Hilltop Economics

# The ESF Model
# (ESF: Econometric Semiconductor Forecast)
## Real Time Forecasting Lessons-Learned

AUBER ANNUAL MEETING
October 2018

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**Based on Consensus Economics, Inc. CONSENSUS FORECASTS®*

# Outline

- Forecast process
- Lessons Learned
- Semiconductor MSI measure
  - Data analysis – pch, unit roots, trends, etc.
  - Seasonal adjustment
- Model philosophy
- Model system & key final demand drivers
- Alternative Models
- ESF historical performance

# Forecast Process

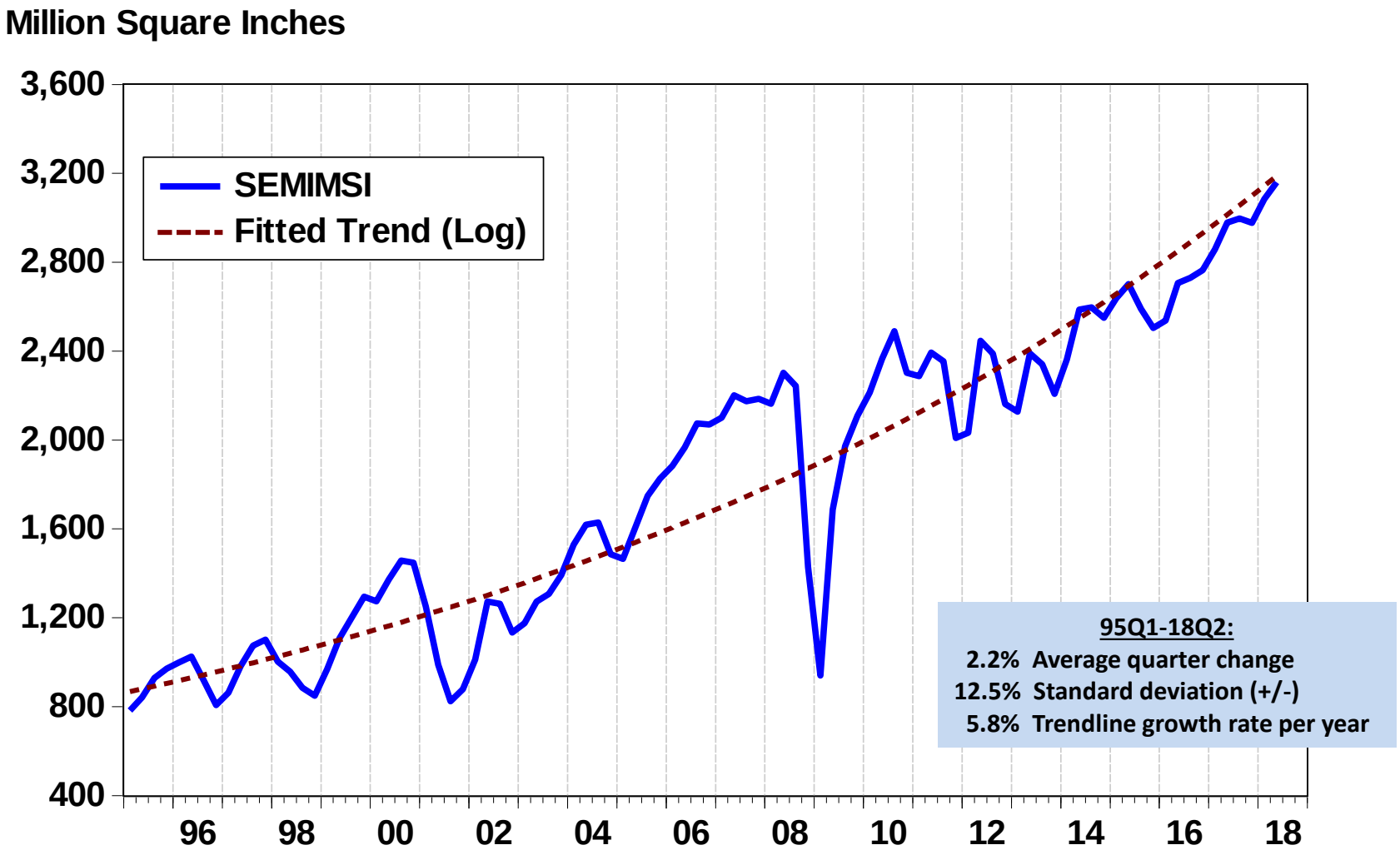
- Analyze data after new quarterly MSI data release
- Evaluate past forecasts against latest actual data
- Validate model and equation structures with latest actual data
- Update Consensus Forecasts for World Economy, key U.S. inputs
- Update non-Consensus forecasts
- Produce preliminary forecast for team discussion
- Create alternative model quarterly forecast (ARIMA, Book-to-bill, MIDAS models)
- Develop final forecast for MSI

# Lessons Learned

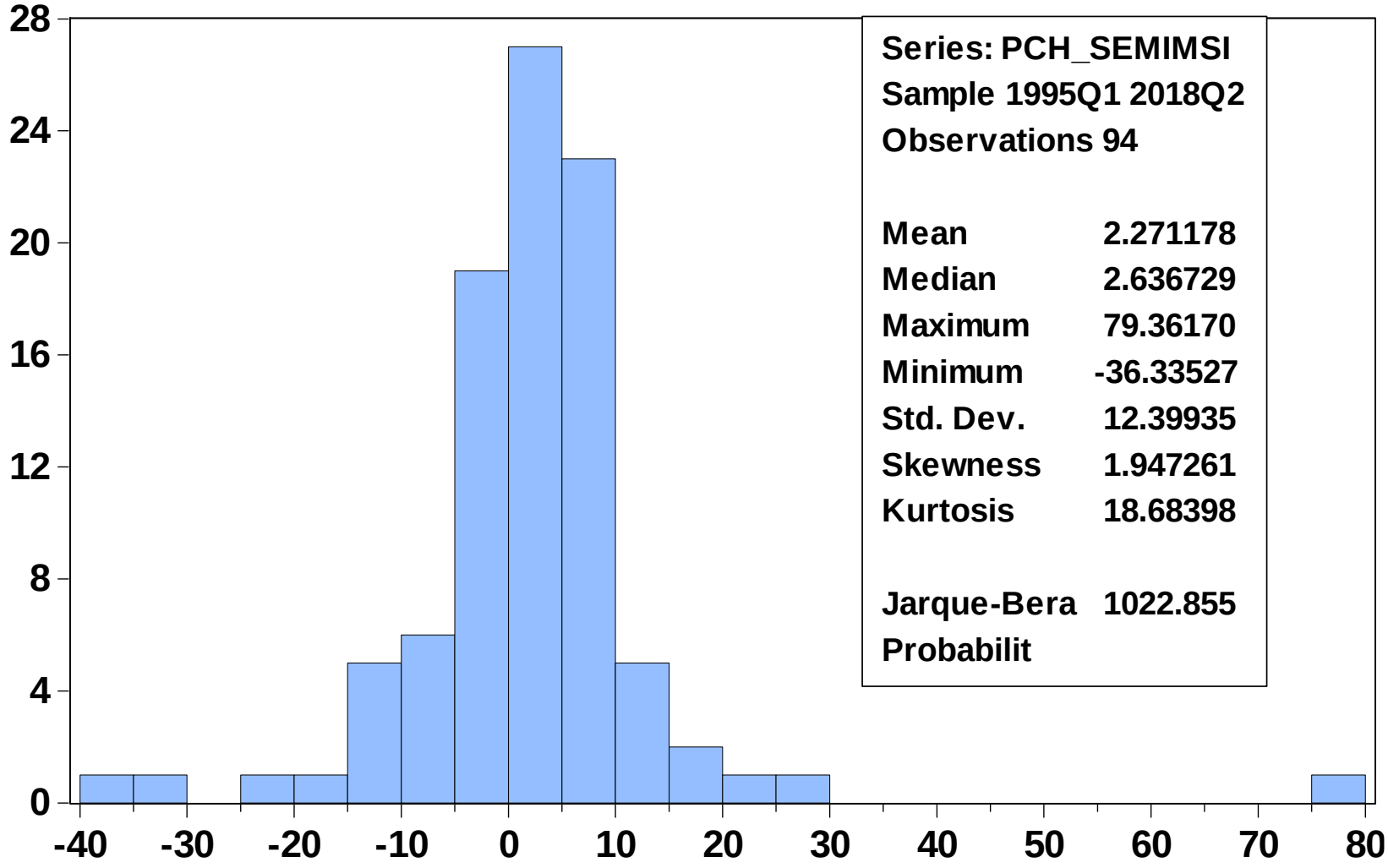
- I will (almost) always be "wrong" – (but not by much).
  - Tetlock: Superforecasting: The Art and Science of Prediction is right: open-mindedness is critical.
- Judgment and flexibility regarding modeling techniques and forecast preparation are essential
- The process is as important as the modeling
  - A model I can understand almost always produces better forecasts than a model I can't understand
- Tracking the forecast and adjusting for errors is key to a good forecast
  - One quarter ahead: use time-series & Midas to adjust
  - Downplay anecdotal evidence not substantiated by any data, but…
  - Pay attention to comments back from the users of the forecasts
- For the MSI and semiconductor industry measures:
  - Seasonal adjustment gets the variability
  - Final demand is more important than immediate markets
    - There is too much "noise" in the immediate markets
    - Data availability in immediate markets is questionable

# Semiconductor Measure: MSI From SEMI.ORG

## *Semiconductor wafers shipped for semiconductor applications*



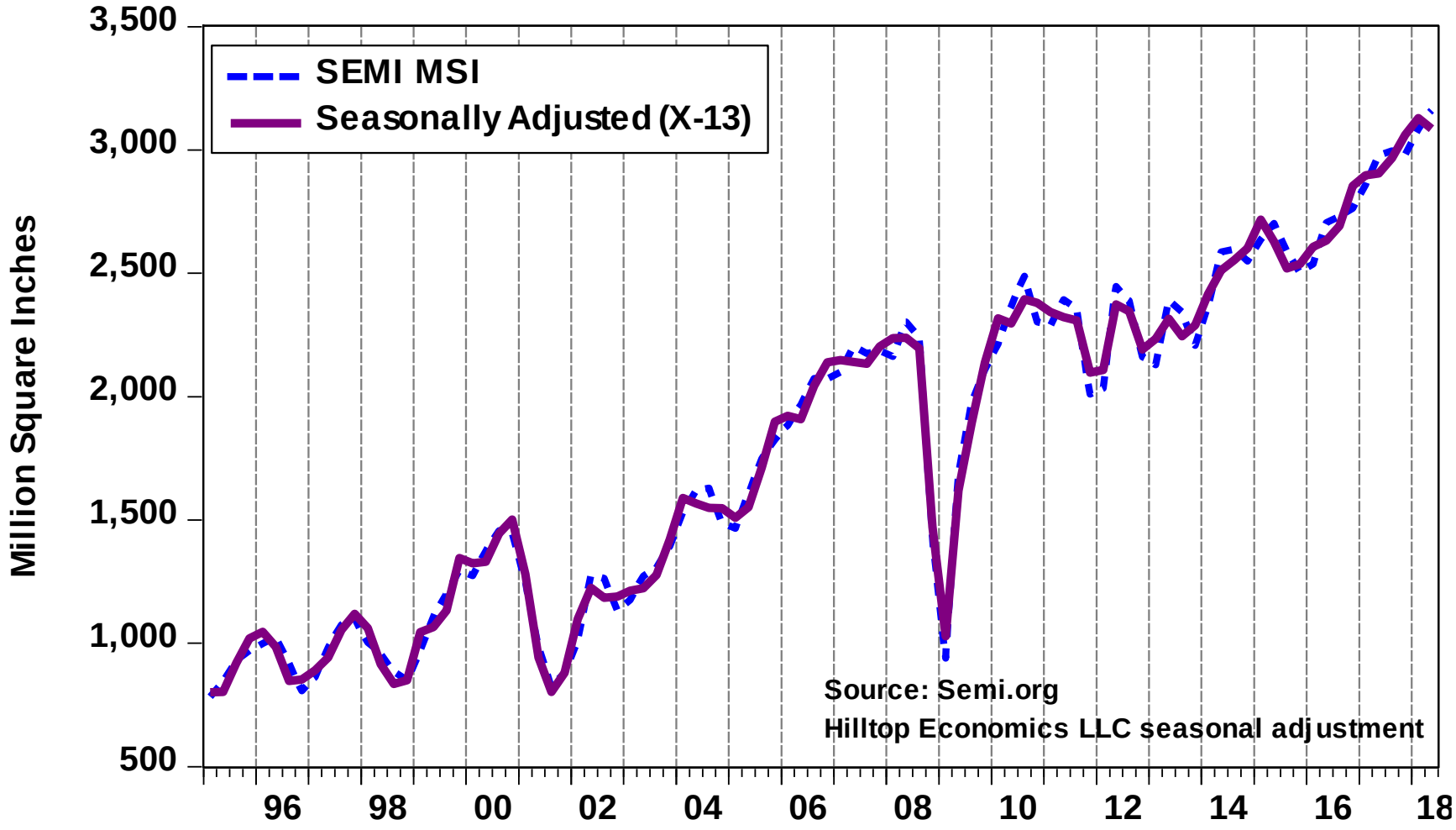
# Distribution of MSI Quarterly Percent Changes



