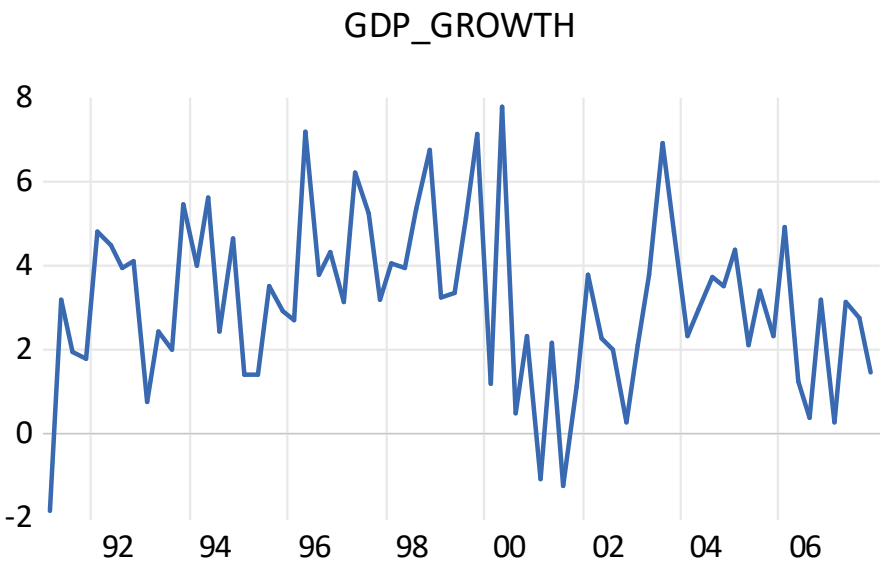
- Housing price declines; slowdown in new home sales.
- Doubling of rate of mortgage foreclosures in 2007
- Questionable practices of rating agencies
- Turmoil in credit default swap market

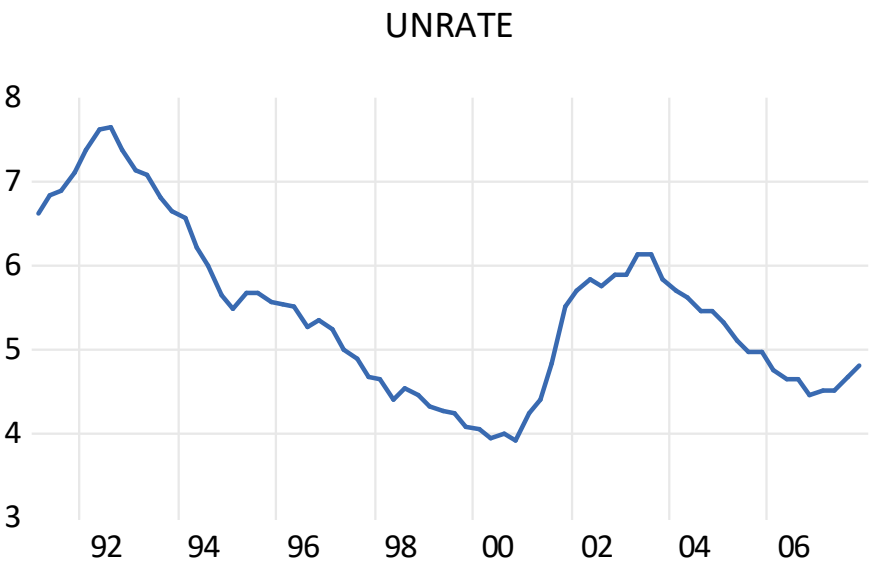
Strong financial market effects on real economy not contained macroeconometric models at that time.

A simple macro model with financial sector linkages

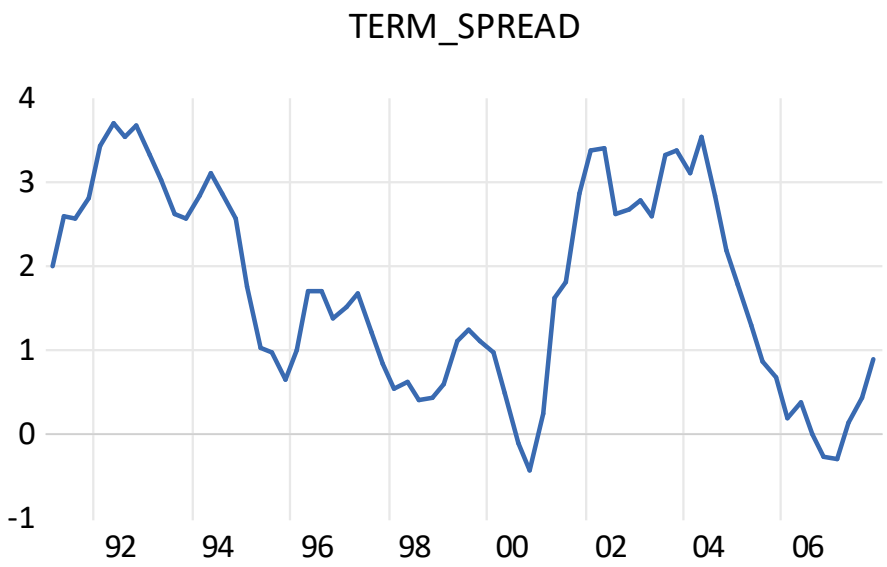
- Compare forecasts of two time series models, estimated through 2007, with predictions of quarterly real GDP growth for 2008 and 2009:
  1. Univariate model with quarterly GDP growth a function of its previous two quarter's growth rates (selected by an automatic ARIMA modeling algorithm)
  2. A six-variable Vector Autoregression (VAR) including three key macroeconomic variables (GDP growth, inflation, unemployment) and three financial indicators (interest rate term spread, interest rate risk spread, mortgage delinquency rate)
     - In VAR each variable depends on own lags and lags of all other variables
     - All variables endogenous and forecast within the model
     - Simple VAR without restrictions – refinements could improve model performance

