



Business Cycle Upswing Impact on the Semiconductor Outlook

Surface Preparation and Cleaning Conference (SPCC)
April 11, 2018

Duncan Meldrum
Chief Economist, Hilltop Economics, LLC

duncan.meldrum@hilltopeconomics.com

610-709-7951

**A global outlook based on Consensus Economics, Inc.
CONSENSUS FORECASTS®*

Outline

- **Last year: forecast versus the results**
- **The new outlook: in the accelerating phase of the current economic cycle**
- **The implications for semiconductors**
- **What worries me the most**


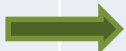
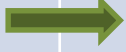
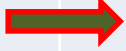
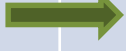

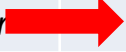

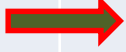

Metrics

- **Real GDP:** Gross Domestic Product (final “real” or “volume” demand for goods and services, in the largest 85 countries measured in Billions of 2010 US\$ - that is, with inflation removed)
 - **Real consumer spending** (for key 45 countries in Consensus Economics)
 - **Real business investment** (for key 45 countries in Consensus Economics)
 - *WHY Real GDP and its final demand components? Semiconductors have become so ubiquitous, used in almost every product and in support of almost every service, that broad final demand measures best explain MSI trends.*
- **Million Square Inches (MSI)** of silicon wafers shipped to semiconductor manufacturers (Source: SEMI.ORG)
 - *WHY MSI? Best volume measure of semiconductors, to relate to the volume of demand as measured by real GDP and other units of products*
- **WSTS semiconductor revenue** (World Semiconductor Trade Statistics) - \$000 sales by major region reported by WSTS.ORG
- Semiconductor **Equipment Billings** (~90% of worldwide semiconductor equipment sales)
 - Reported for North America by SEMI.ORG
 - Reported for Japan by SEAJ.ORG

Global Economic Outlook Summary: 2017-18

- Modest growth, faster than 2016
- Improving investment climate
- Slightly higher inflation, diverging interest rates
- Currency turmoil, stronger U.S. dollar
- Much higher economic policy uncertainty
- *MSI: Up a little in 2016, rises above trend in 2017, eases to around trend in 2018*

Outlook by the Numbers

% Change	2016	SPCC 2017	2017 Prelim
Real GDP	2.3	2.7 	3.1
Consumption	2.6	2.8 	3.2
Investment	1.2	2.8 	4.3
PC Units	(7.0)	(0.3) 	(2.4)
MSI	2.9	6.5 	10.0
US 10YR Treasuries	1.8	Higher 	2.3
Dollar		Stronger 	Weakened
CPI: China	2.0	2.5 	1.6
Japan	(0.1)	0.7 	0.5
Germany	0.5	1.8	1.8
US	1.3	2.5 	2.1

- Solid green: actual stronger than forecast
- Green outlined in red: actual weaker than forecast
- Solid red: direction wrong

Outlook by the Numbers

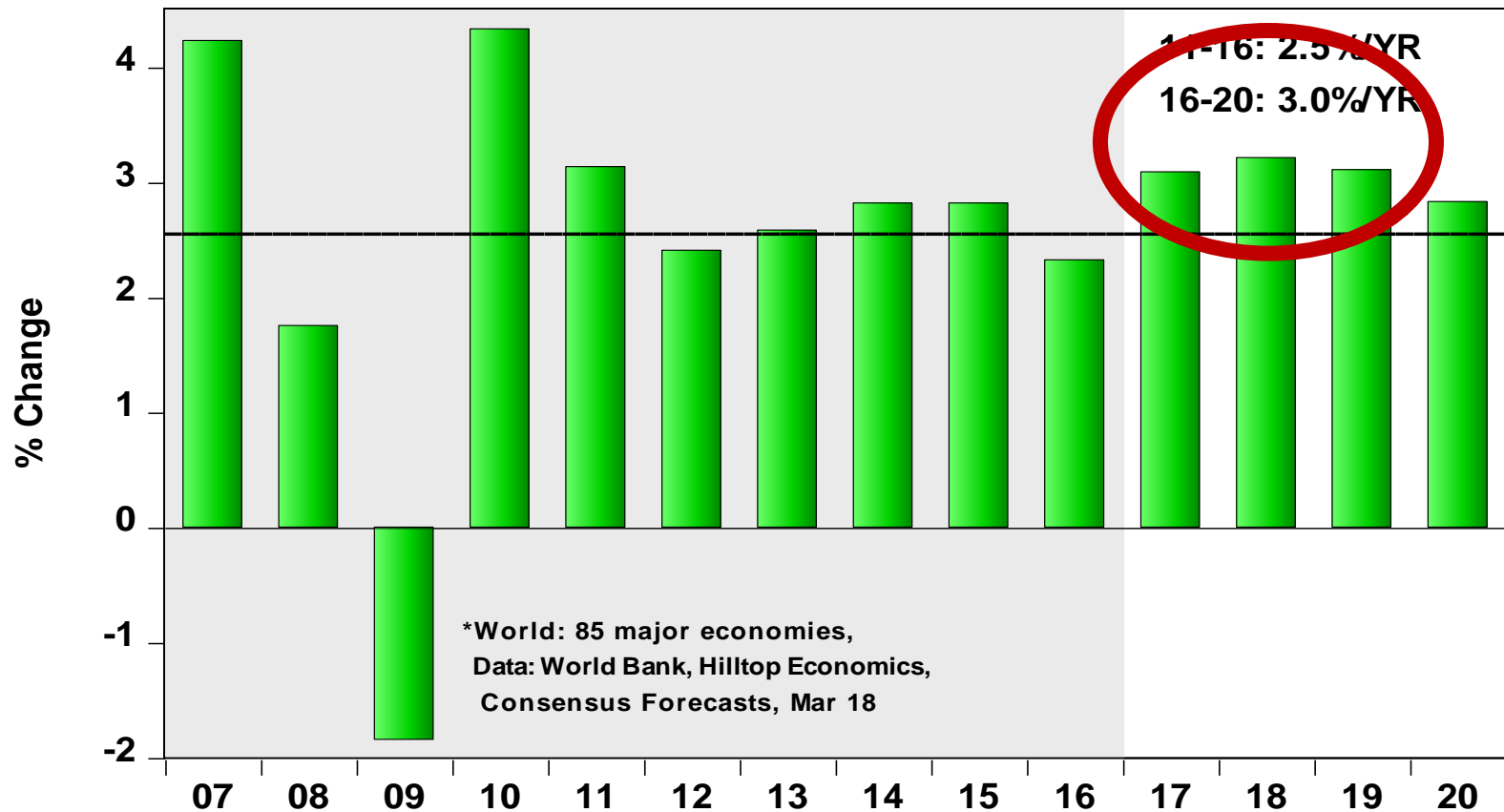
% Change	2016		2017 Prelim	2018	2019
Real GDP	2.3		3.1	3.2	3.1
Consumption	2.6		3.2	3.1	3.1
Investment	1.2		4.3	4.2	3.8
PC Units	(7.0)		(2.4)	0.7	0.9
MSI	2.9		10.0	6.7	5.2
US 10YR Treasuries	1.8		2.3	Higher (2.9)	Higher
Dollar			Weakened	Volatile, flat	Volatile, flat
CPI: China	2.0		1.6	2.3	2.3
Japan	(0.1)		0.5	1.0	1.1
Germany	0.5		1.8	1.7	1.8
US	1.3		2.1	2.4	2.1