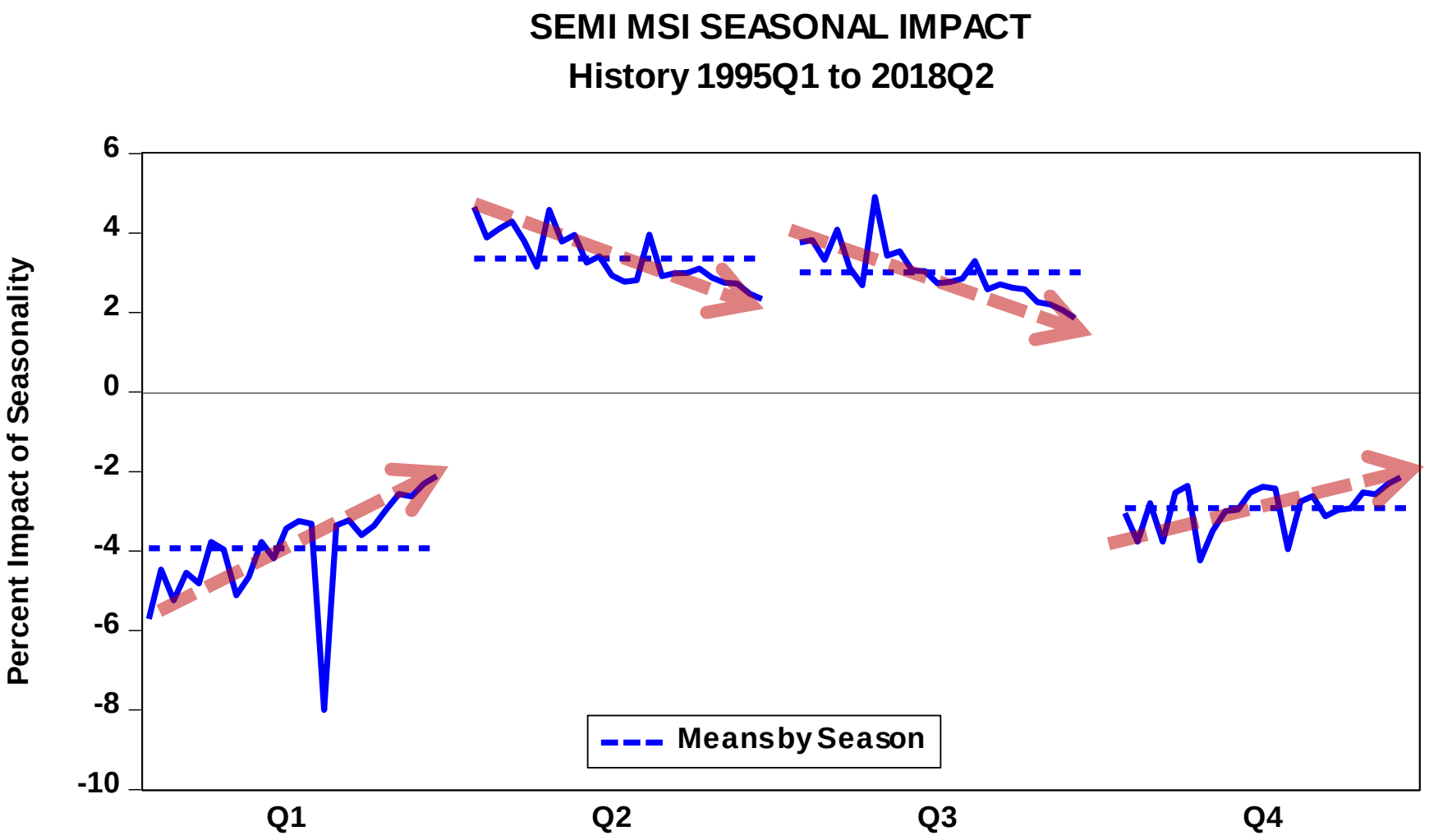
# Census X-13 Analytical Results:

```
SIGNIFICANCE OF SEASONALITY
---------------------------

  Significance of seasonality is assessed using the variances of the
  total estimation error, which includes the error in the preliminary estimator
  (the revision error) and the error in the final estimator.
  Because the S.E. of the seasonal component estimator varies (it reaches a minimum
  for historical estimation and a maximum for the most distant forecast), the significance of seasonality
  will be different for different periods.
  An extreme example would be a series showing significant seasonality for historical estimates,
  that is poorly captured concurrently, and useless for forecasting.


      SEASONAL                      NUMBER OF PERIODS IN A YEAR THAT
      COMPONENT                     HAVE SIGNIFICANT SEASONALITY
                                          90%          95%

  HISTORICAL ESTIMATOR                     4            4

  PRELIMINARY ESTIMATOR                    4            3
  FOR LAST YEAR

  FORECAST FOR NEXT YEAR                   4            3


  For the present series :
  ------------------------

    FINAL OR HISTORICAL ESTIMATION SHOWS CLEARLY SIGNIFICANT SEASONALITY IN THE SERIES.

    CONCURRENT AND PRELIMINARY ESTIMATION SHOW CLEARLY SIGNIFICANT SEASONALITY FOR RECENT PERIODS (LAST YEAR).

    ONE-YEAR AHEAD FORECAST FUNCTION CONTAINS CLEARLY SIGNIFICANT SEASONALITY.
```

# Seasonal Factor Analysis



# Becoming Less Seasonal



# Model Philosophy

- Semiconductors a dynamic but maturing industry
  - Technological change ("supply side") no longer creates large step-changes in MSI demand.
  - Chips ubiquitous in products
  - Products ubiquitous in global regions
- Final Demand a valid driver of MSI
  - Demand driven by "final demand" – consumers and businesses using technology products
    - Consumption
    - Investment
  - Consumers & businesses buy technology products based on economic factors, so MSI can be modeled similar to other dynamic but maturing materials and products.
- Final Demand is best forecast by the global Consensus Forecasts of key (85) economies
  - "Wall Street credibility"

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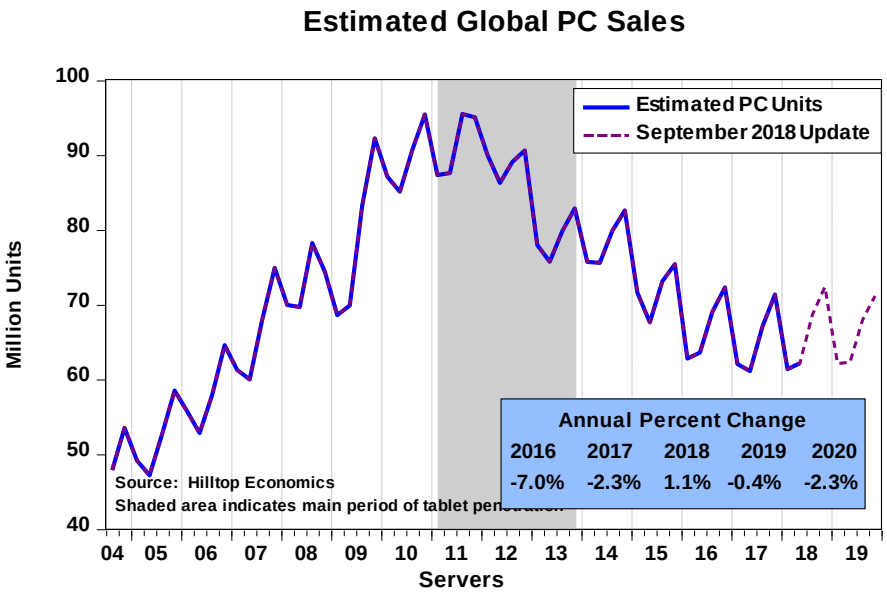
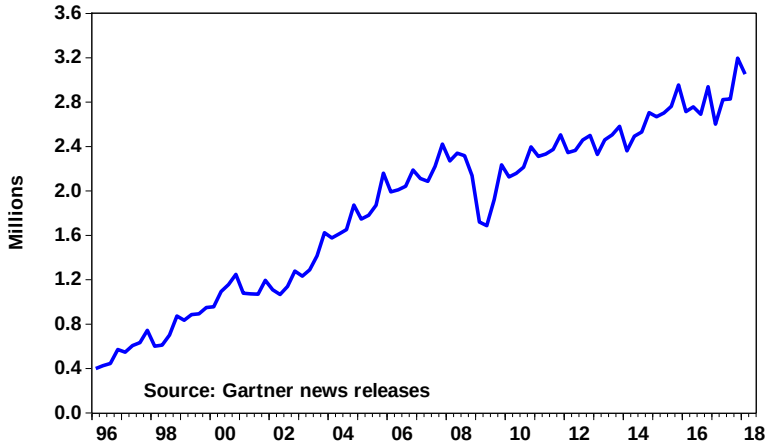
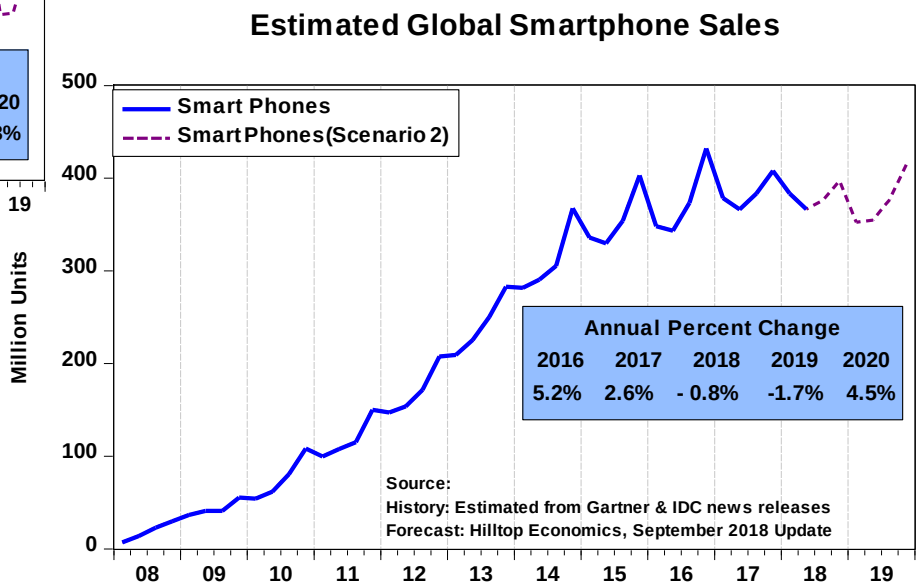
# Some Key Immediate End-use Markets

*(The "typical" industry forecast drivers)*



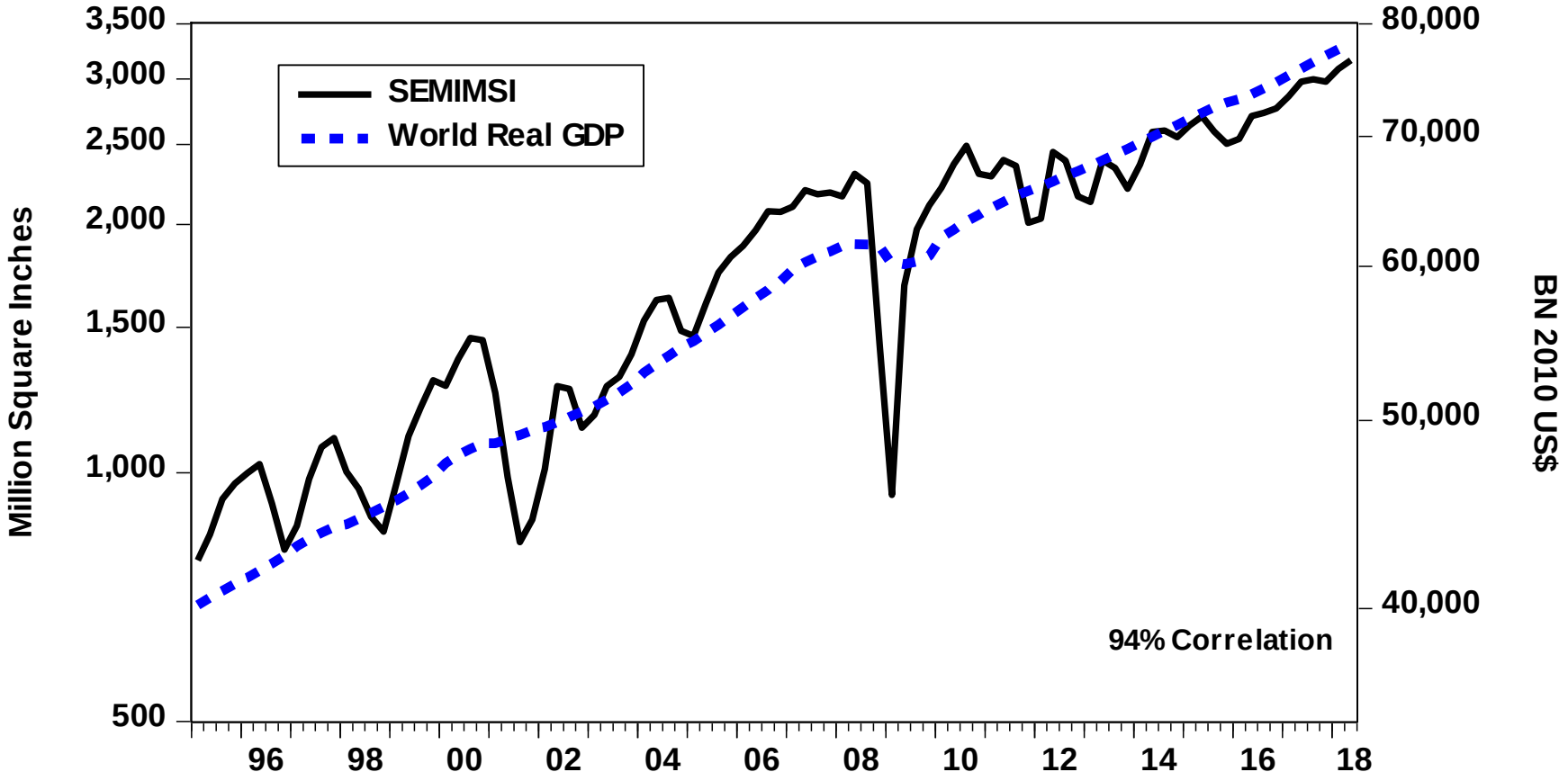



# MSI VS "World" Real GDP

## *.94 Correlation From 95Q1 to 18Q2, Level Log-Log*

## *Note, however, penetration moderation 2011-2016*



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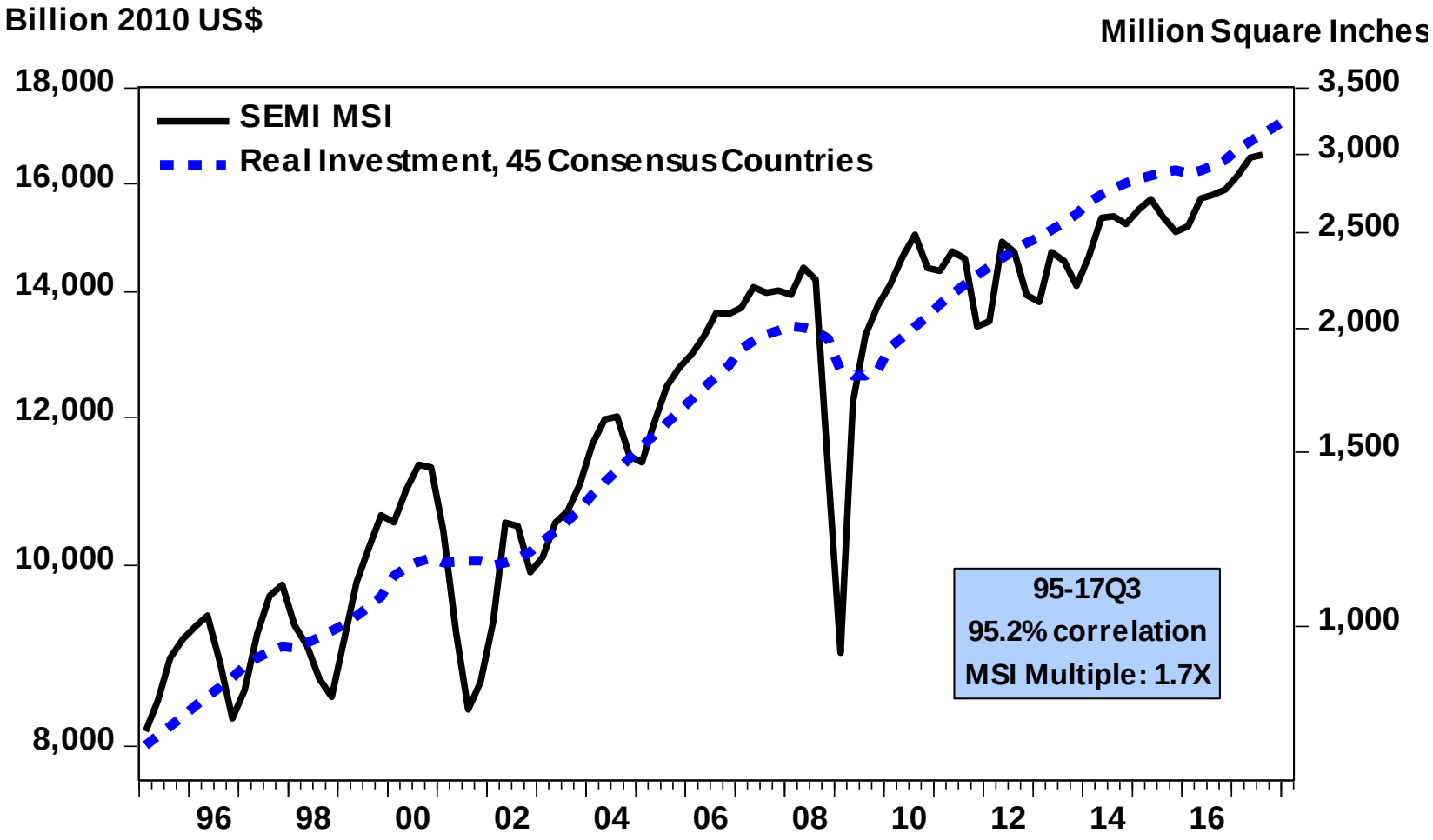
# MSI VS Real Investment