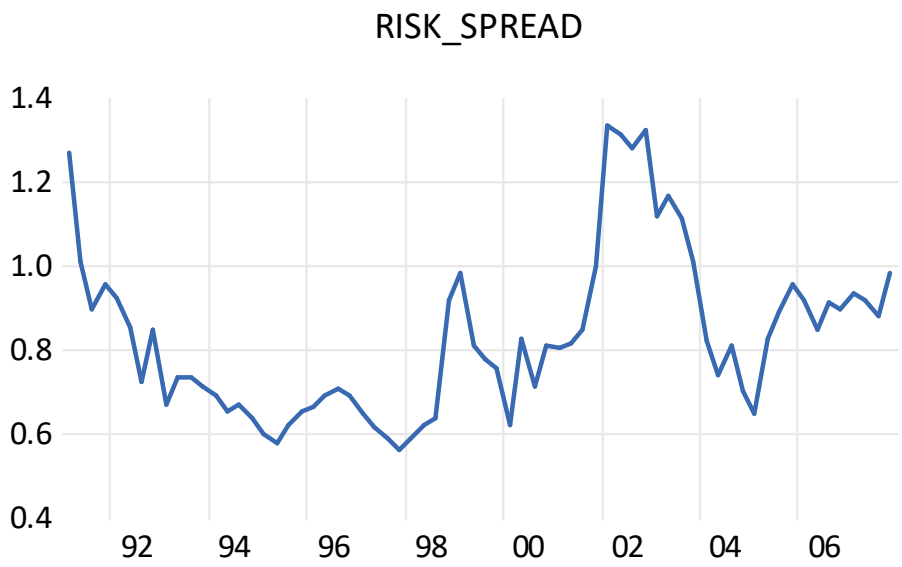
Does economy appear vulnerable in 2007?