Summary Overview: 2018-19

- In the **accelerating phase of the economic cycle**
 - Investment upsurge driving the global economy stronger
 - Slightly higher inflation, diverging interest rates
 - Currency turmoil
 - Potential for much higher economic policy uncertainty: trade, geopolitics the current wild cards
- **Healthy semiconductor industry:**
 - Demand for semiconductors grows above trend through 19
 - Wafer Fab Equipment investment strong

Accelerating: Growth Gets Stronger Than Past Five Years

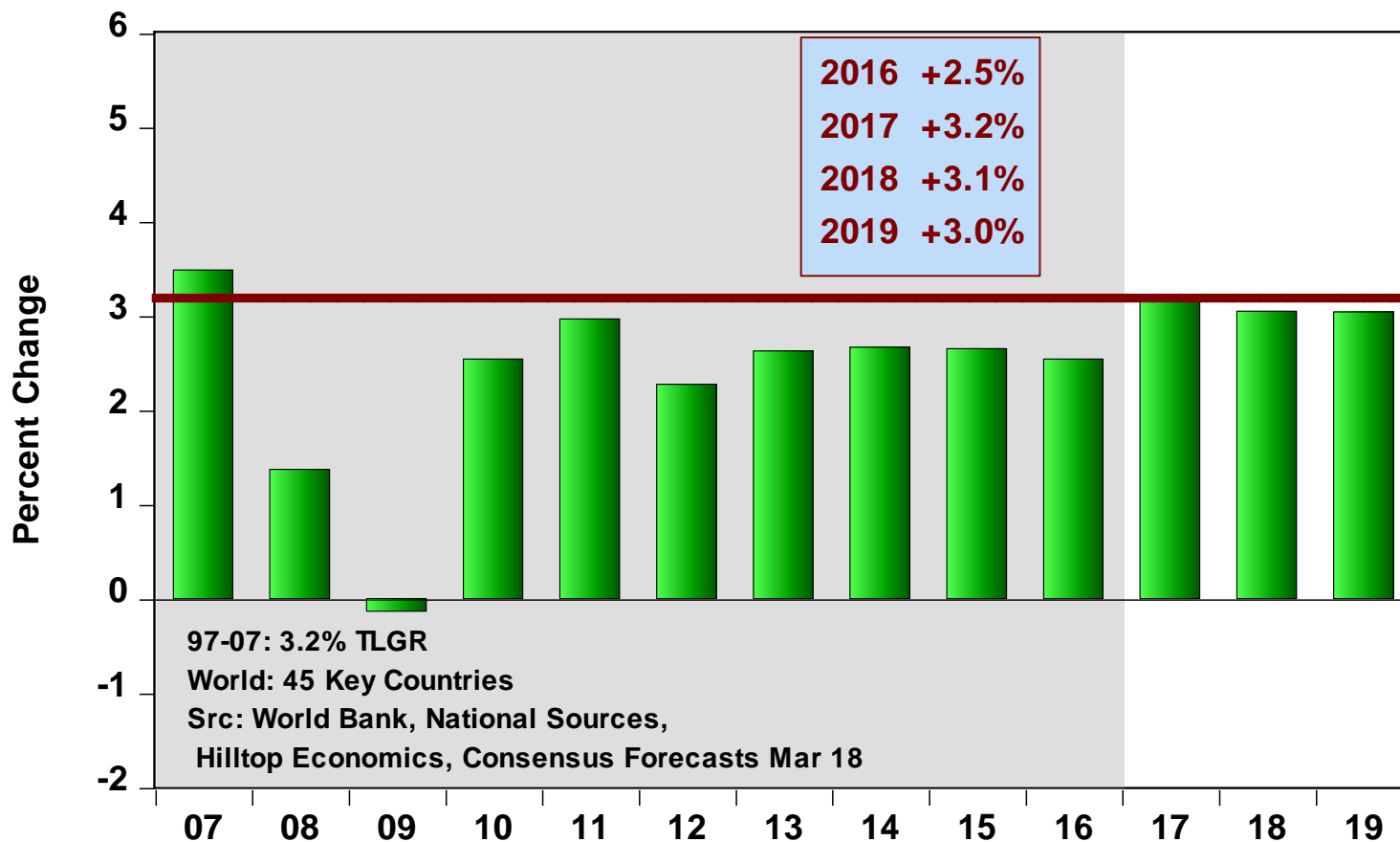
World* Real GDP Growth
2017: 3.1% 2018: 3.2% 2019: 3.1%