## *.952 Correlation From 95Q1 to 17Q3, Level*

## *Slightly better correlation, slightly lower growth multiple*

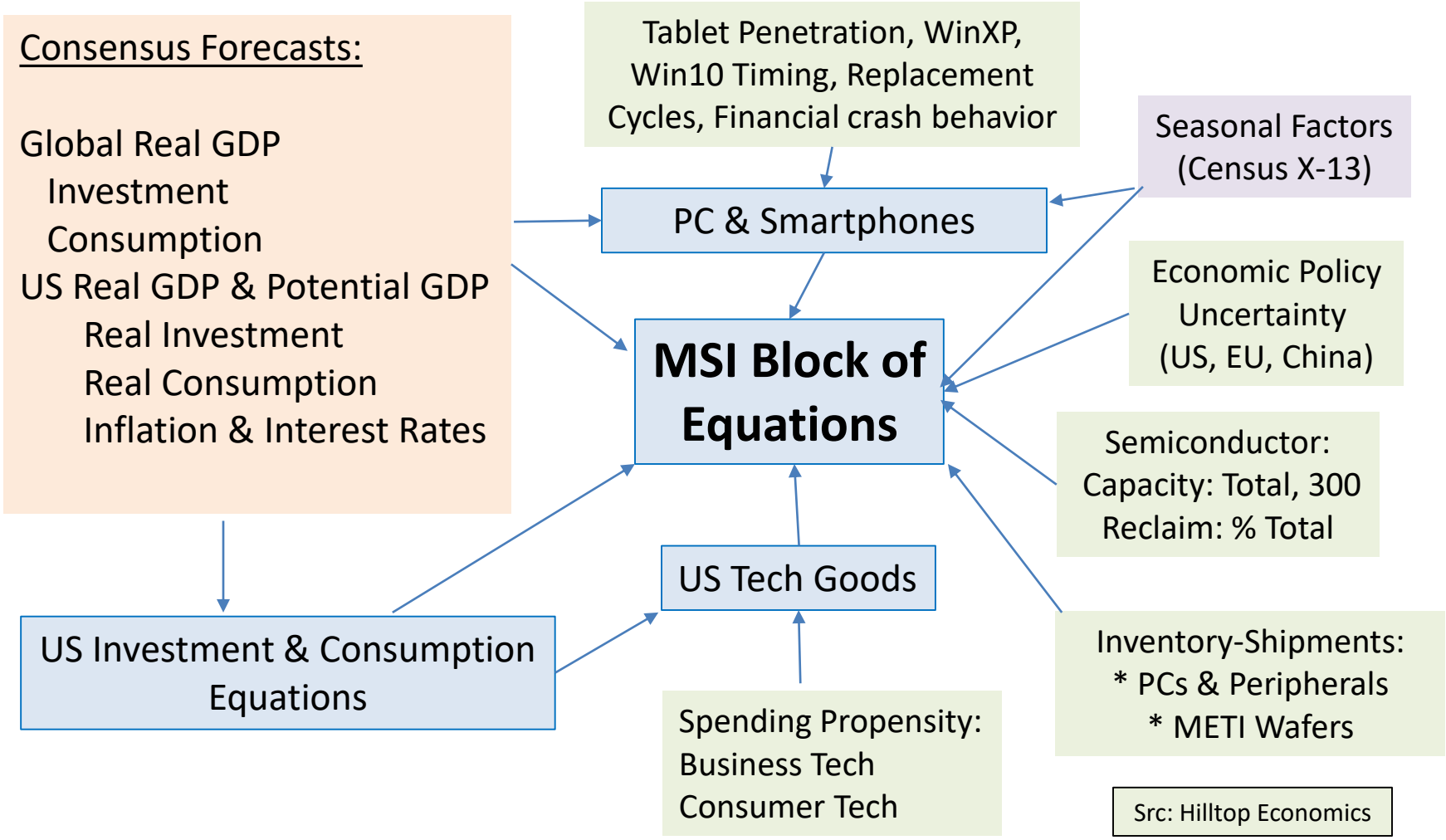


# MSI Block: The Core Model Structure

- Error Correction Model (ECM) system
  - MSI seasonal adjustment model (Census X-13 Tramo/Seats) to capture "typical" seasonal patterns.
  - Long run MSI-final demand embedded equation
  - Short run MSI-dynamic cyclical equation to capture excursions from underlying long-run relationships
- Driven by exogenous inputs and models of final demand, plus any necessary supply-side developments.

# ESF Model System

*(ESF: Econometric Semiconductor Forecast)*



# Long Run Embedded Equation

- Seasonally-adjusted MSI modeled as a function of key inputs:
  - "Global" ex US investment and consumption
  - US technology goods spending (business & consumer)
  - Global PC and smartphone unit sales
  - Economic Policy Uncertainty (*Global*)
  - Interest rates
  - Semi wafer capacity estimates (total, VNAND introduction)
  - METI I-S ratios (wafers)
  - Behavioral dummies: financial collapse & 9/11

# Short Run Cycle Equation

- Quarterly rate of change in MSI modeled as a function of key inputs:
  - Deviation from long run embedded equation estimates
  - Rate of change in key long run inputs:
    - Global final demands
    - US Tech
    - PCs & smartphones
    - Economic policy uncertainty
  - Rate of change in US inventory-shipments ratio for computers & peripherals, METI I-S ratio
  - Special events measures (9/11, Financial Crisis onset, Win10)
  - Rate of change in SEMI capacity measure and impacts from 300mm and VNAND intorductions (lagged one Qtr)

# Unit Root Test:

## Log(SEMI MSI) does not have a unit root

Augmented Dickey-Fuller Unit Root Test on SEMIMSI

Null Hypothesis: SEMIMSI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.301380 | 0.0048 |
| Test critical values: | 1% level | -4.058619 | |
| | 5% level | -3.458326 | |
| | 10% level | -3.155161 | |

*MacKinnon (1996) one-sided p-values.

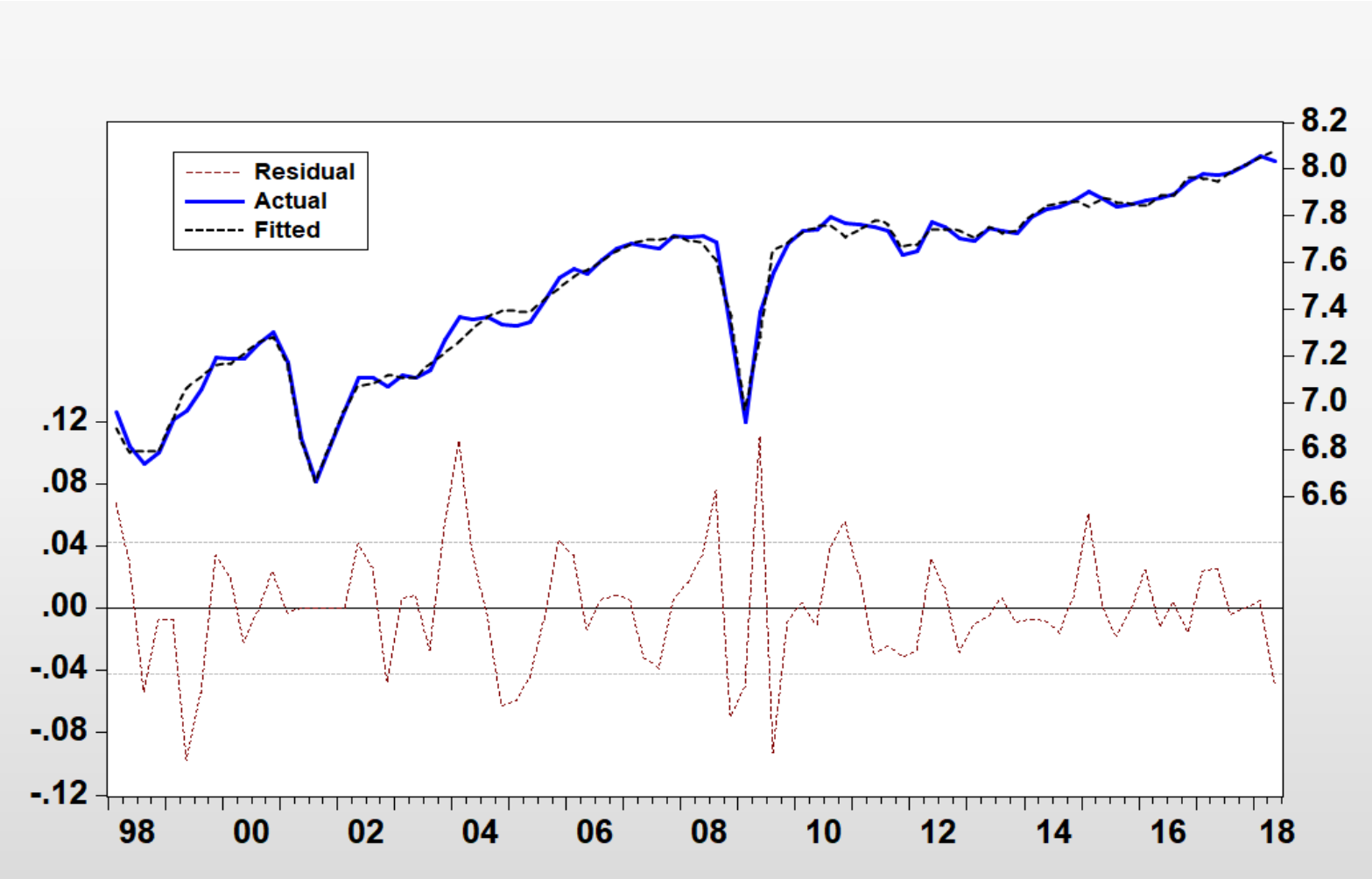
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SEMIMSI)
Method: Least Squares
Date: 08/07/18 Time: 13:57
Sample (adjusted): 1995Q1 2018Q2
Included observations: 94 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| SEMIMSI(-1) | -0.354590 | 0.082436 | -4.301380 | 0.0000 |
| D(SEMIMSI(-1)) | 0.630718 | 0.107418 | 5.871638 | 0.0000 |
| D(SEMIMSI(-2)) | -0.398206 | 0.097048 | -4.103173 | 0.0001 |
| D(SEMIMSI(-3)) | 0.314847 | 0.102404 | 3.074545 | 0.0028 |
| C | 250.5032 | 60.87198 | 4.115246 | 0.0001 |
| @TREND("1995Q1") | 8.393038 | 1.973005 | 4.253936 | 0.0001 |

| | | | |
|---|---|---|---|
| R-squared | 0.441692 | Mean dependent var | 25.86968 |
| Adjusted R-squared | 0.409970 | S.D. dependent var | 172.7812 |
| S.E. of regression | 132.7191 | Akaike info criterion | 12.67605 |
| Sum squared resid | 1550063. | Schwarz criterion | 12.83839 |
| Log likelihood | -589.7743 | Hannan-Quinn criter. | 12.74162 |
| F-statistic | 13.92384 | Durbin-Watson stat | 2.024711 |
| Prob(F-statistic) | 0.000000 | | |