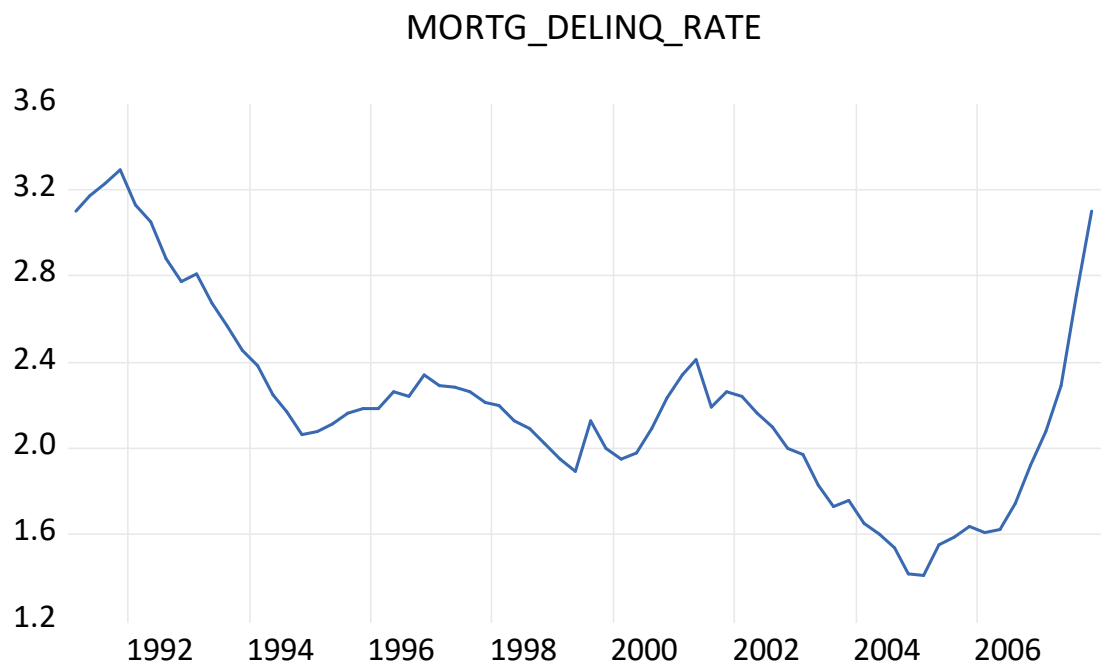


Financial indicators prior to 2008

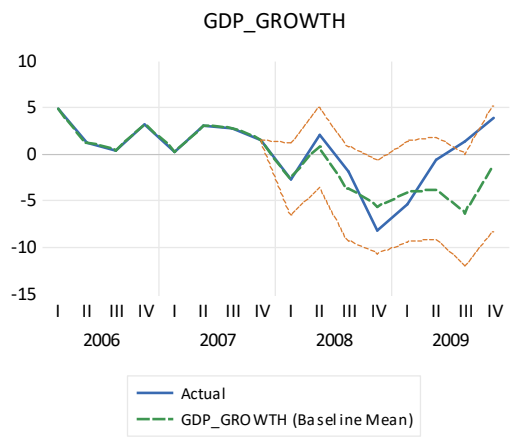


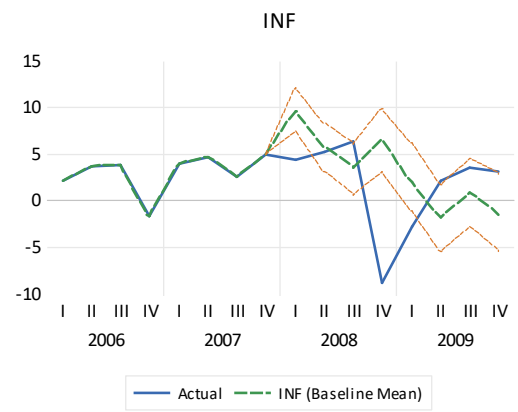


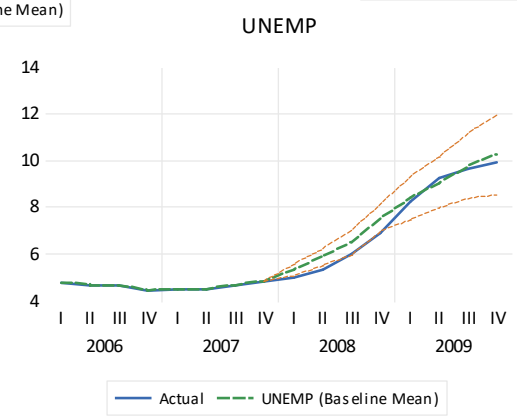
One more financial indicator: mortgage delinquency rate



VAR forecasts of key macro variables







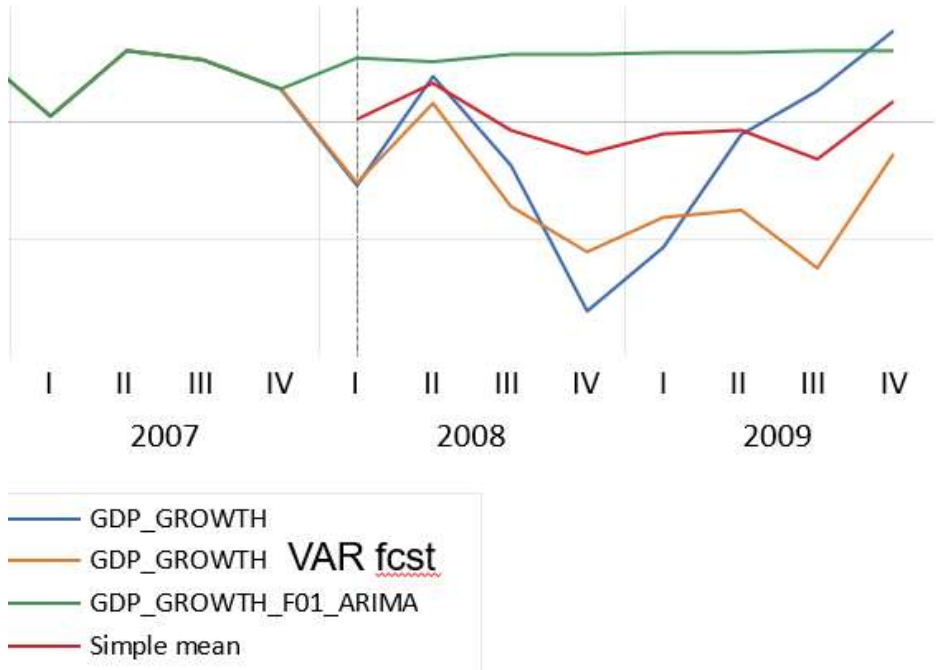
Comparison and combination of forecasts

-Blue line = actuals

-VAR forecast (orange line) captures downturn in early 2008, but remains depressed in 2009.

-ARIMA forecast (Green line) misses recession.

- Red line = mean of VAR and ARIMA forecasts.



Evaluation and combination of forecasts

-VAR forecast = GDP_Growth_0M

-ARIMA forecast = GDP_Growth_F0

- Simple mean has smallest Roor Mean Squared Error (RMSE)!

- Why is Mean Absolute Percent Error (MAPE) so large?

Evaluation statistics

Forecast	RMSE	MAE	MAPE
GDP_GROWTH_0M	3.707717	2.887391	192.1753
GDP_GROWTH_F0...	5.753344	4.576727	198.8858
Simple mean	3.514012	2.814414	87.61553

Lessons from forecasts of Great Recession

- Simple VAR can produce reasonable forecasts, even capturing turning points.
  - Essential to include relevant predictors, e.g. mortgage delinquency rate.
  - VAR provides interval forecasts to convey uncertainty
  - VARs and related multivariate time series model widely used forecasting tools.
- Evaluation criteria.
  - Graphical analysis: does forecast capture turning points?
  - MAPE is useless when variable is close to zero.
  - Forecast (combination) with lowest RMSE may not be the most useful.