Consumption Strengthened in 2017

Little downside risk in consumer outlook in the current upswing

World* Real Consumption

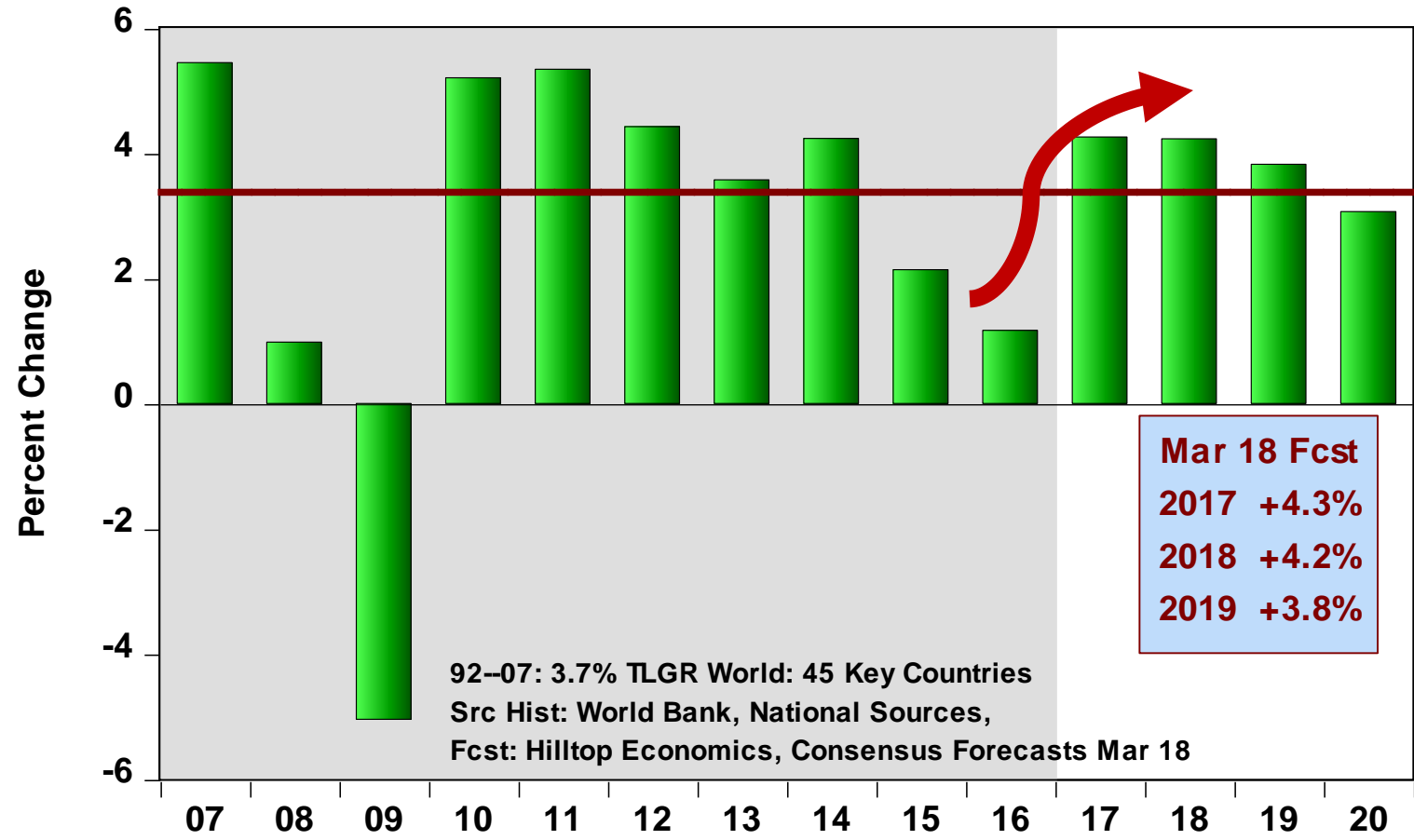


2016 +2.5%
 2017 +3.2%
 2018 +3.1%
 2019 +3.0%

Consumption roughly 60% of real GDP

Global Investment Out of a Cycle Low in 2016

World* Real Investment



Investment Roughly 1/4 of GDP Demand

Investment Positive: A Key Cycle Driver

- **Revenue growth more assured**
 - Real GDP growth (volume) keeps looking a little stronger
 - Some inflation (price) on average from ~0 to 1% to ~1% - 2%
- **Most economies are at capacity** (labor & capital)