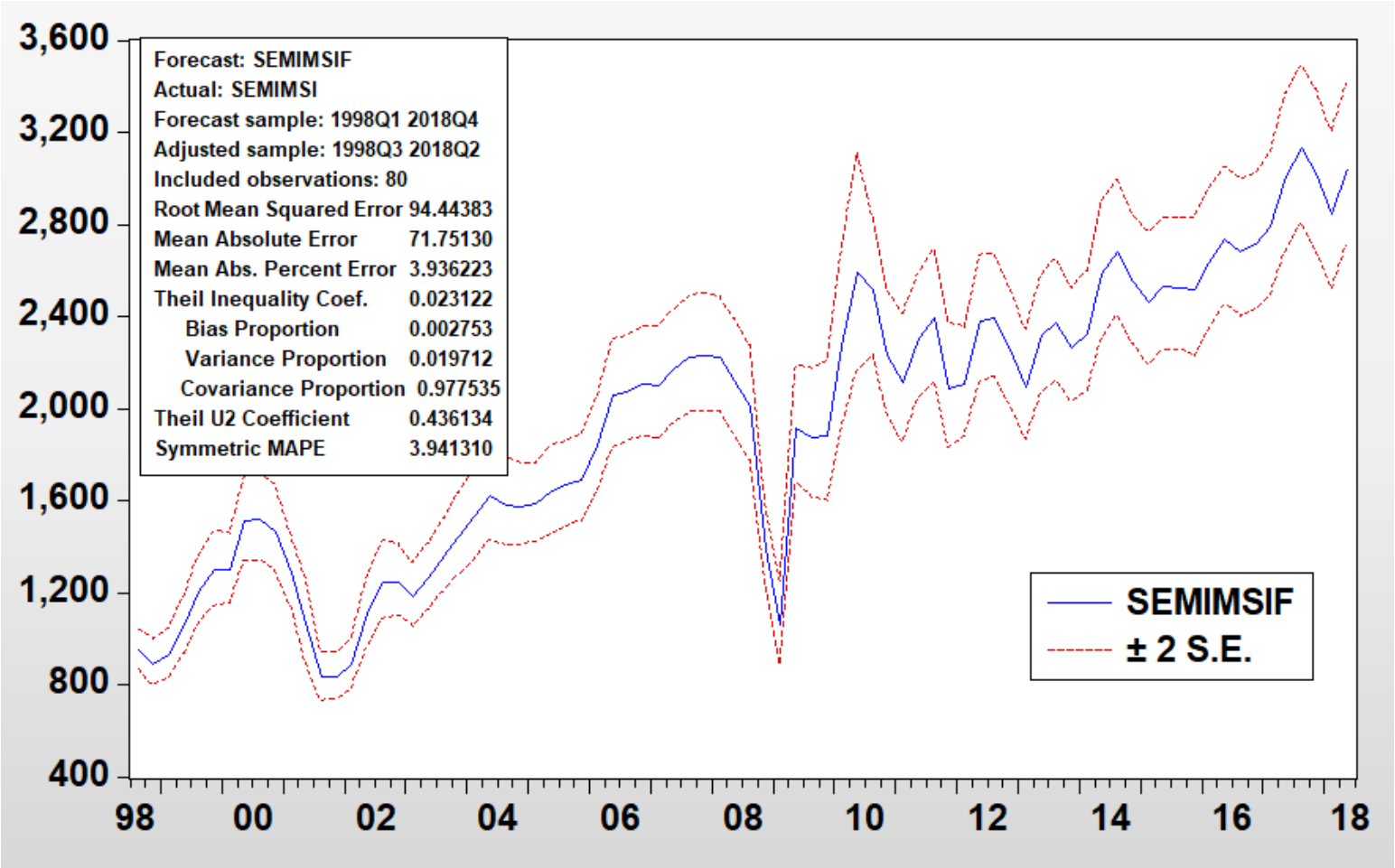
# The Long-run Embedded MSI Equation

***Aug 18: Adjusted R-square: .986 D-W: 1.76 SER: 4.2% MAPE: 3.9%***



# The Long-run Embedded MSI Equation

***Nov 17: Adjusted R-square: .986 D-W: 1.76 SER: 4.2% MAPE: 3.9%***



# Long-run Embedded Equation

Dependent Variable: LOG(SEMIMSI)-LOG(SEMIMSI_SF)
Method: Least Squares
Date: 08/11/18 Time: 14:30
Sample (adjusted): 1998Q1 2018Q2
Included observations: 82 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -8.173018 | 1.697363 | -4.815126 | 0.0000 |
| LOG(WORIF10C+WORCE10C) | 0.976460 | 0.180174 | 5.419538 | 0.0000 |
| LOG(USTECH(-1)) | 0.197409 | 0.124508 | 1.585519 | 0.1177 |
| LOG(DGS10) | 0.142250 | 0.035639 | 3.991462 | 0.0002 |
| @MOVAV(DSPIKELONG,2) | -0.562244 | 0.076534 | -7.346371 | 0.0000 |
| DASIACRISIS(-2) | -0.218395 | 0.029495 | -7.404424 | 0.0000 |
| D911(1) | -0.291738 | 0.018160 | -16.06480 | 0.0000 |
| D911 | -0.415628 | 0.015679 | -26.50923 | 0.0000 |
| D911(-1) | -0.230776 | 0.017279 | -13.35609 | 0.0000 |
| D911(-2) | -0.094280 | 0.018482 | -5.101081 | 0.0000 |
| DHYNIX | -0.274047 | 0.039096 | -7.009541 | 0.0000 |
| LOG(JPNMSI_I_S) | -0.210251 | 0.041241 | -5.098077 | 0.0000 |
| LOG(PC_NEW) | 0.152623 | 0.038531 | 3.961030 | 0.0002 |
| @MOVAV((LOG(SMARTPHONE)-LOG... | 0.009843 | 0.004461 | 2.206440 | 0.0309 |
| LOG(@MOVAV(JPOLUNC_GLOBAL(-... | -0.059712 | 0.032828 | -1.818925 | 0.0735 |
| LOG(KSEMI) | 0.138483 | 0.063161 | 2.192528 | 0.0319 |
| DVNAND | 0.085792 | 0.013515 | 6.348004 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.989449 | Mean dependent var | 7.500683 |
| Adjusted R-squared | 0.986852 | S.D. dependent var | 0.367396 |
| S.E. of regression | 0.042128 | Akaike info criterion | -3.313915 |
| Sum squared resid | 0.115359 | Schwarz criterion | -2.814961 |
| Log likelihood | 152.8705 | Hannan-Quinn criter. | -3.113593 |
| F-statistic | 380.9692 | Durbin-Watson stat | 1.737848 |
| Prob(F-statistic) | 0.000000 | | |

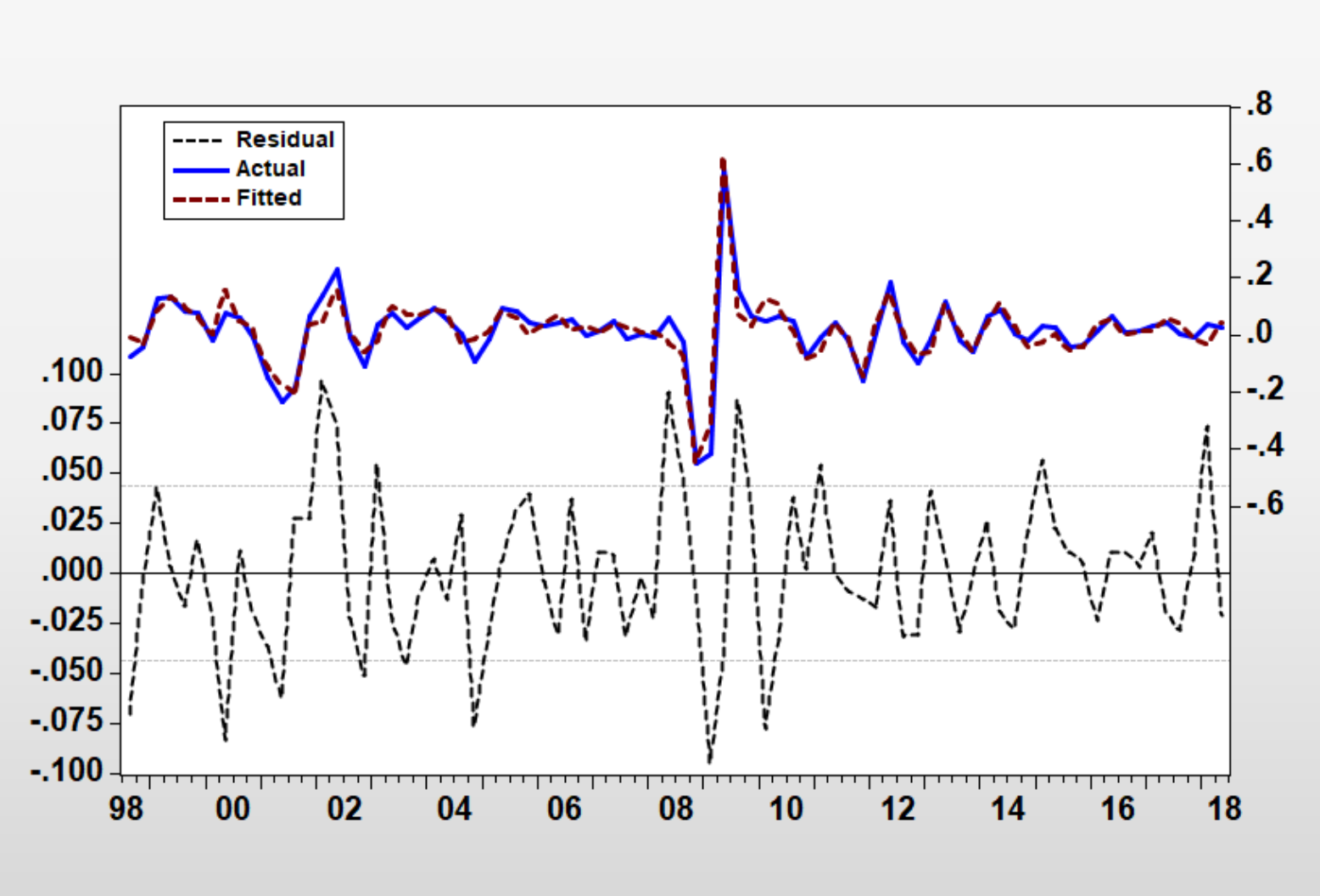
# Dynamic Error Correction Equation

Dependent Variable: DLOG(SEMIMSI)
Method: Least Squares
Date: 08/11/18 Time: 14:36
Sample (adjusted): 1998Q3 2018Q2
Included observations: 80 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

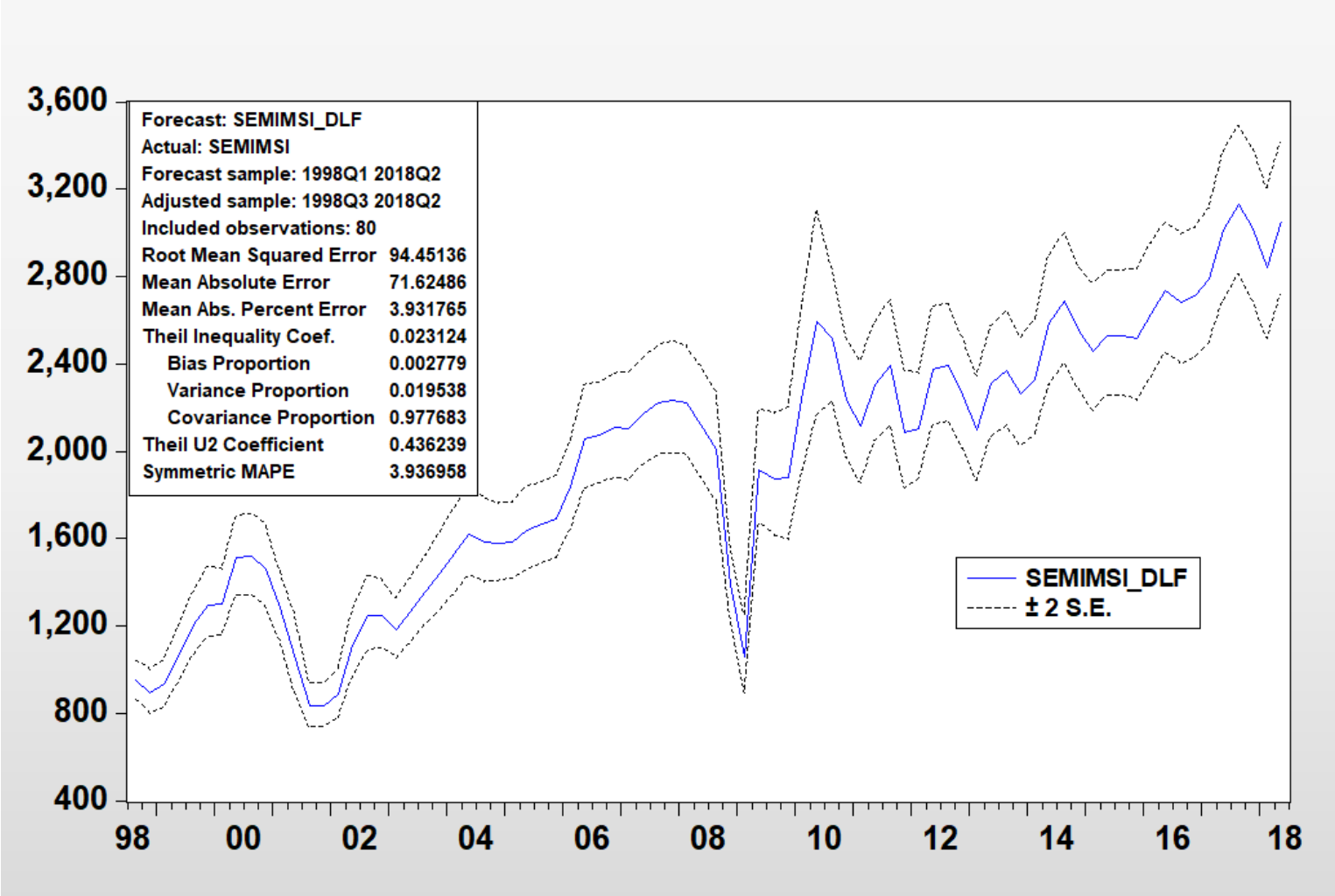
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| DLOG(SEMIMSI_SF) | 0.587905 | 0.179433 | 3.276463 | 0.0017 |
| C | 0.008144 | 0.005402 | 1.507493 | 0.1365 |
| DLOG(@MOVAV((WOR10C)/(WOR10... | 2.147947 | 1.262748 | 1.701011 | 0.0937 |
| DLOG(@MOVAV(USTECH(-1),1)) | 0.411429 | 0.232954 | 1.766141 | 0.0821 |
| DLOG(PC_NEW/PC_NEW_SF) | 0.414427 | 0.180435 | 2.296818 | 0.0249 |
| DLOG(@MOVAV(JPOLUNC_GLOBAL... | -0.061175 | 0.020972 | -2.917019 | 0.0048 |
| DSPIKE | -0.378602 | 0.041483 | -9.126723 | 0.0000 |
| D(D911) | -0.129331 | 0.015987 | -8.089509 | 0.0000 |
| DLOG(@MOVAV(KISUSPC(-1),2)) | -0.266936 | 0.105522 | -2.529682 | 0.0139 |
| DLOG(JPNMSI_I_S) | -0.196580 | 0.056422 | -3.484070 | 0.0009 |
| DLOG(KSEMI(-1)-KSEMI300(-1)) | 0.396333 | 0.151575 | 2.614767 | 0.0111 |
| DLOG(KSEMI300(-1)) | -0.032891 | 0.016757 | -1.962840 | 0.0539 |
| @MOVAV(LOG(SEMIMSI(-1))-LOG(S... | -0.754926 | 0.235292 | -3.208467 | 0.0021 |
| D(DVNAND) | 0.070331 | 0.012160 | 5.783655 | 0.0000 |
| DLOG(SMARTPHONE/SMARTPHONE... | 0.005345 | 0.004576 | 1.167978 | 0.2471 |

| | | | |
|---|---|---|---|
| R-squared | 0.895851 | Mean dependent var | 0.014932 |
| Adjusted R-squared | 0.873419 | S.D. dependent var | 0.122783 |
| S.E. of regression | 0.043684 | Akaike info criterion | -3.256305 |
| Sum squared resid | 0.124039 | Schwarz criterion | -2.809675 |
| Log likelihood | 145.2522 | Hannan-Quinn criter. | -3.077238 |
| F-statistic | 39.93631 | Durbin-Watson stat | 1.772067 |
| Prob(F-statistic) | 0.000000 | Wald F-statistic | 159.7351 |
| Prob(Wald F-statistic) | 0.000000 | | |

# Dynamic Fit 98Q3-18Q2



# In-sample Forecast



# Consensus Forecasts®

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1) Developed World
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## CONSENSUS FORECASTS®



**Survey Date**
**November 9, 2015**

Every month, Consensus Economics surveys over 250 prominent financial and economic forecasters for their estimates of a range of variables including future growth, inflation, interest rates and exchange rates. More than 20 countries are covered and the reference data, together with analysis and polls on topical issues, is rushed to subscribers by express mail and e-mail.