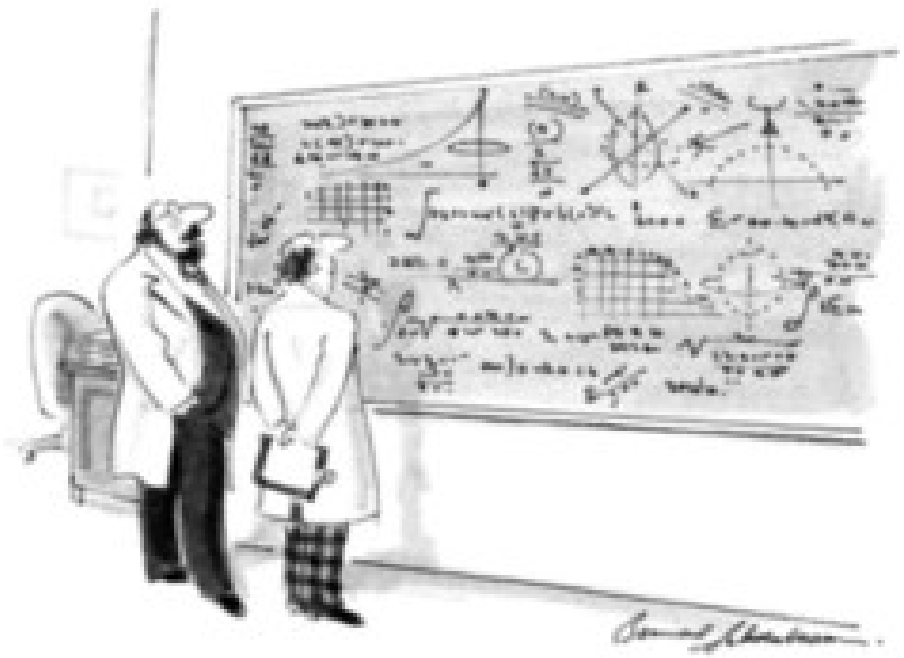
Transparency: what are the theoretical basis and assumptions behind the forecasts

- Problem with univariate model forecast – not based on economic theory
- Forecaster should provide rationale for predictions and revisions
  - Underlying assumptions
  - Theoretical relations

“If only it were so simple”

Black Box (Neural Nets, Machine Learning) forecasting tools.

- Algorithms may pick up associations among variables that reflect spurious correlations
- Some strong correlations may be implausible
- Strong historical correlations may not hold up in the future



"Oh, if only it were so simple."

Econometric criteria to support forecasting model

- Model equations should meet standard econometric criteria
  - Autocorrelated errors => equation misspecification
- Employ methodologies appropriate for non-stationary data
  - Grounded in cointegration framework and error correction models (ECMs)
  - System of error correction equations incorporate short run dynamics and adjustments to long run equilibria.

Forecast uncertainty

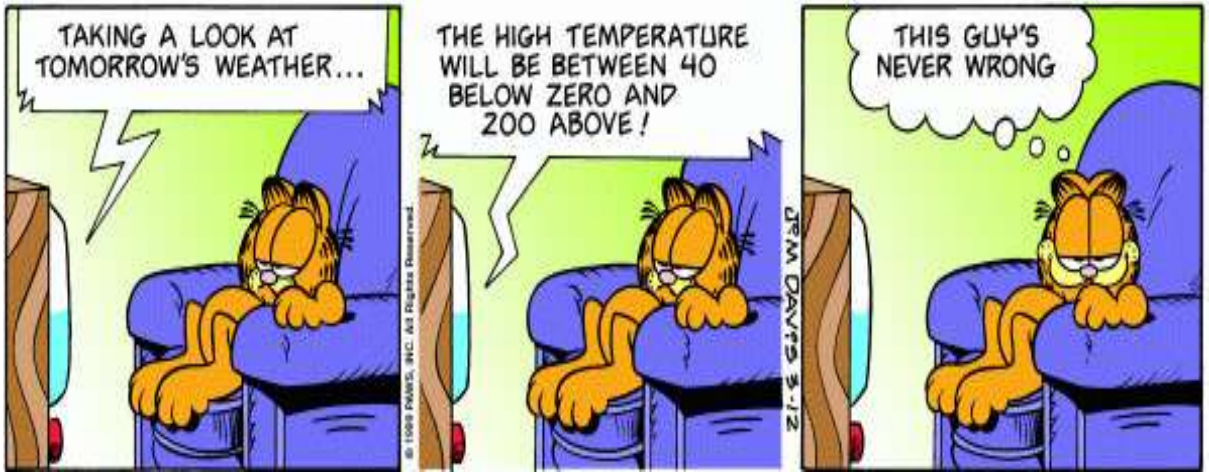
- Forecasts often presented with a single point forecast or a single path into the future.
  - Suggests an unrealistic picture of certainty
  - Why? Model forecasts incorporating human adjustments cannot produce probability based prediction intervals
  - Why? Forecast confidence bounds are discouragingly wide
    - Recall earlier slide: 95% prediction interval is +/- 4.6%
    - A point forecast of 2.5% growth is consistent with a serious recession or an economic boom based on these prediction intervals.
- VARs, ECMs provide statistically based interval forecasts, giving information on range of possible outcomes.