 - “Output gaps” closed, need capital to grow
- **Profitability still positive**
 - Productivity-related investment needed
 - Interest rate increases still modest
 - Tax law changes, at least in U.S., positive for investment (at the margin)
- **Risk aversion declined**
 - Consumer attitudes back to normal
 - Small business attitudes finally recovered
 - Economic policy uncertainty down
 - Improving more than expected in earlier forecasts

What Worries Me About the Economy

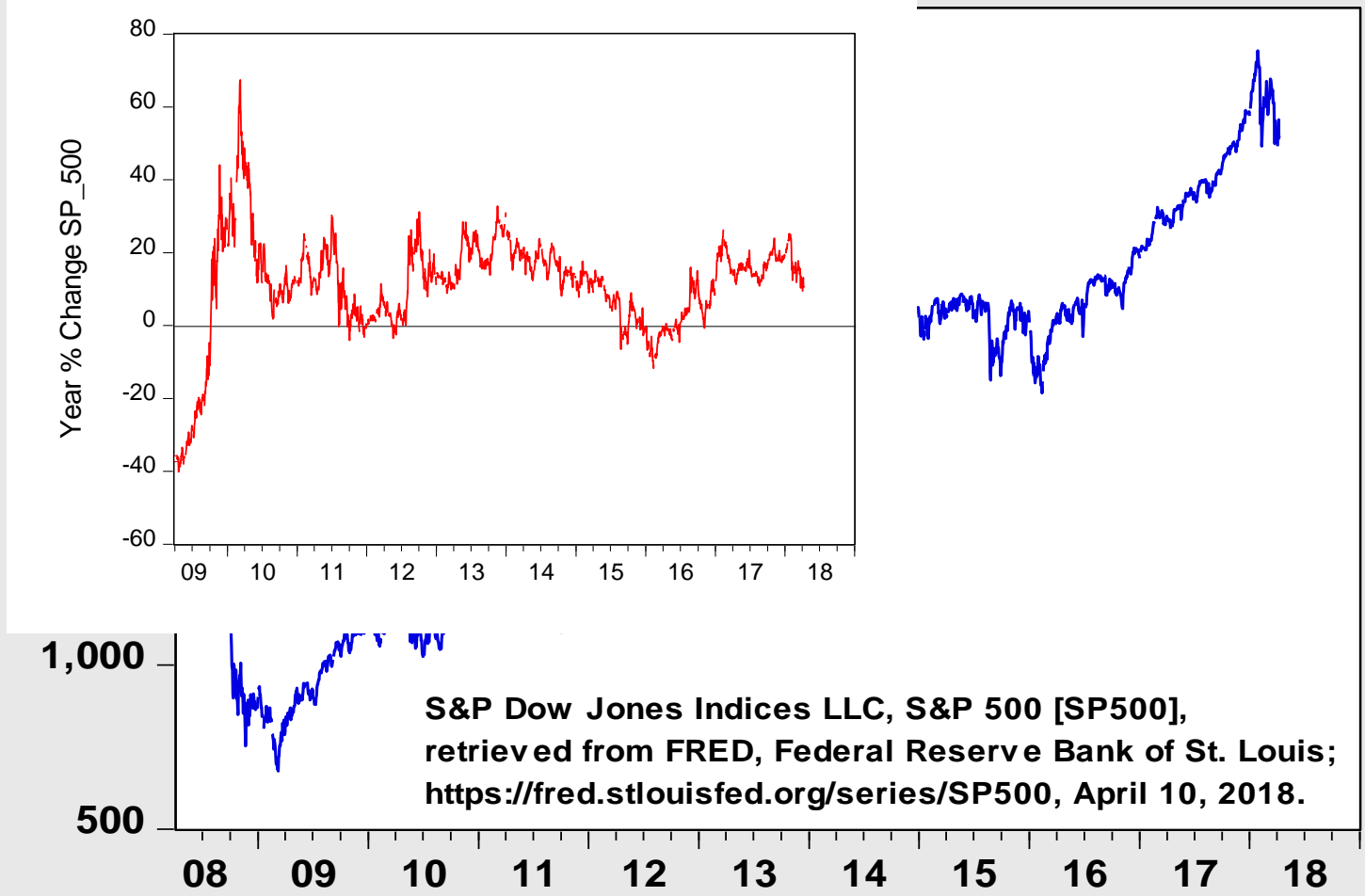
The factors that could disrupt the outlook