**Contents**

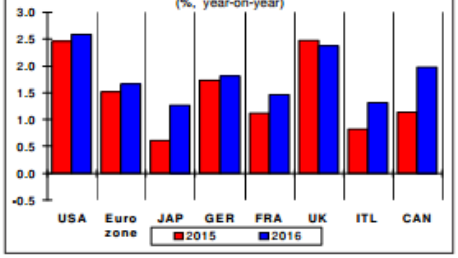


**Survey Highlights**

- Q3 GDP growth slowed to 0.5% (q-o-q) in the **UK** economy, as manufacturing and construction output slumped noticeably. In **Spain**, GDP expanded by 0.8% (q-o-q) and the unemployment rate dropped to 21.2% in Q3, its lowest level for four years.
- Activity in the **US** moderated in Q3, although strong jobs data in October has raised expectations of a **Federal Reserve** interest rate rise. Our panel gives a 70% probability of a rate rise at the next **Fed** meeting in December.
- The **Canadian** Liberal Party swept to power in the October elections. The new government is planning deficit spending to boost activity which has suffered from lower commodity prices.
- **German** industrial activity and factory orders declined again in September.
- In our **Corporate Profits** survey (pages 28-29), we have included quarterly estimates for the **US**. **Real Interest Rates**, meanwhile, compare inflation-adjusted 10-year bonds (page 3) across all countries surveyed.

Our next issue of **Consensus Forecasts** will be available at the end of the day on **December 10, 2015** and will include **Quarterly Forecasts.**

**G-7 GDP Growth Forecasts – 2015 and 2016**
(%, year-on-year)

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Assistant Editor: Luke N. George
Publisher: Philip M. Hubbard

# Typical Country Output:

Key concepts for ESF forecast:

- Gross Domestic Product
- Personal Consumption
- Business Investment
- Consumer Prices
- Producer Prices

Interest Rates (on second page o document, not shown)

**UNITED STATES** **NOVEMBER 2015**

| | Average % Change on Previous Calendar Year | | | | | | | | | | | | | | | | Annual Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gross Domestic Product | | Personal Consum-ption | | Business Invest-ment | | Pre - Tax Corporate Profits | | Industrial Product-ion | | Con-sumer Prices | | Producer Prices | | Employ-ment Costs | | Auto & Light Truck Sales (inc. imports, mn units) | | Housing Starts (mn units) | |
| Economic Forecasters | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| Ford Motor Company | 2.6 | 2.7 | 3.2 | 3.2 | 3.8 | 3.7 | na | na | 1.6 | 2.4 | 0.1 | 1.7 | -3.0 | 1.3 | na | na | na | na | 1.16 | 1.41 |
| Standard & Poor's | 2.5 | 2.8 | 3.1 | 3.3 | 3.5 | 5.4 | na | na | 1.7 | 1.7 | 0.1 | 2.2 | -2.7 | 3.1 | 2.0 | 2.6 | 17.2 | 17.4 | 1.13 | 1.35 |
| Swiss Re | 2.5 | 3.1 | 3.2 | 2.9 | 3.3 | 6.4 | 0.7 | 5.9 | 1.6 | 2.5 | 0.2 | 1.6 | -2.9 | 0.8 | na | na | 17.2 | 16.7 | 1.14 | 1.39 |
| Moody's Analytics | 2.5 | 3.2 | 3.3 | 3.9 | 3.4 | 5.3 | 0.6 | 9.2 | 1.4 | 1.7 | 0.2 | 2.1 | -2.4 | 3.1 | 2.1 | 2.6 | 17.2 | 17.0 | 1.15 | 1.48 |
| Econ Intelligence Unit | 2.5 | 2.4 | 3.0 | 2.2 | 4.1 | 5.4 | na | na | 1.6 | 2.6 | 0.1 | 1.7 | -2.1 | 1.7 | na | na | na | na | na | na |
| UBS | 2.5 | 2.8 | 3.2 | 3.0 | 3.2 | 5.0 | na | na | 1.6 | 2.0 | 0.2 | 1.6 | na | na | 2.2 | 3.1 | na | na | 1.14 | 1.31 |
| Inforum - Univ of Maryland | 2.5 | 2.7 | 3.2 | 2.7 | 3.3 | 4.8 | 1.6 | 5.0 | 1.5 | 2.7 | 0.2 | 1.9 | -0.7 | 1.8 | 2.0 | 1.8 | 17.3 | 17.4 | 1.13 | 1.29 |
| Credit Suisse | 2.5 | 2.7 | 3.2 | 3.2 | 3.2 | 3.7 | -0.1 | 3.2 | 1.5 | 2.1 | 0.2 | 1.4 | na | na | na | na | na | na | na | na |
| Nat Assn of Home Builders | 2.5 | 2.8 | 3.2 | 2.9 | 3.2 | 3.9 | na | na | 1.5 | 2.1 | 0.2 | 1.6 | -0.7 | 1.3 | 2.1 | 2.1 | 17.3 | 17.3 | 1.12 | 1.26 |
| Bank of America - Merrill | 2.5 | 2.5 | 3.2 | 3.0 | 3.2 | 4.0 | na | na | 1.5 | 1.9 | 0.1 | 2.0 | na | na | na | na | 17.3 | 18.1 | 1.13 | 1.27 |
| The Conference Board | 2.5 | 2.4 | 3.2 | 2.7 | 3.2 | 3.9 | -0.2 | 0.3 | 1.6 | 2.3 | 0.2 | 1.7 | na | na | na | na | 17.3 | 17.0 | 1.13 | 1.32 |
| Eaton Corporation | 2.4 | 2.2 | 3.2 | 3.5 | 3.3 | 3.3 | na | na | 2.2 | 2.2 | 0.3 | 1.9 | -2.8 | 1.3 | na | na | 17.2 | 17.2 | 1.13 | 1.24 |
| RDQ Economics | 2.4 | 2.6 | 3.1 | 2.7 | 3.2 | 4.6 | 0.3 | 4.5 | 1.5 | 1.8 | 0.2 | 2.0 | na | na | na | na | 17.5 | 18.0 | 1.10 | 1.15 |
| Georgia State University | 2.4 | 2.6 | 3.2 | 3.0 | 3.2 | 5.2 | 1.5 | 9.2 | 1.3 | 1.8 | 0.0 | 1.6 | -3.4 | 1.0 | 2.1 | 2.4 | 17.3 | 17.0 | 1.11 | 1.21 |
| Northern Trust | 2.4 | 2.6 | 3.2 | 2.8 | 3.2 | 4.1 | na | na | na | na | 0.2 | 1.6 | na | na | na | na | 16.9 | 17.1 | 1.04 | 1.30 |
| Univ of Michigan - RSQE | 2.4 | 2.6 | 3.2 | 3.0 | 3.0 | 2.6 | -0.1 | 6.3 | 1.3 | 0.9 | 0.1 | 1.6 | -3.0 | 1.2 | na | na | 17.4 | 18.0 | 1.13 | 1.32 |
| Citigroup | 2.4 | 2.5 | 3.2 | 2.8 | 3.6 | 4.1 | na | na | 1.6 | 2.7 | 0.2 | 1.8 | na | na | na | na | na | na | na | na |
| Macroeconomic Advisers | 2.4 | 2.6 | 3.2 | 3.1 | 3.0 | 2.5 | -1.8 | -0.5 | 1.4 | 1.3 | 0.1 | 1.6 | -3.2 | 0.2 | na | na | 17.3 | 17.3 | 1.12 | 1.29 |
| General Motors | 2.4 | 2.5 | 3.1 | 2.8 | 3.7 | 2.9 | -2.6 | 0.5 | 1.4 | 1.7 | 0.1 | 1.7 | -2.9 | 1.4 | na | na | na | na | 1.11 | 1.32 |
| JP Morgan | 2.4 | 2.3 | 3.2 | 2.8 | 3.2 | 4.4 | 0.6 | 4.7 | 1.7 | 1.8 | 0.1 | 1.7 | -0.7 | 1.6 | 2.1 | 2.6 | 17.3 | 17.5 | 1.11 | 1.20 |
| Goldman Sachs | 2.4 | 2.3 | 3.2 | 3.0 | 3.1 | 3.9 | na | na | 1.6 | 2.5 | 0.2 | 1.9 | na | na | na | na | 17.2 | 17.3 | 1.13 | 1.27 |
| IHS Economics | 2.4 | 2.9 | 3.2 | 3.2 | 3.3 | 5.8 | 0.3 | 7.8 | 1.3 | 1.6 | 0.0 | 1.4 | -3.3 | 0.7 | 2.1 | 2.3 | 17.4 | 17.8 | 1.11 | 1.28 |
| Oxford Economics | 2.4 | 2.7 | 3.2 | 3.0 | 3.0 | 3.8 | -1.0 | 0.7 | 1.4 | 2.0 | 0.1 | 1.6 | -3.0 | 1.2 | 2.1 | 2.2 | 17.3 | 17.6 | 1.13 | 1.33 |
| Barclays | 2.4 | 2.5 | 3.2 | 3.0 | 3.3 | 5.1 | na | na | 1.6 | 2.3 | 0.1 | 1.5 | na | na | na | na | na | na | 1.13 | 1.31 |
| Fannie Mae | 2.4 | 2.4 | 3.2 | 2.9 | 3.0 | 2.7 | -1.6 | 1.1 | 1.5 | 2.0 | 0.1 | 1.8 | -3.2 | 0.1 | na | na | 17.4 | 17.6 | 1.12 | 1.23 |
| First Trust Advisors | 2.4 | 2.5 | 3.1 | 2.1 | 3.1 | 5.2 | na | na | 1.4 | 1.1 | 0.2 | 2.2 | na | na | na | na | 17.4 | 18.0 | 1.12 | 1.33 |
| HSBC | 2.4 | 2.3 | 3.2 | 2.6 | 3.2 | 4.2 | na | na | 1.3 | 2.1 | 0.1 | 1.6 | na | na | 2.1 | 2.2 | 17.5 | 18.0 | 1.11 | 1.19 |
| Wells Capital Mgmt | 2.4 | 2.6 | 3.2 | 2.9 | 3.2 | 4.0 | 0.0 | 3.7 | 1.6 | 3.2 | 0.1 | 1.6 | -2.7 | 1.7 | 2.2 | 2.5 | 17.3 | 17.3 | 1.12 | 1.17 |
| Wells Fargo | 2.4 | 2.5 | 3.2 | 2.8 | 3.3 | 4.6 | 4.4 | 6.1 | 1.5 | 2.1 | 0.1 | 1.8 | -0.7 | 1.6 | 2.2 | 2.7 | 17.4 | 17.5 | 1.13 | 1.25 |
| American Int'l Group | 2.4 | 2.2 | 3.0 | 2.5 | 3.0 | 2.8 | -2.3 | 0.8 | 1.5 | 1.8 | 0.2 | 1.6 | -2.7 | 1.6 | 1.6 | 1.2 | 17.1 | 16.9 | 1.11 | 1.27 |
| Consensus (Mean) | 2.4 | 2.6 | 3.2 | 2.9 | 3.3 | 4.2 | 0.0 | 4.0 | 1.5 | 2.0 | 0.1 | 1.7 | -2.4 | 1.4 | 2.1 | 2.3 | 17.3 | 17.4 | 1.12 | 1.29 |
| Last Month's Mean | 2.5 | 2.6 | 3.2 | 2.9 | 3.6 | 4.6 | 0.3 | 4.7 | 1.6 | 2.2 | 0.2 | 1.8 | -2.1 | 1.8 | 2.1 | 2.4 | 17.2 | 17.3 | 1.12 | 1.27 |
| 3 Months Ago | 2.3 | 2.7 | 3.0 | 2.9 | 2.7 | 4.6 | 0.8 | 4.4 | 1.9 | 2.7 | 0.3 | 2.0 | -1.9 | 1.9 | 2.3 | 2.6 | 17.0 | 17.1 | 1.11 | 1.29 |
| High | 2.6 | 3.2 | 3.3 | 3.9 | 4.1 | 6.4 | 4.4 | 9.2 | 2.2 | 3.2 | 0.3 | 2.2 | -0.7 | 3.1 | 2.2 | 3.1 | 17.5 | 18.1 | 1.16 | 1.48 |
| Low | 2.4 | 2.2 | 3.0 | 2.1 | 3.0 | 2.5 | -2.6 | -0.5 | 1.3 | 0.9 | 0.0 | 1.4 | -3.4 | 0.1 | 1.6 | 1.2 | 16.9 | 16.7 | 1.04 | 1.15 |
| Standard Deviation | 0.0 | 0.2 | 0.1 | 0.3 | 0.2 | 1.0 | 1.7 | 3.2 | 0.2 | 0.5 | 0.1 | 0.2 | 1.0 | 0.8 | 0.2 | 0.5 | 0.1 | 0.4 | 0.02 | 0.07 |
| Comparison Forecasts | | | | | | | | | | | | | | | | | | | | |
| CBO (Aug. '15) | 2.3 | 3.0 | | | | | | | | | 0.1 | 2.1 | | | 2.7 | 3.1 | | | | |
| OMB (Jul. '15) | 2.1 | 3.0 | | | | | | | | | 0.2 | 1.9 | | | | | | | | |
| IMF (Oct. '15) | 2.6 | 2.8 | 3.2 | 3.5 | | | | | | | 0.1 | 1.1 | | | | | | | | |
| OECD (Nov. '15) | 2.4 | 2.5 | 3.2 | 3.0 | 3.3 | 5.0 | | | | | 0.0 | 1.0 | | | | | | | | |

**Government and Background Data**

**President -** Mr. Barack Obama (Democrat). **Congress -** Republicans have a majority with 244 seats in the House of Representatives (lower house) and in the Senate (upper house) with 53 seats. **Next Elections**

**Historical Data**

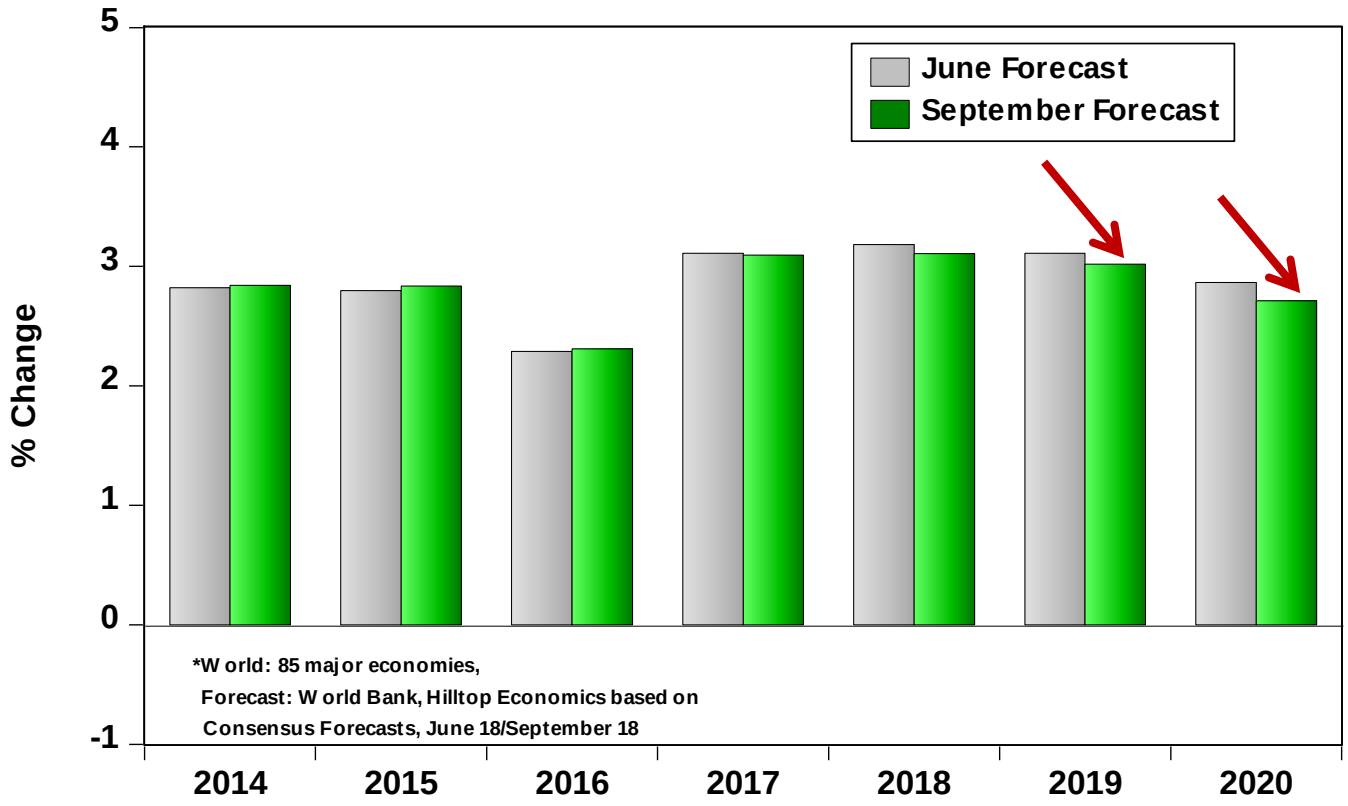
** % change on previous year*

| | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|
| Gross Domestic Product* | 1.6 | 2.2 | 1.5 | 2.4 |
| Personal Consumption* | 2.3 | 1.5 | 1.7 | 2.7 |