Set modest goals for expressing forecast uncertainty

Volatility & noisiness of economic data implies wide interval forecasts.

Garfield's meteorologist sets an extremely high bar to avoid being wrong.

Present more modest uncertainty statements, e.g. 67% prediction intervals.



Forecasting during the pandemic

- Recession induced by pandemic is an **exogenous shock**
  - In February 2020 no idea of impact of COVID; mixed messaging from multiple sources
  - Unlike Great Recession; not a predictable event
  - Economists have no expertise for forecasting infection surges
    - Contraction of March, April could not be forecast
    - Not knowing govt response, difficult to forecast immediate turn-around
  - Given a few months of data from first half of 2020, can we generate a reasonable forecast?

Strategies for coping with exogenous structural breaks

- Legislative changes (tax rates, marijuana legalization, regulation)
  - Projection of “new” sales based on information in related markets, e.g. medical marijuana sales prior to recreational
  - Example of Marketplace Facilitator Ordinance
- Differential impact of exogenous shock on related markets.
  - E.g. restaurant sales vs. grocery store sales during shut-down => disaggregation and separate modeling of components
- Economic disequilibrium during adjustment to shock
  - Disconnect between personal income and retail sales
  - Rolling regression allows model parameters to adjust gradually to new equilibrium.

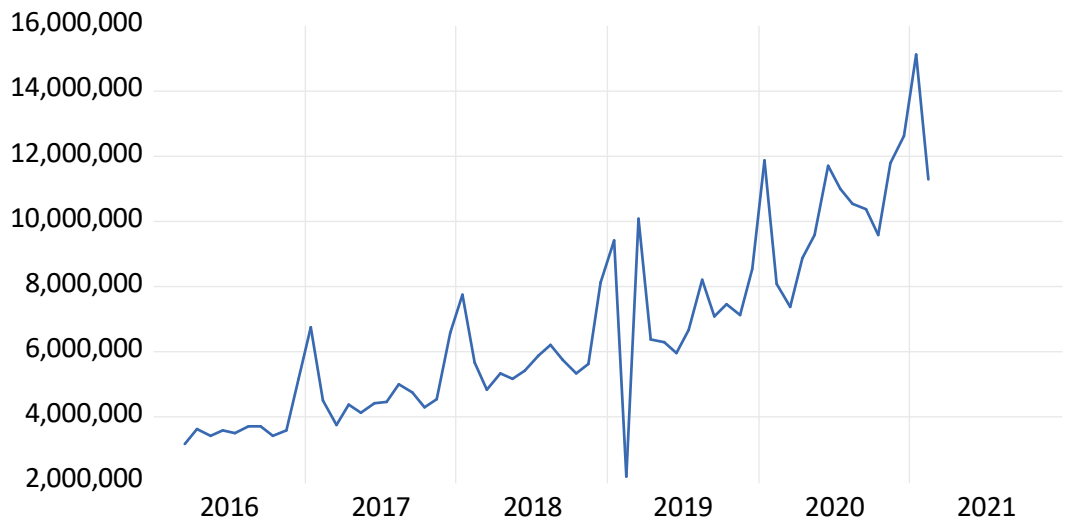
Dealing with anomalies

- Ecommerce sales, especially on Amazon, soared during pandemic.
- Here they grew from $10.5 m. in August 2020 to $39.6 m. in January 2021
- Was this possible?

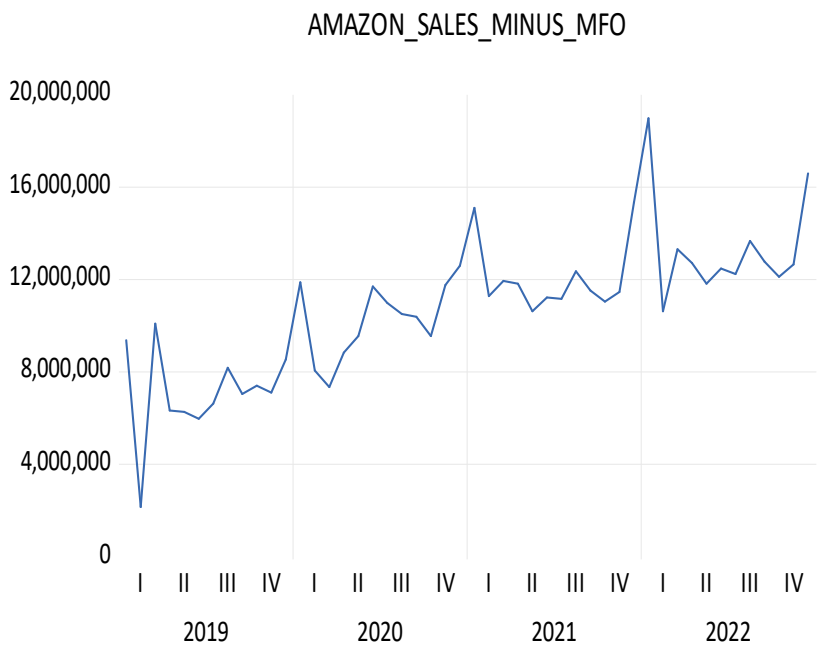
Municipalities adopted Marketplace Facilitator Ordinances (MFOs) in second half of 2020