- Forecasters under-anticipate business investment and consumer spending: **actual data is better than the expectation (+)**
- Global trade protectionism (-)
- Differential global monetary policy
 - Interest rates (U.S. tightens as others still easing/loose)
 - Currency & financial asset turmoil
 - U.S. yield curve flattening
- China post 19th Party Congress (geopolitical, debt, property market bubble, etc.)
- Political extremism (US & EU)
- Geopolitical
 - N. Korea, Middle East
 - Global terrorism
- Oil

Stock Prices Reflect Uncertainty, Volatility

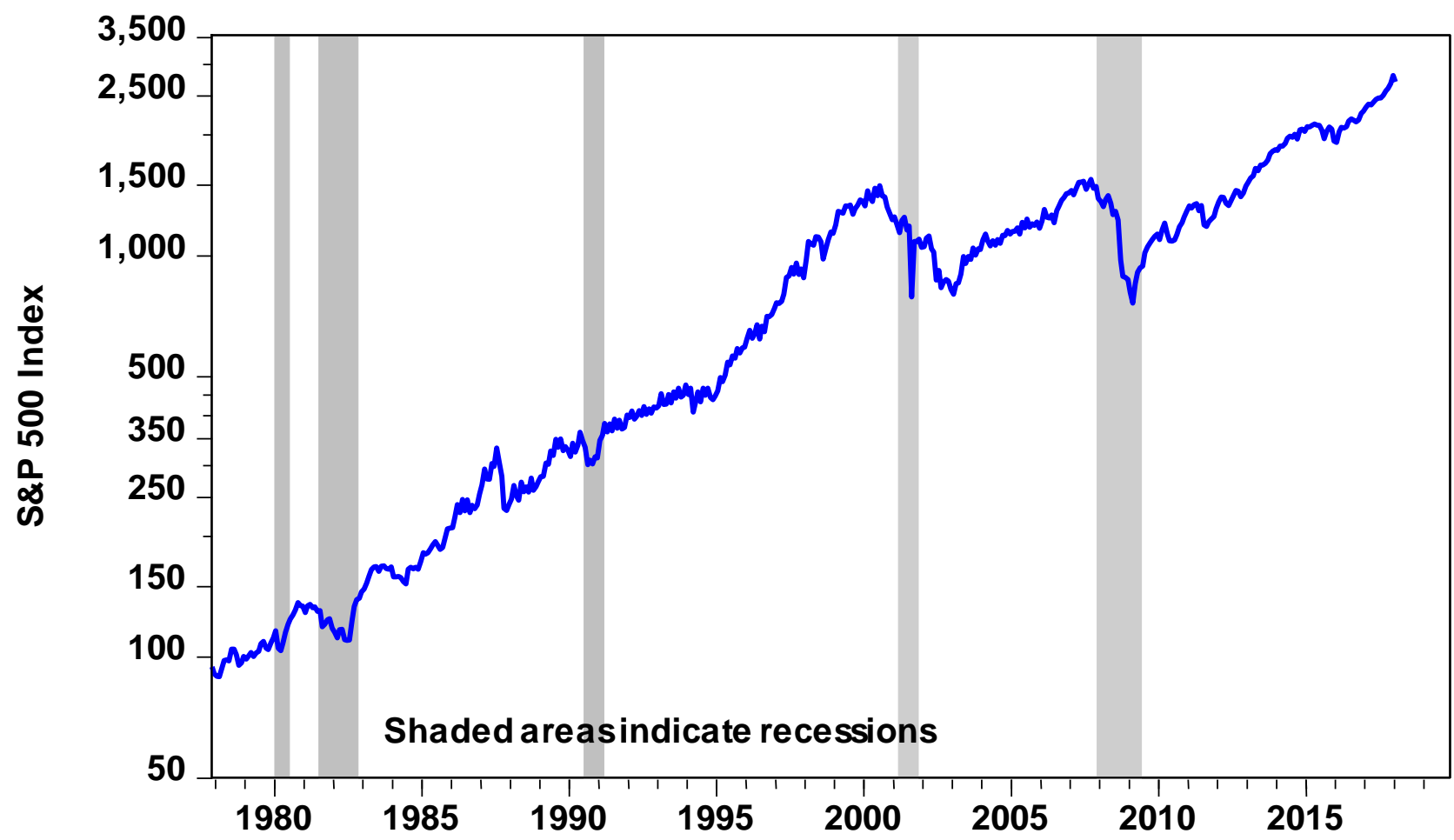
But remain up 10% versus this time last year