# Examine Changes to Consensus Forecasts

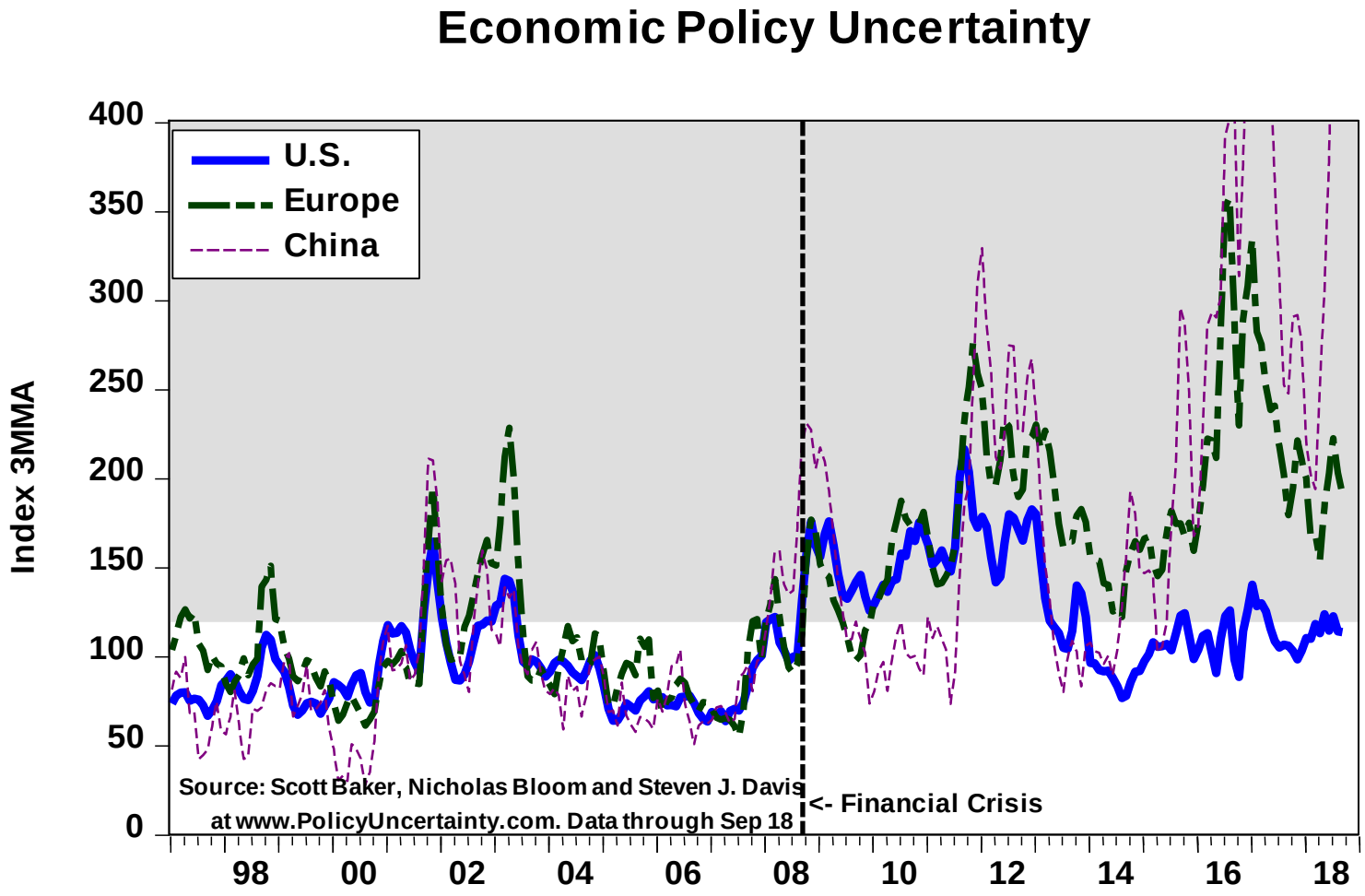
## World* Real GDP Growth

**2017: 3.1%  2018: 3.1%  2019: 3.0%  2020: 2.7%**

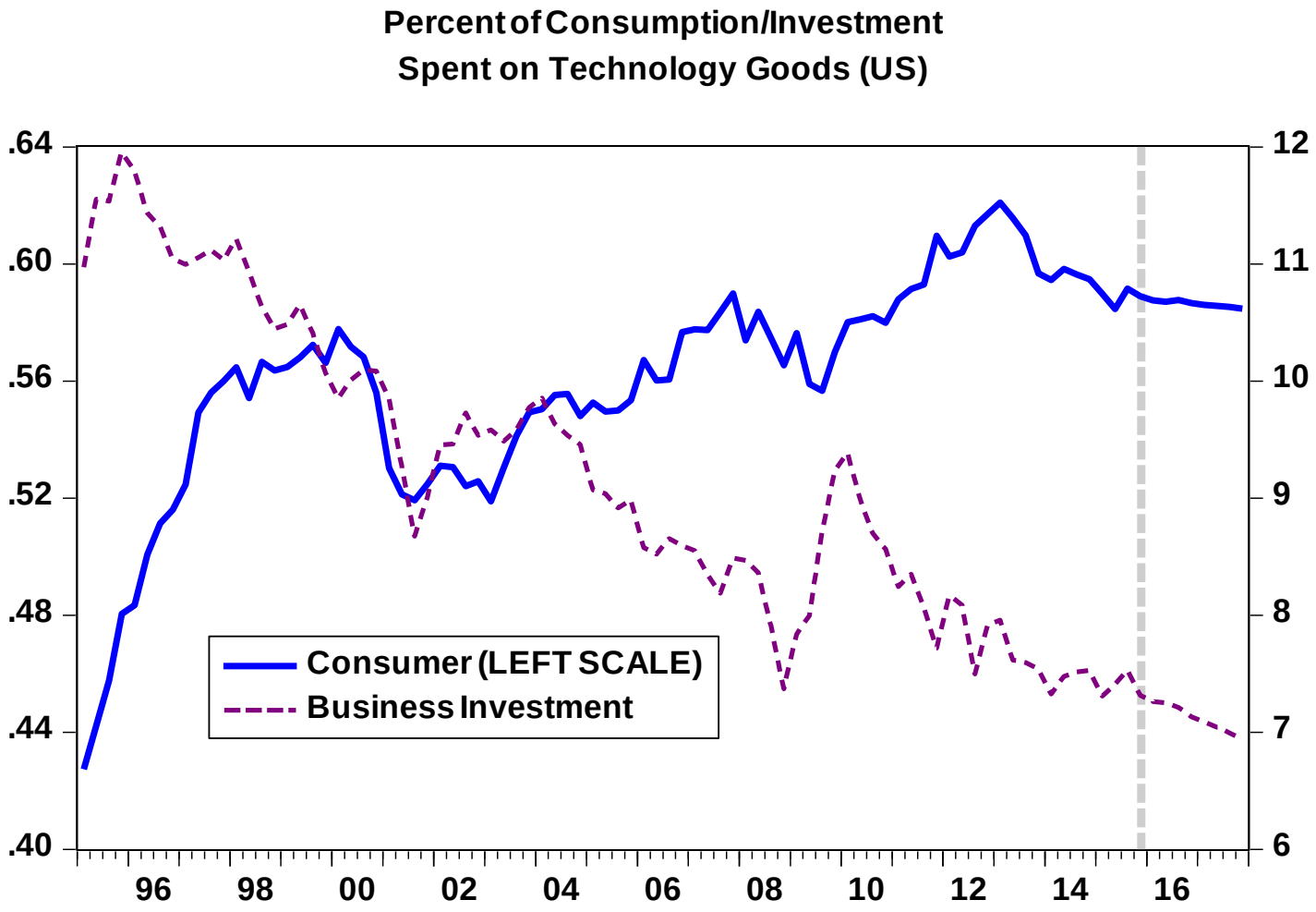



**World: 85 countries in Consensus Forecasts. Source: November Consensus, IMF, Hilltop Economics*

# Increased Uncertainty Raises Downside Risk

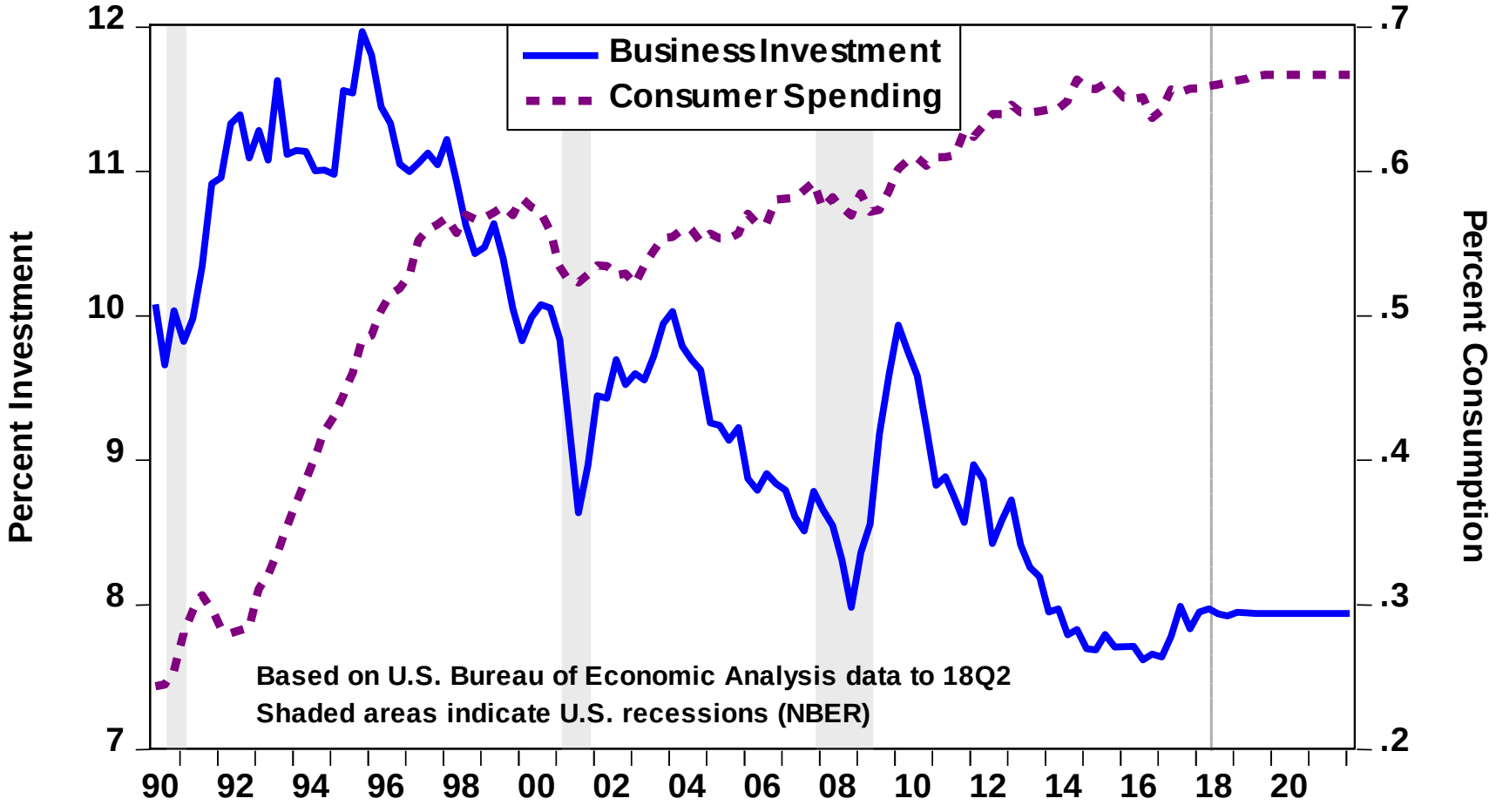


# Conservative Projections of U.S. Behavior 15Q4

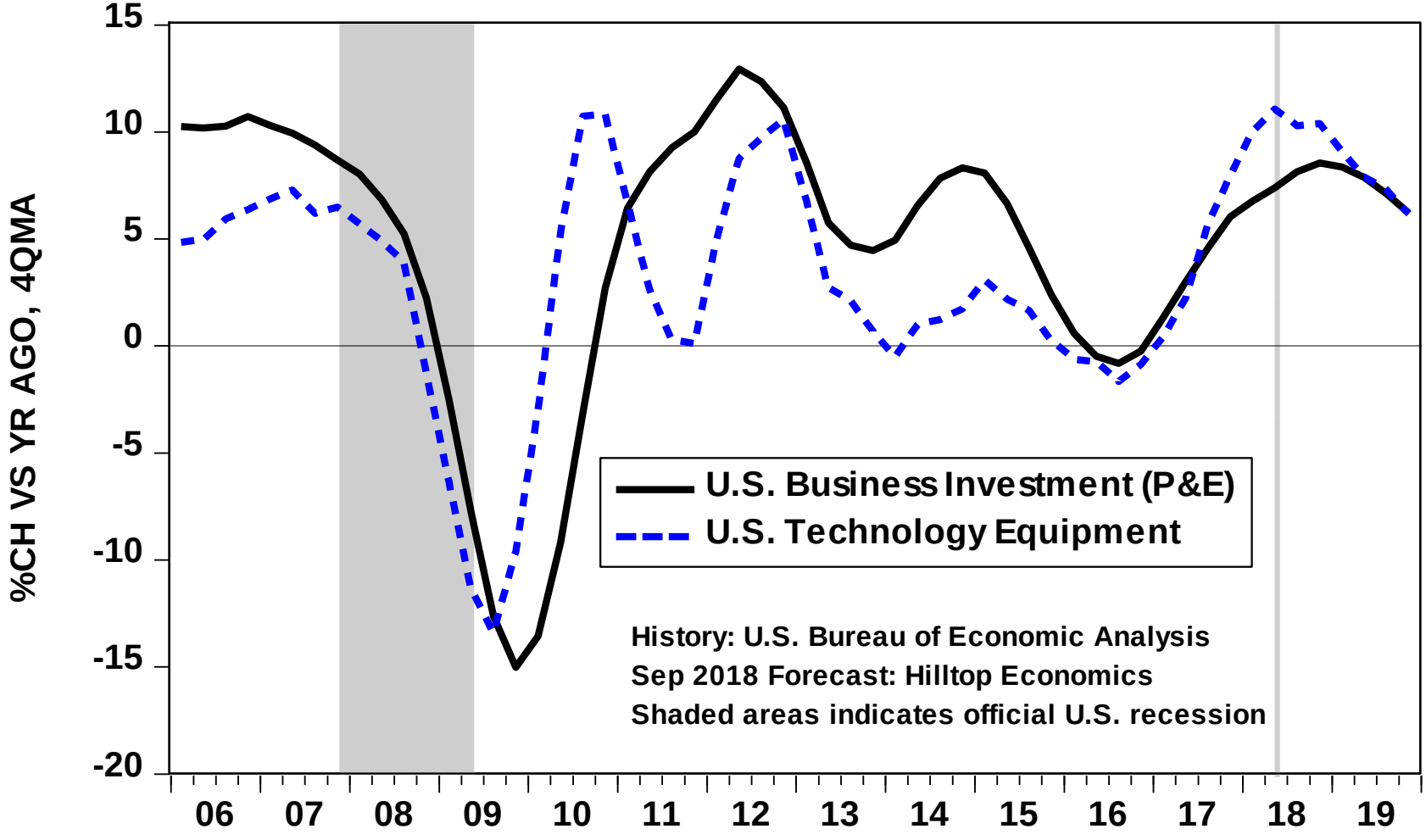


# Conservative Projections of U.S. Behavior

## *A judgmental input based on recent trends*



# Updated Monthly For U.S. NIA Releases



# Tracking the Alternatives

| | 2018q2 | 2018q3 | 2018q4 | 2019q1 | 2019q2 | |
|---|---|---|---|---|---|---|
| SEMIMSI | 3,160 | -- | -- | -- | -- | Actual |
| SEMIMSI (Scenario 2 Mean) | 3,160 | 3,213 | 3,197 | 3,255 | 3,367 | "ESF" |
| SEMI MSI (Scenario 2) | 3,160 | 3,210 | 3,187 | 3,237 | 3,366 | Ranges |
| SEMIMSI 2M+SEMIM | 3,160 | 3,484 | 3,532 | 3,667 | 3,819 | |
| SEMIMSI 2M-SEMIM | 3,160 | 2,943 | 2,862 | 2,843 | 2,916 | |
| SEMIMSI (Scenario 2 Upper) | 3,160 | 3,300 | 3,313 | 3,385 | 3,527 | |
| SEMIMSI (Scenario 2 Lower) | 3,160 | 3,121 | 3,081 | 3,111 | 3,200 | |
| SEMIMSI F | 3,160 | 3,056 | 2,976 | 2,906 | 3,092 | ARIMA |
| SEMIMSI (Scenario 2 S.D.) | 0 | 135 | 167 | 206 | 226 | 2 Std Dev |
| SEMIMSI BBF18M7 | 3,233 | -- | -- | -- | -- | Book-to-Bill: Latest 3 months |
| SEMIMSI BBF18M8 | 3,160 | 3,185 | -- | -- | -- | |
| SEMIMSI BBF18M9 | 3,160 | 3,162 | -- | -- | -- | |
| SEMIMSI MIDAS18M7 | 3,236 | -- | -- | -- | -- | MIDAS: Latest 3 months |
| SEMIMSI MIDAS18M8 | 3,160 | 3,178 | -- | -- | -- | |
| SEMIMSI MIDAS18M9 | 3,160 | 3,229 | -- | -- | -- | |
| SEMIMSI A (Scenario 2) | -0.021 | 0.000 | -0.032 | -0.035 | -0.030 | Add factors |
| SEMIMSI SF | 1.023 | 1.017 | 0.979 | 0.979 | 1.024 | Seasonal factors |
| SEMIMSI AUG18 | 3,160 | 3,198 | 3,190 | 3,238 | 3,367 | Previous month's forecast |

# Tracking the Alternatives

| | 2018q2 | 2018q3 | 2018q4 | 2019q1 | 2019q2 | |
|---|---|---|---|---|---|---|
| SEMIMSI | 3,160 | -- | -- | -- | -- | Actual |
| SEMIMSI (Scenario 2 Mean) | 3,160 | 3,213 | 3,197 | 3,255 | 3,367 | "ESF" |
| SEMI MSI (Scenario 2) | 3,160 | 3,210 | 3,187 | 3,237 | 3,366 | Ranges |
| SEMIMSI 2M+SEMIM | 3,160 | 3,484 | 3,532 | 3,667 | 3,819 | |
| SEMIMSI 2M-SEMIM | 3,160 | 2,943 | 2,862 | 2,843 | 2,916 | |
| SEMIMSI (Scenario 2 Upper) | 3,160 | 3,300 | 3,313 | 3,385 | 3,527 | |
| SEMIMSI (Scenario 2 Lower) | 3,160 | 3,121 | 3,081 | [illegible] | [illegible] | |
| SEMIMSI F | 3,160 | 3,056 | 2,976 | 2,906 | 3,092 | ARIMA |
| SEMIMSI (Scenario 2 S.D.) | 0 | 135 | 167 | 206 | 226 | 2 Std Dev |
| SEMIMSI BBF18M7 | 3,233 | -- | -- | -- | -- | Book-to-Bill: Latest 3 months |
| SEMIMSI BBF18M8 | 3,160 | 3,185 | -- | -- | -- | |
| SEMIMSI BBF18M9 | 3,160 | 3,162 | -- | -- | -- | |
| SEMIMSI MIDAS18M7 | 3,236 | -- | -- | -- | -- | MIDAS: Latest 3 months |
| SEMIMSI MIDAS18M8 | 3,160 | 3,178 | -- | -- | -- | |