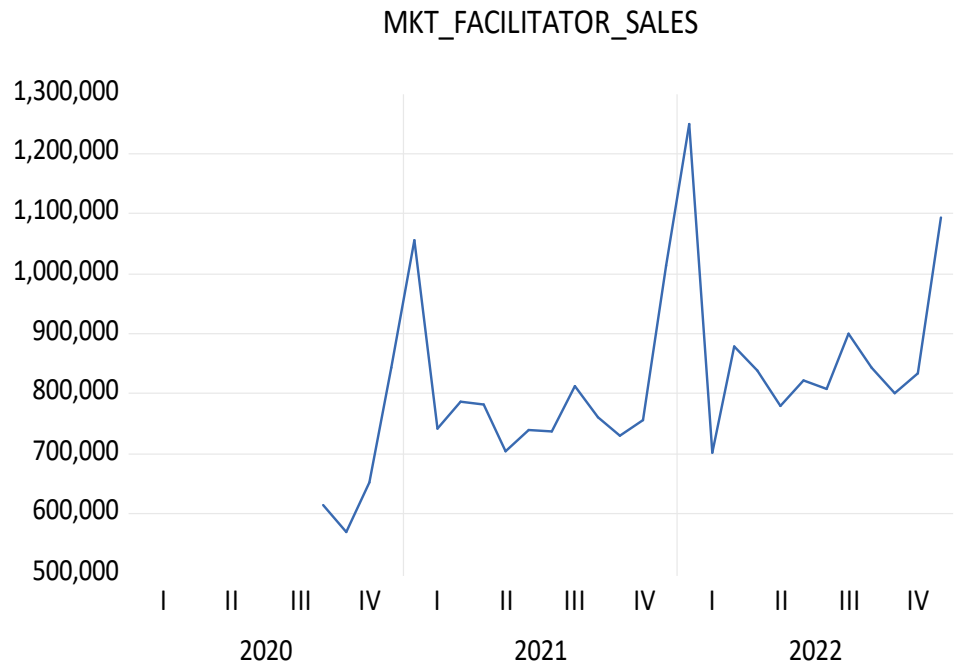
- Amazon collects & submits sales taxes from 3rd party sellers
- Huge increase in e-sales in previous slide due to this new revenue component.
- New component & Amazon sales treated separately in forecast.

AMAZON SALES MINUS MFO SALES



How to forecast MFO sales with 6 months of data? Forecast incorporates trend and seasonal factors from historical patterns of ecommerce.

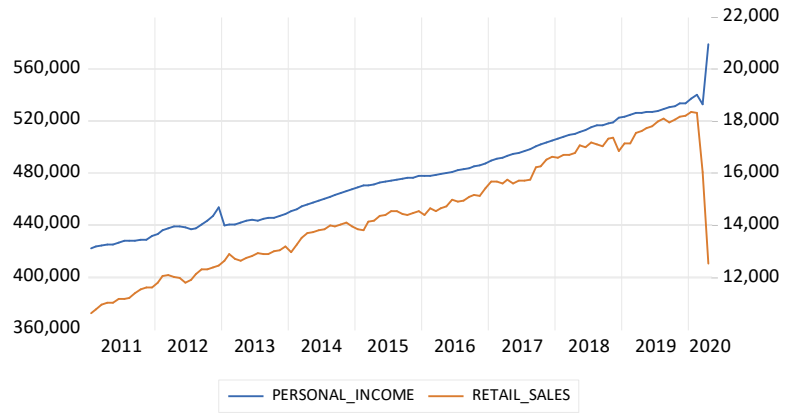




Forecaster's Nightmare

Stable historical relation between personal income & retail sales through February 2020 – no hint of structural break. Forecast of March drop in retail sales impossible. Cause is exogenous to economy.

Once break occurs how can we forecast through the pandemic & recovery?