S&P 500 Index



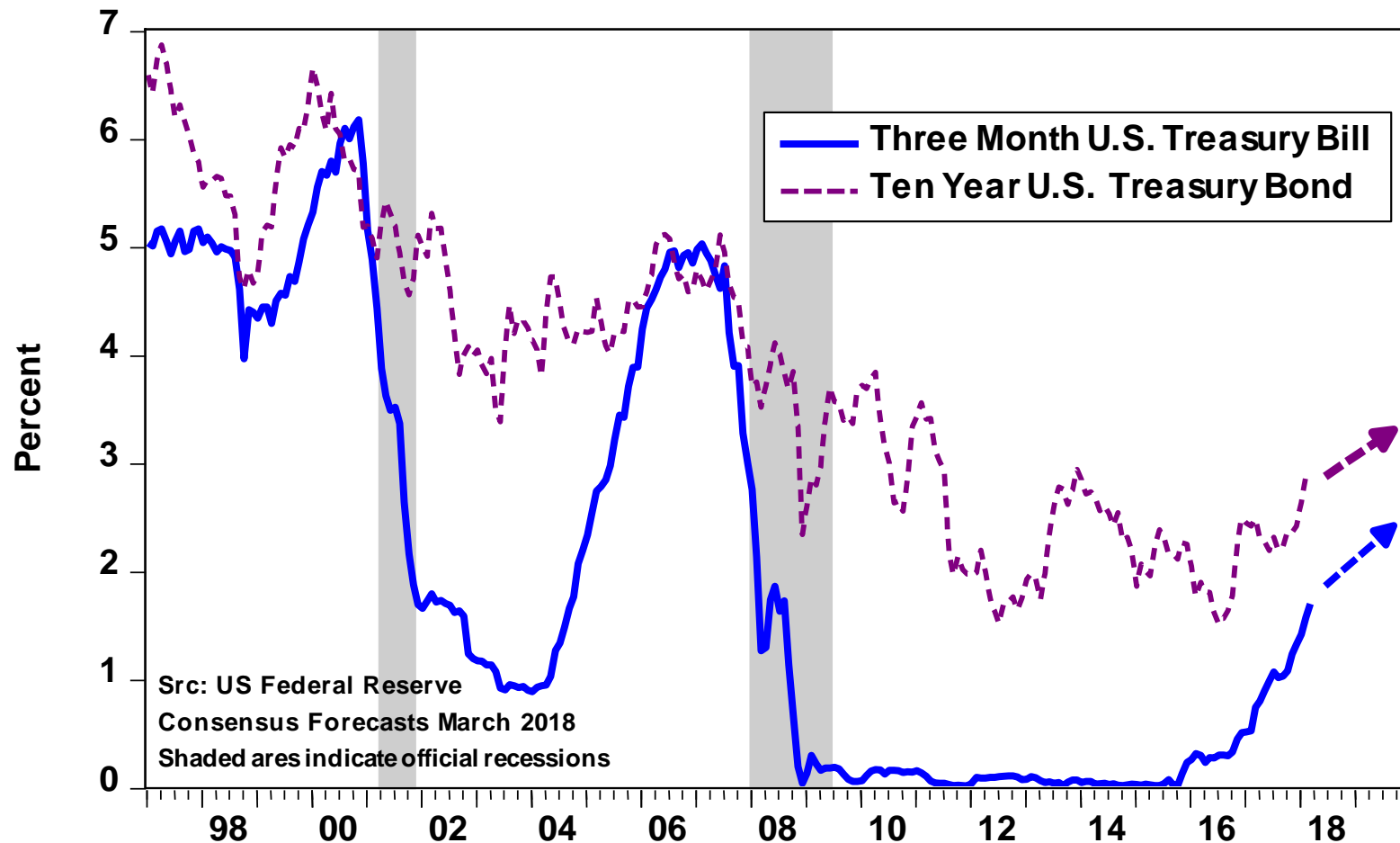
S&P Dow Jones Indices LLC, S&P 500 [SP500],
retrieved from FRED, Federal Reserve Bank of St. Louis;
<https://fred.stlouisfed.org/series/SP500>, April 10, 2018.