| SEMIMSI MIDAS18M9 | 3,160 | 3,229 | -- | -- | -- | |
| SEMIMSI A (Scenario 2) | -0.021 | 0.000 | -0.032 | -0.035 | -0.030 | Add factors |
| SEMIMSI SF | 1.023 | 1.017 | 0.979 | 0.979 | 1.024 | Seasonal factors |
| SEMIMSI AUG18 | 3,160 | 3,198 | 3,190 | 3,238 | 3,367 | Previous month's forecast |

# Tracking the Alternatives

| | 2018q2 | 2018q3 | 2018q4 | 2019q1 | 2019q2 | |
|---|---|---|---|---|---|---|
| SEMIMSI | 3,160 | -- | -- | -- | -- | Actual |
| SEMIMSI (Scenario 2 Mean) | 3,160 | 3,213 | 3,197 | 3,255 | 3,367 | "ESF" |
| SEMI MSI (Scenario 2) | 3,160 | 3,210 | 3,187 | 3,237 | 3,366 | Ranges |
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| SEMIMSI (Scenario 2 Upper) | 3,160 | 3,300 | 3,313 | 3,385 | 3,527 | |
| SEMIMSI (Scenario 2 Lower) | 3,160 | 3,121 | 3,081 | 3,111 | 3,200 | |
| SEMIMSI F | 3,160 | 3,056 | 2,976 | 2,906 | 3,092 | ARIMA |
| SEMIMSI (Scenario 2 S.D.) | 0 | 135 | 167 | 206 | [illegible] | 2 Std Dev |
| SEMIMSI BBF18M7 | 3,233 | -- | -- | -- | -- | |
| SEMIMSI BBF18M8 | 3,160 | 3,185 | -- | -- | -- | Book-to-Bill: Latest 3 months |
| SEMIMSI BBF18M9 | 3,160 | 3,162 | -- | -- | -- | |
| SEMIMSI MIDAS18M7 | [illegible] | | | -- | -- | |
| SEMIMSI MIDAS18M8 | 3,160 | 3,178 | -- | -- | -- | MIDAS: Latest 3 months |
| SEMIMSI MIDAS18M9 | 3,160 | 3,229 | -- | -- | -- | |
| SEMIMSI A (Scenario 2) | -0.021 | 0.000 | -0.032 | -0.035 | -0.030 | Add factors |
| SEMIMSI SF | 1.023 | 1.017 | 0.979 | 0.979 | 1.024 | Seasonal factors |
| SEMIMSI AUG18 | 3,160 | 3,198 | 3,190 | 3,238 | 3,367 | Previous month's forecast |

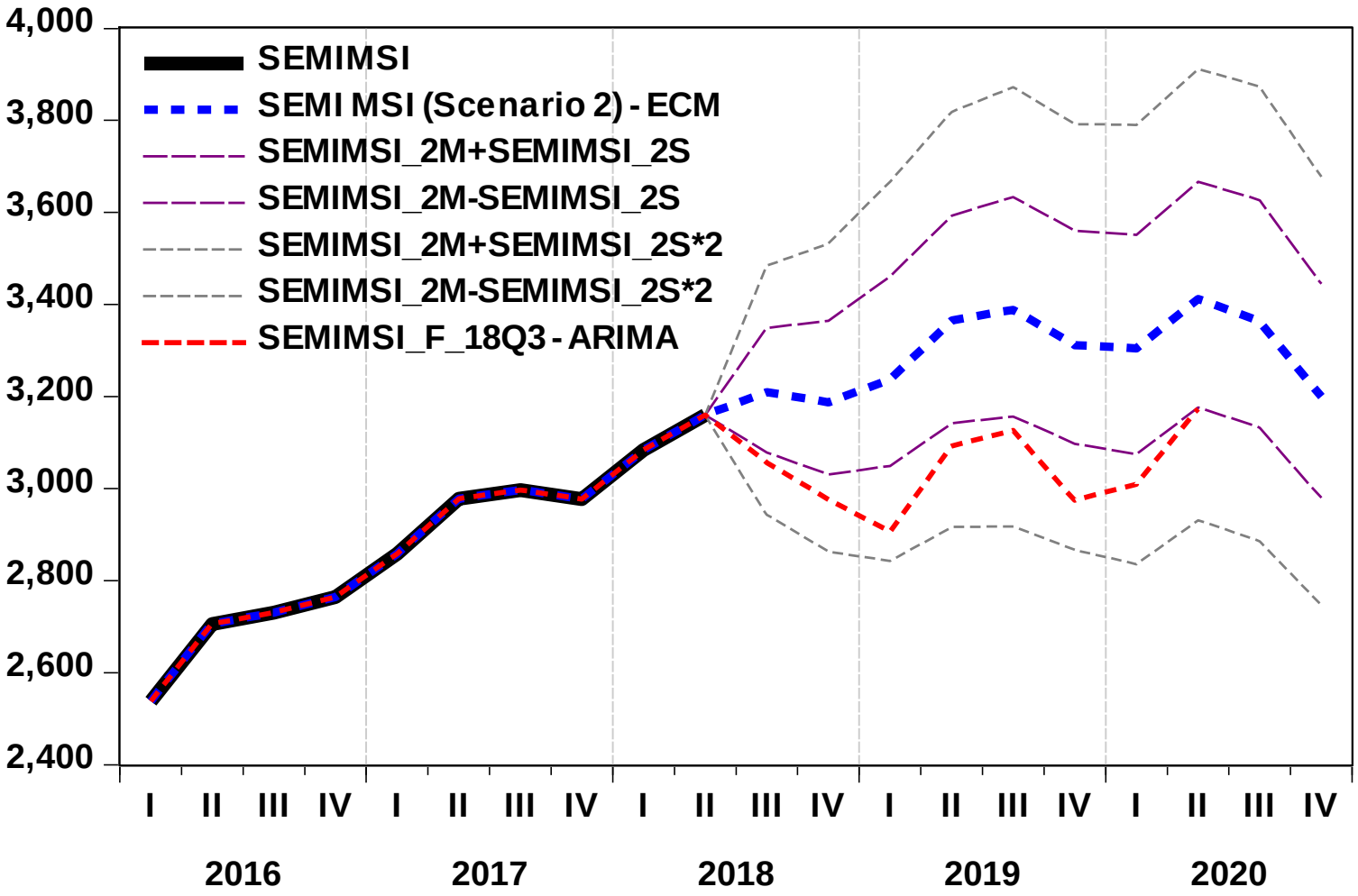
# Tracking the Alternatives

| | 2018q2 | 2018q3 | 2018q4 | 2019q1 | 2019q2 | |
|---|---|---|---|---|---|---|
| SEMIMSI | 3,160 | -- | -- | -- | -- | Actual |
| SEMIMSI (Scenario 2 Mean) | 3,160 | 3,213 | 3,197 | 3,255 | 3,367 | "ESF" |
| SEMI MSI (Scenario 2) | 3,160 | 3,210 | 3,187 | 3,237 | 3,366 | Ranges |
| SEMIMSI 2M+SEMIM | 3,160 | 3,484 | 3,532 | 3,667 | 3,819 | |
| SEMIMSI 2M-SEMIM | 3,160 | 2,943 | 2,862 | 2,843 | 2,916 | |
| SEMIMSI (Scenario 2 Upper) | 3,160 | 3,300 | 3,313 | 3,385 | 3,527 | |
| SEMIMSI (Scenario 2 Lower) | 3,160 | 3,121 | 3,081 | 3,111 | 3,200 | |
| SEMIMSI F | 3,160 | 3,056 | 2,976 | 2,906 | 3,092 | ARIMA |
| SEMIMSI (Scenario 2 S.D.) | 0 | 135 | 167 | 206 | 226 | 2 Std Dev |
| SEMIMSI BBF18M7 | 3,233 | -- | -- | -- | -- | |
| SEMIMSI BBF18M8 | 3,160 | 3,185 | -- | -- | -- | Book-to-Bill: Latest 3 months |
| SEMIMSI BBF18M9 | 3,160 | 3,162 | -- | -- | | |
| SEMIMSI MIDAS18M7 | 3,236 | -- | -- | -- | -- | |
| SEMIMSI MIDAS18M8 | 3,160 | 3,178 | -- | -- | -- | MIDAS: Latest 3 months |
| SEMIMSI MIDAS18M9 | 3,160 | 3,229 | -- | -- | -- | |
| SEMIMSI A (Scenario 2) | [illegible] | [illegible] | [illegible] | [illegible] | -0.030 | Add factors |
| SEMIMSI SF | 1.023 | 1.017 | 0.979 | 0.979 | 1.024 | Seasonal factors |
| SEMIMSI AUG18 | 3,160 | 3,198 | 3,190 | 3,238 | 3,367 | Previous month's forecast |