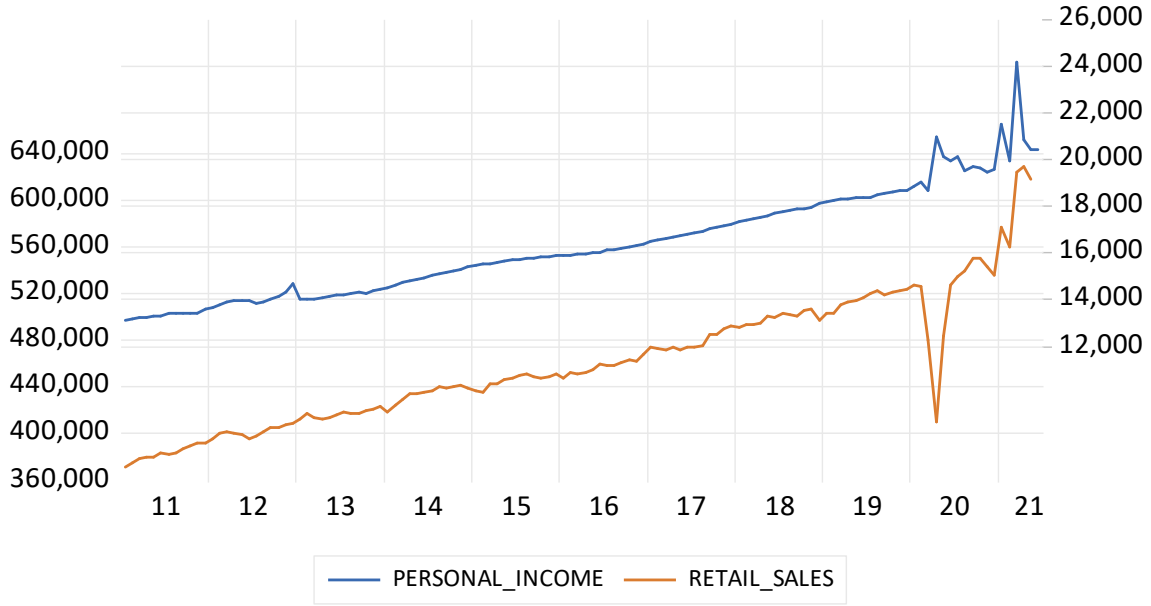


Forecaster's Nightmare

Here the graph is extended through more recent data (2021m05 for retail sales; 2021m06 for Personal Income).

By June 2020 retail sales return to pre-pandemic levels, then accelerate.

To what extent was this pattern predictable given data on personal income?



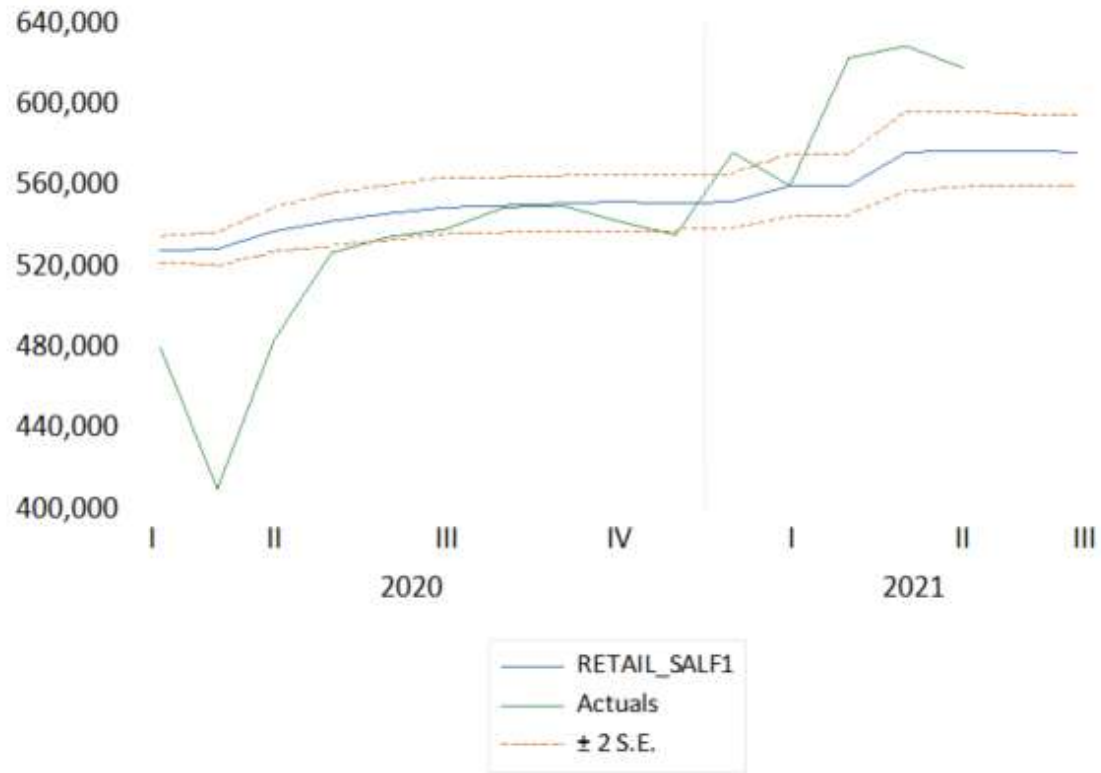
ECM (Error Correction Model) has retail sales adjusting to the disequilibrium between sales and income.

Adjustment parameter = .17

(slow speed of adjustment of sales to increased income)

Forecast continues pre-pandemic trend, misses fluctuations in retail sales.