Stock Prices Over Time: Not A Clear Leading Indicator of Recession



Improving Economy: Rising Interest Rates

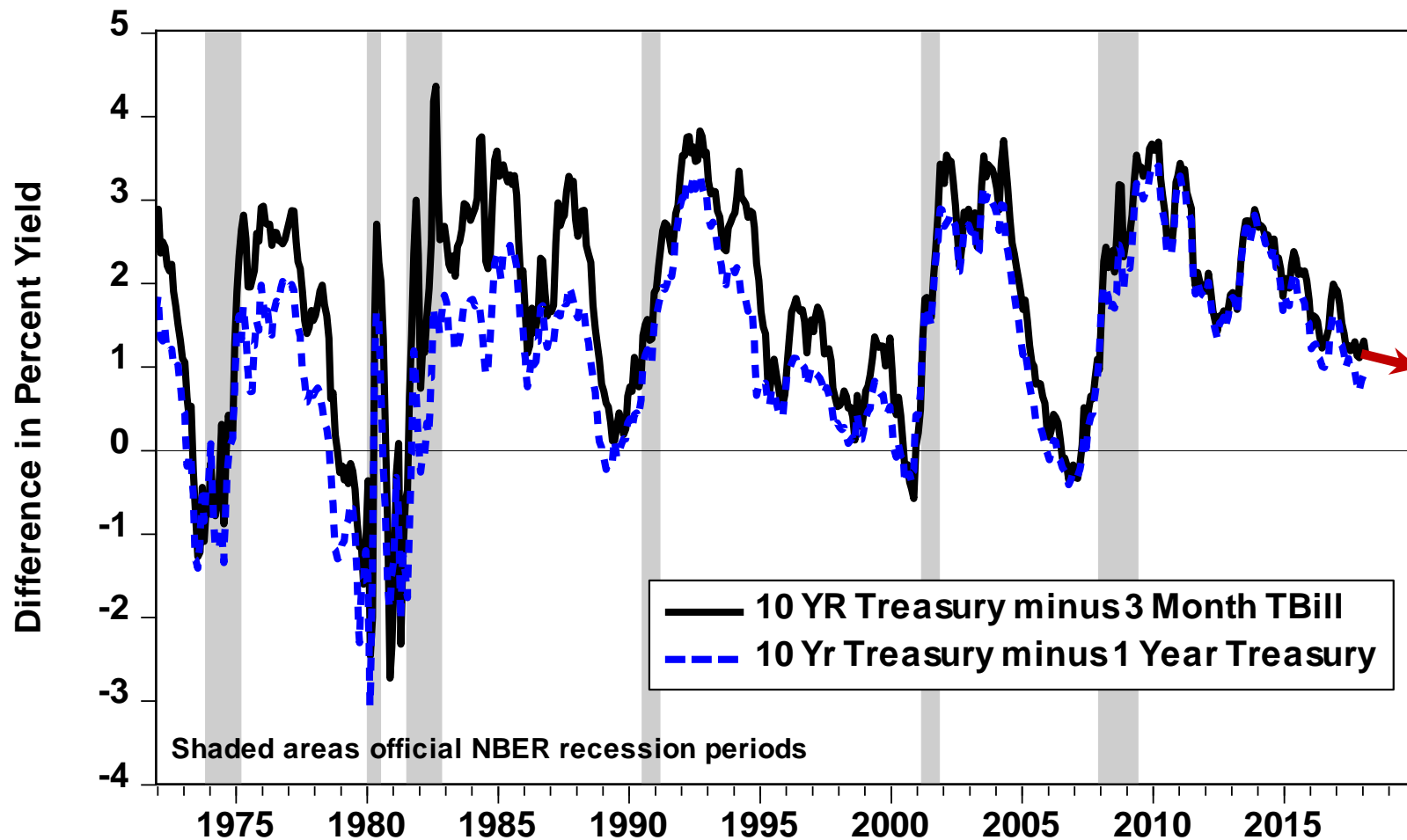
But watch that short-term rates don't exceed long-term rates