# Tracking the Alternatives

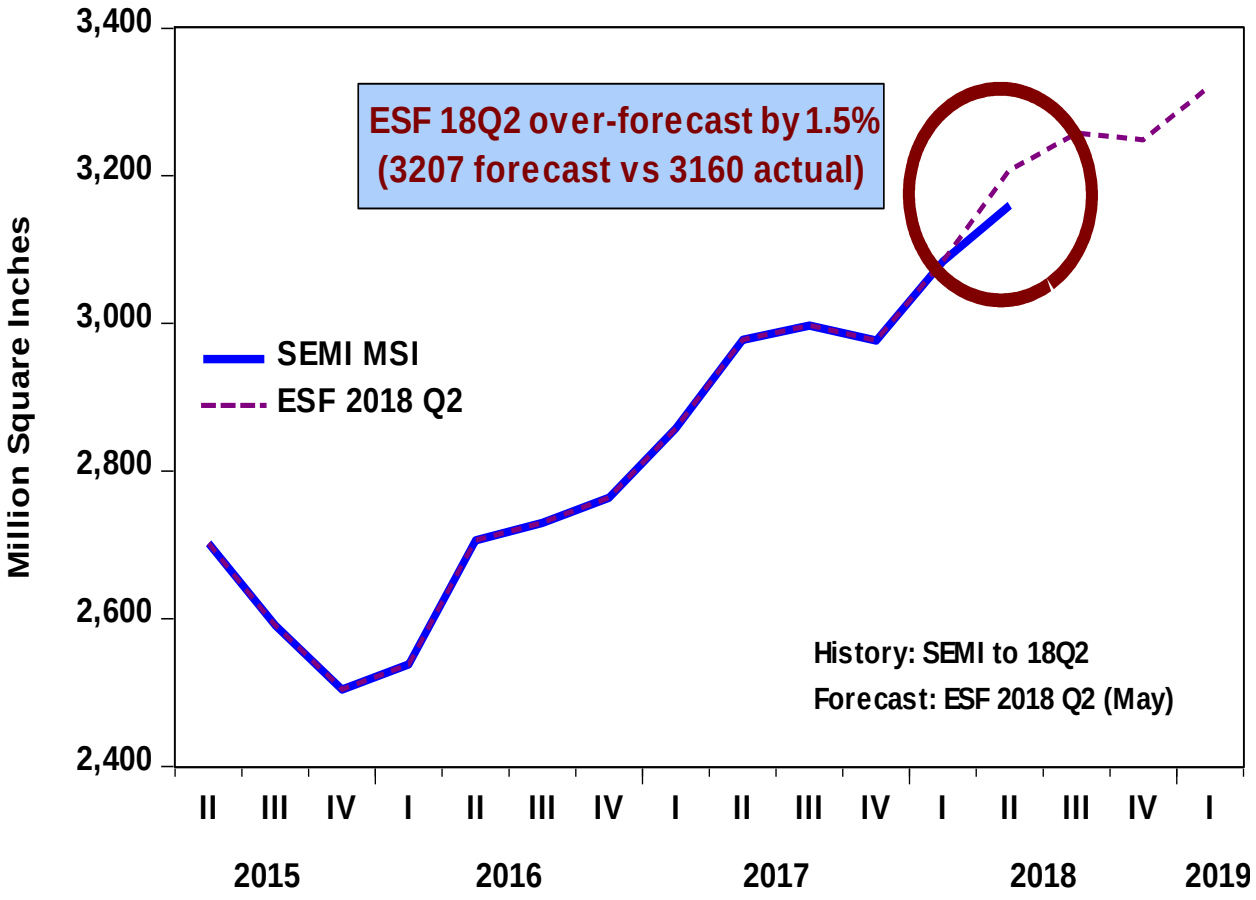
| | 2018q2 | 2018q3 | 2018q4 | 2019q1 | 2019q2 | |
|---|---|---|---|---|---|---|
| SEMIMSI | 3,160 | -- | -- | -- | -- | Actual |
| SEMIMSI (Scenario 2 Mean) | 3,160 | 3,213 | 3,197 | 3,255 | 3,367 | "ESF" |
| SEMI MSI (Scenario 2) | 3,160 | 3,210 | 3,187 | 3,237 | 3,366 | Ranges |
| SEMIMSI 2M+SEMIM | 3,160 | 3,484 | 3,532 | 3,667 | 3,819 | |
| SEMIMSI 2M-SEMIM | 3,160 | 2,943 | 2,862 | 2,843 | 2,916 | |
| SEMIMSI (Scenario 2 Upper) | 3,160 | 3,300 | 3,313 | 3,385 | 3,527 | |
| SEMIMSI (Scenario 2 Lower) | 3,160 | 3,121 | 3,081 | 3,111 | 3,200 | |
| SEMIMSI F | 3,160 | 3,056 | 2,976 | 2,906 | 3,092 | ARIMA |
| SEMIMSI (Scenario 2 S.D.) | 0 | 135 | 167 | 206 | 226 | 2 Std Dev |
| SEMIMSI BBF18M7 | 3,233 | -- | -- | -- | -- | |
| SEMIMSI BBF18M8 | 3,160 | 3,185 | -- | -- | -- | Book-to-Bill: Latest 3 months |
| SEMIMSI BBF18M9 | 3,160 | 3,162 | -- | -- | -- | |
| SEMIMSI MIDAS18M7 | 3,236 | -- | -- | -- | -- | |
| SEMIMSI MIDAS18M8 | 3,160 | 3,178 | -- | -- | -- | MIDAS: Latest 3 months |
| SEMIMSI MIDAS18M9 | 3,160 | 3,229 | -- | -- | -- | |
| SEMIMSI A (Scenario 2) | -0.021 | 0.000 | -0.032 | [illegible] | [illegible] | Add factors |
| SEMIMSI SF | 1.023 | 1.017 | 0.979 | 0.979 | 1.024 | Seasonal factors |
| SEMIMSI AUG18 | 3,160 | 3,198 | 3,190 | 3,238 | 3,367 | Previous month's forecast |

# Graphic Examination of Forecasts



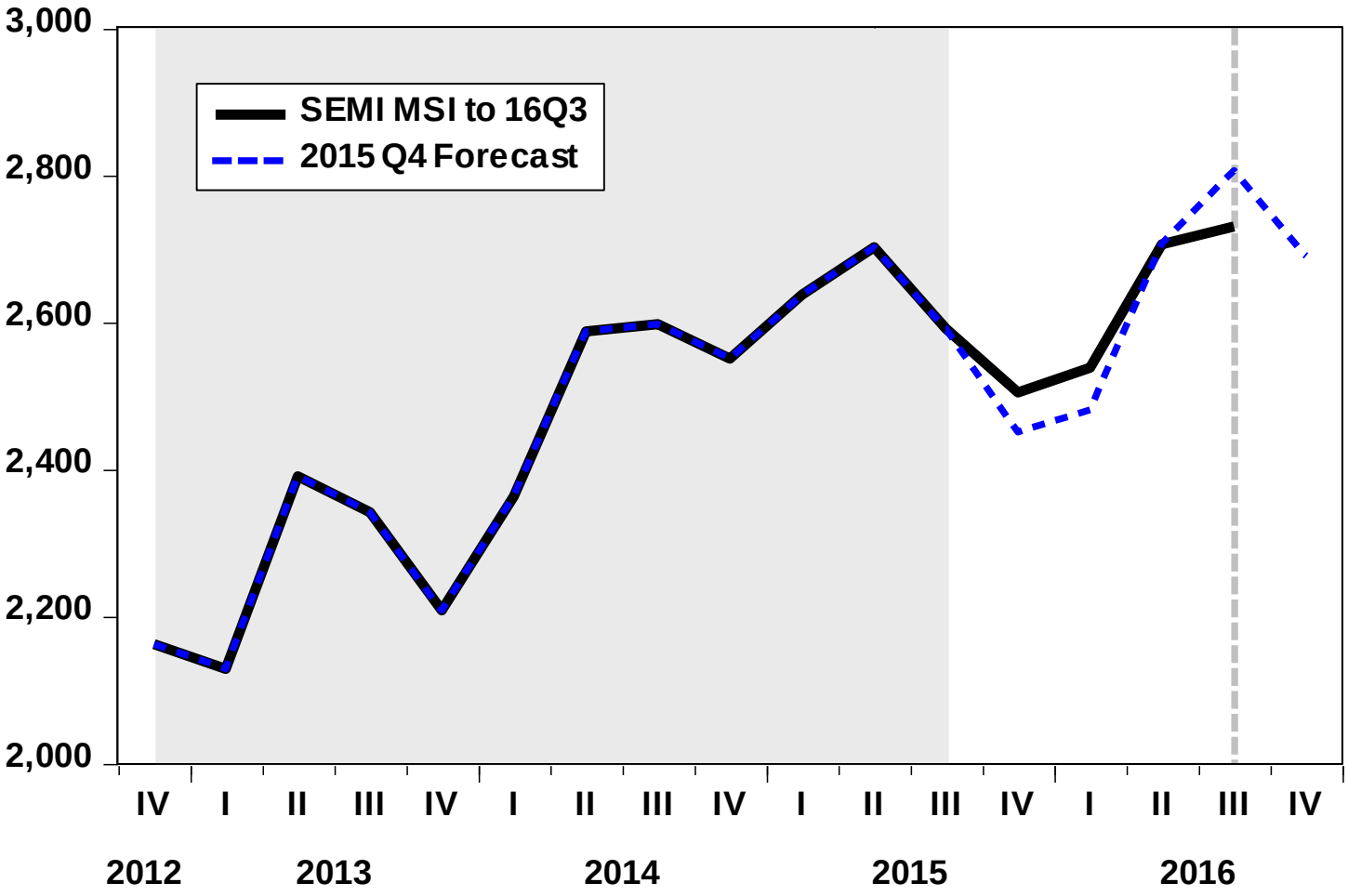
# How Well Does this Forecast Process Work?

***The August ESF forecast a weaker Q3 than developed***

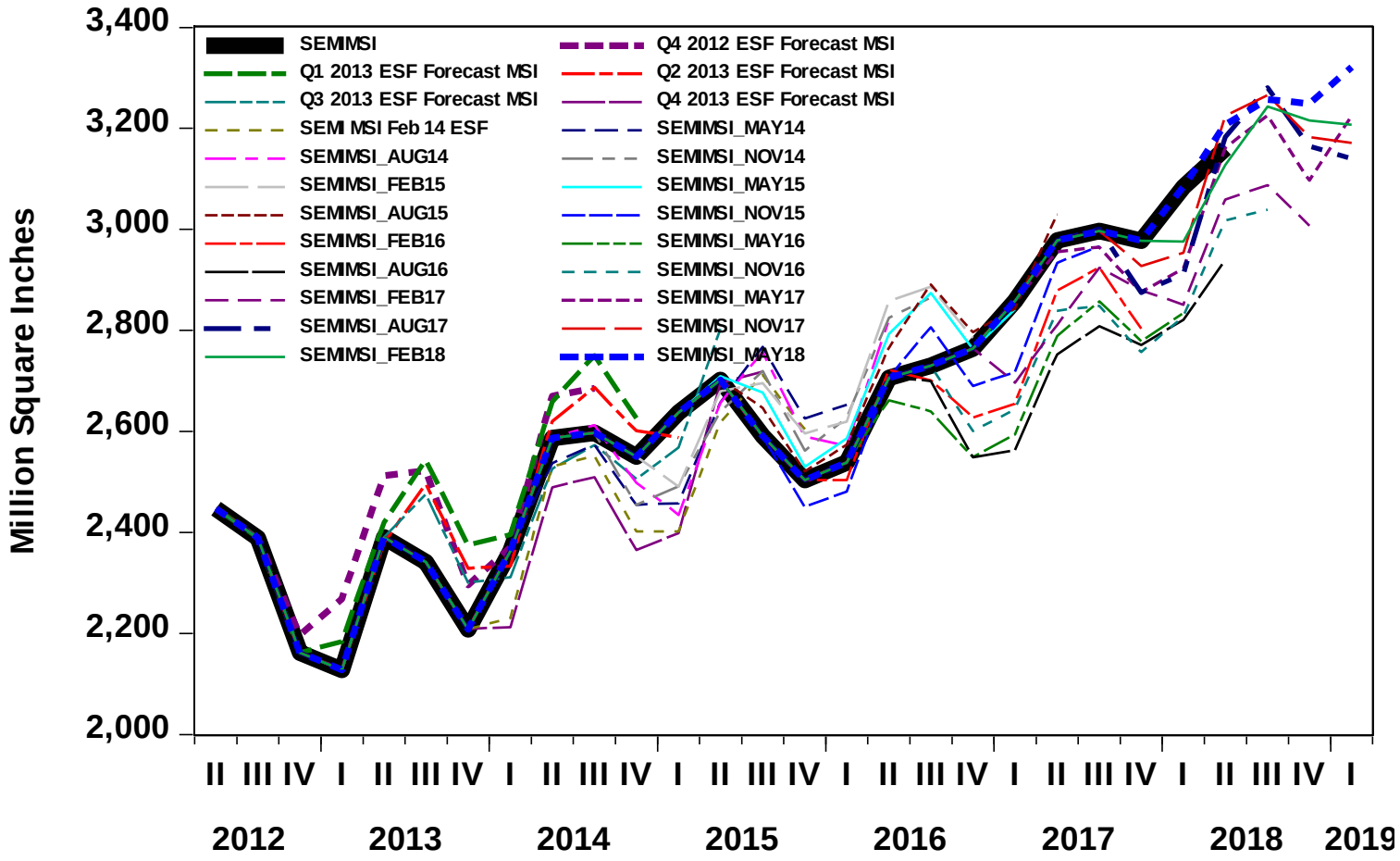


# How Well Does this Forecast Process Work?

***Last November's Forecast VS Actual***



# Now 23 Forecasts Since the First Forecast (of 2012Q4)



# Summary Performance

| Cumulative Error on LEVELS (FCST VS ACTUAL) | 1 Quarter Ahead | 2 Quarters Ahead | 3 Quarters Ahead | 4 Quarters Ahead | 8 Quarters Ahead |
|---|---|---|---|---|---|
| ESF: Average % Error | -1.1% | -0.8% | -0.9% | -0.8% | -0.6% |
| ESF: Mean Absolute % Error | 2.4% | 2.4% | 2.6% | 2.6% | 2.6% |
| ARIMA Average % Error | -0.5% | -0.9% | -1.2% | -1.3% | -2.4% |
| # Forecasts | 23 | 22 | 21 | 20 | 16 |

# Lessons Learned

- I will (almost) always be "wrong" – (but not by much).
  - Tetlock: Superforecasting: The Art and Science of Prediction is right: open-mindedness is critical.
- Judgment and flexibility regarding modeling techniques and forecast preparation are essential
- The process is as important as the modeling
  - A model I can understand almost always produces better forecasts than a model I can't understand
- Tracking the forecast and adjusting for errors is key to a good forecast
  - One quarter ahead: use time-series & Midas to adjust
  - Downplay anecdotal evidence not substantiated by any data, but…
  - Pay attention to comments back from the users of the forecasts
- For the MSI and semiconductor industry measures:
  - Seasonal adjustment gets the variability
  - Final demand is more important than immediate markets
    - There is too much "noise" in the immediate markets
    - Data availability in immediate markets is questionable