Forecast with EMC estimated through 2020M02



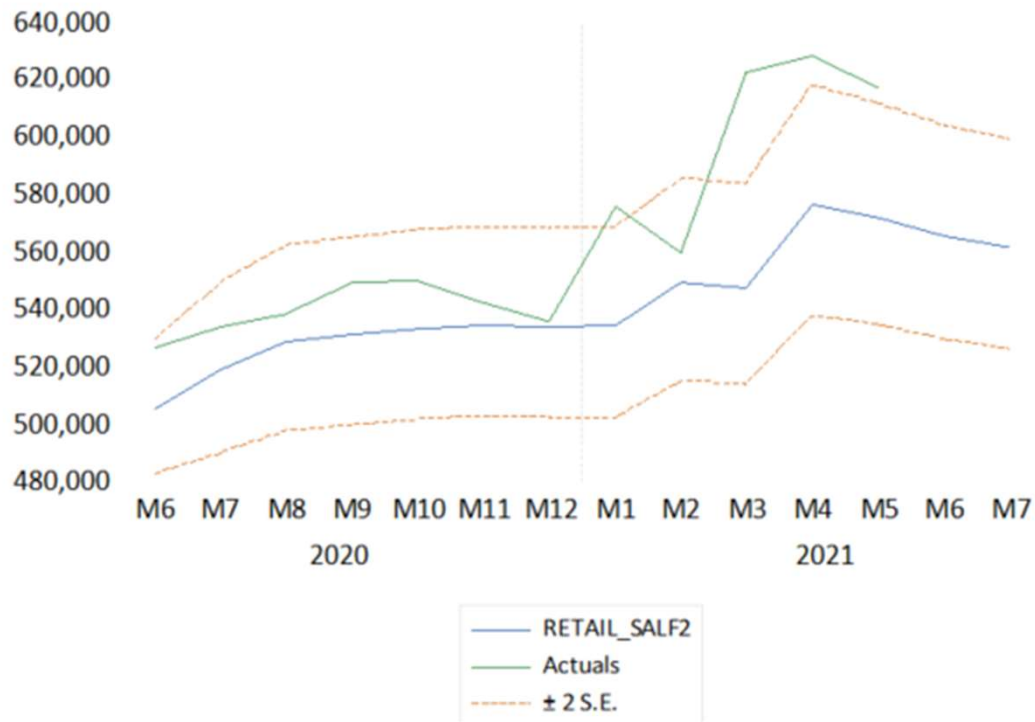
3 months of new data on relation during pandemic.

Adjustment parameter = .35.

Forecast picks up some acceleration of sales in 2021, responding to rise in income.

MAPE = 4.5%

Forecast with EMC estimated through 2020M05



3 more months of data point to equation revisions:

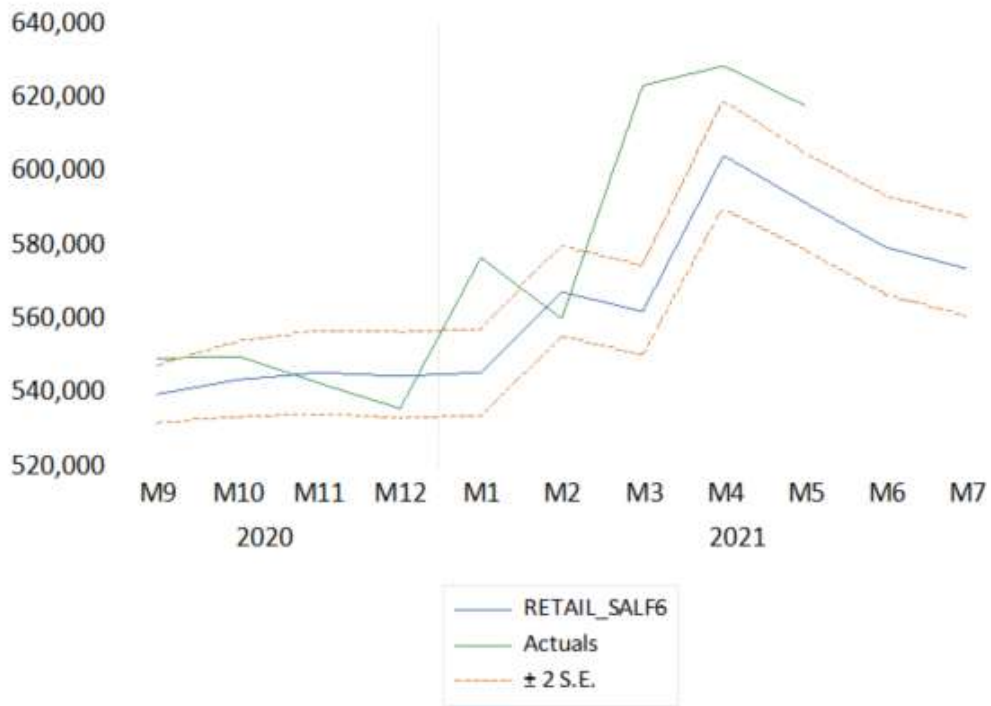
Dummy variables for March, April 2020

Adjustment parameter = .46

Forecast picks up more of sales acceleration in 2021, but delayed.

MAPE = 3.3%

Forecast with revised EMC estimated through 2020M08



Lessons from retail sales forecast experiment

- Prior to pandemic shock (February 2020) historical relation merely projects prior trend, missing precipitous drop in sales.
- As economy moves into the pandemic period, information available on changing relation between income & sales =>
  - Changing parameter values
  - Equation revisions: richer dynamics
- Rolling regressions (dropping early observations as new ones added) allows pandemic period to have more influence on parameter estimates.

Final Thoughts

Economic forecasting is inherently difficult.

Present information on forecast uncertainty – track record; confidence bounds.

Present alternative scenarios with clear assumptions.

Watch out for extremes in updated data.

Allow equation coefficients to adjust to shocks