**Sign of optimism: stronger demand + tighter supply
 Not too high to dampen investment (through 18)**

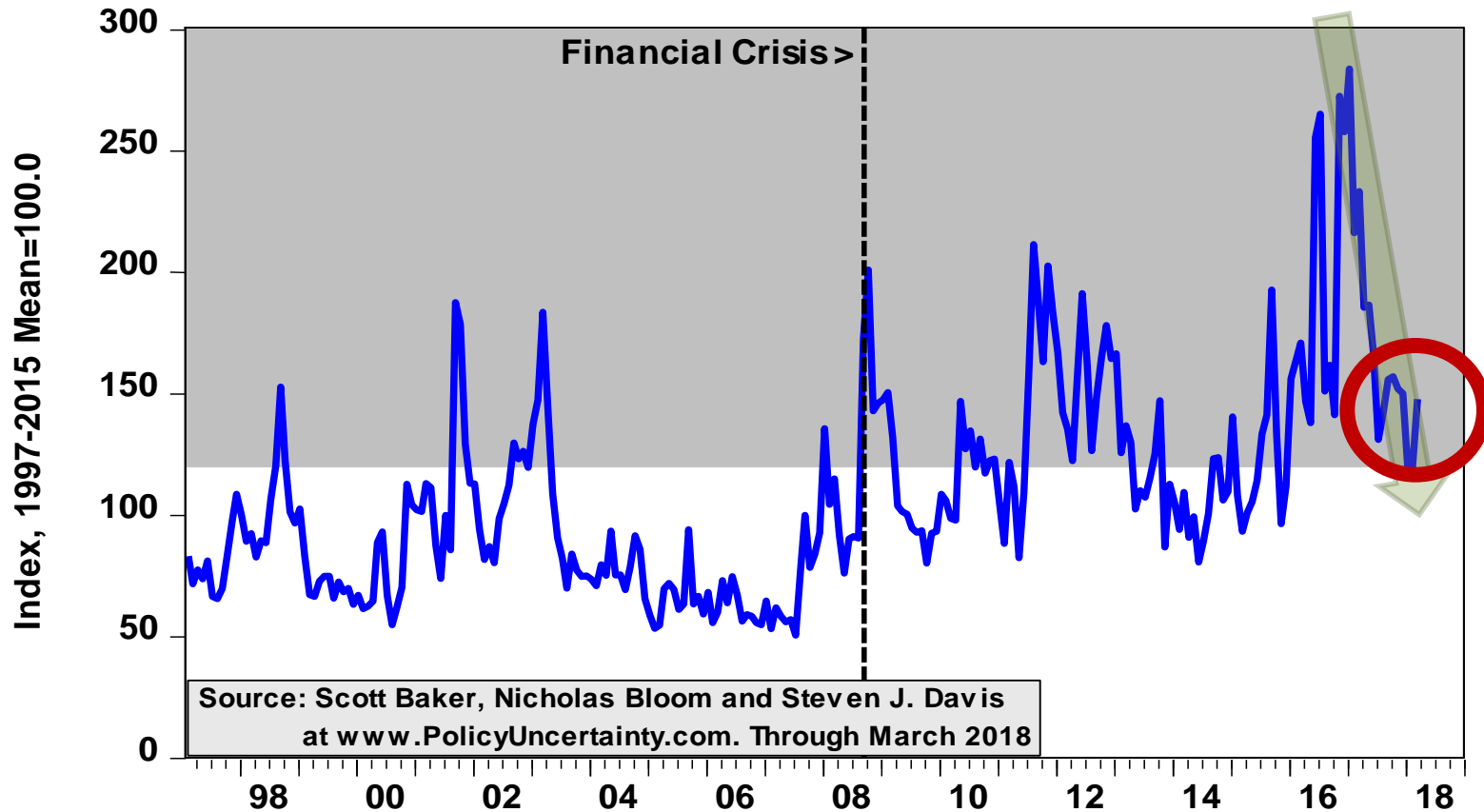
Yield Curve Continues to Tighten

Consensus Forecast Mar 18: a flatter yield curve by March 19, but consistent with accelerating phase of the business cycle



Economic Policy Uncertainty Peaked Late 2016

Global Economic Policy Uncertainty

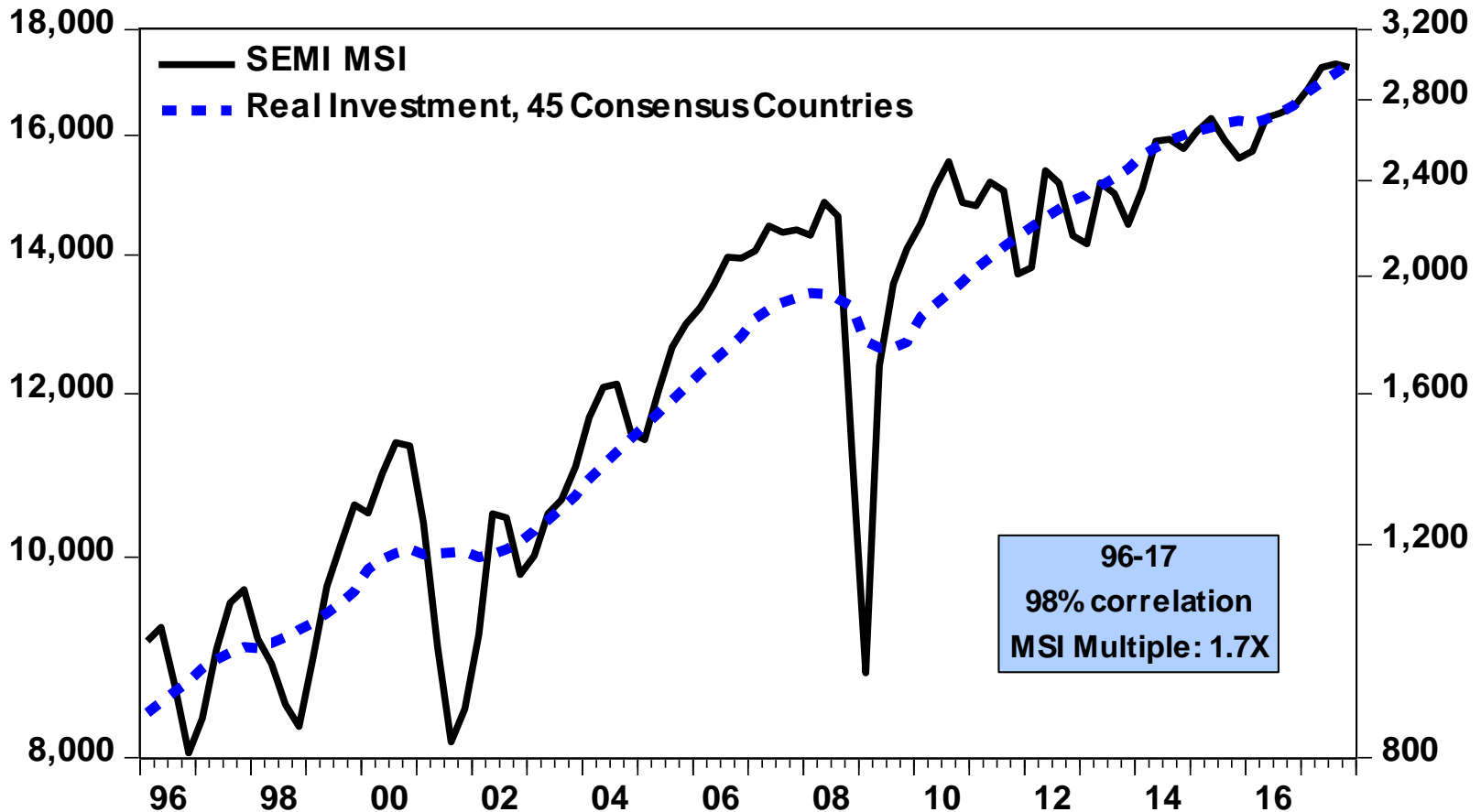


The impact of uncertainty in the model began to lessen in late 2016: evidence the financial crisis impact on investment may have begun to fade.

Healthy Investment Despite the Risks: Healthy Investment = Healthy Semiconductors

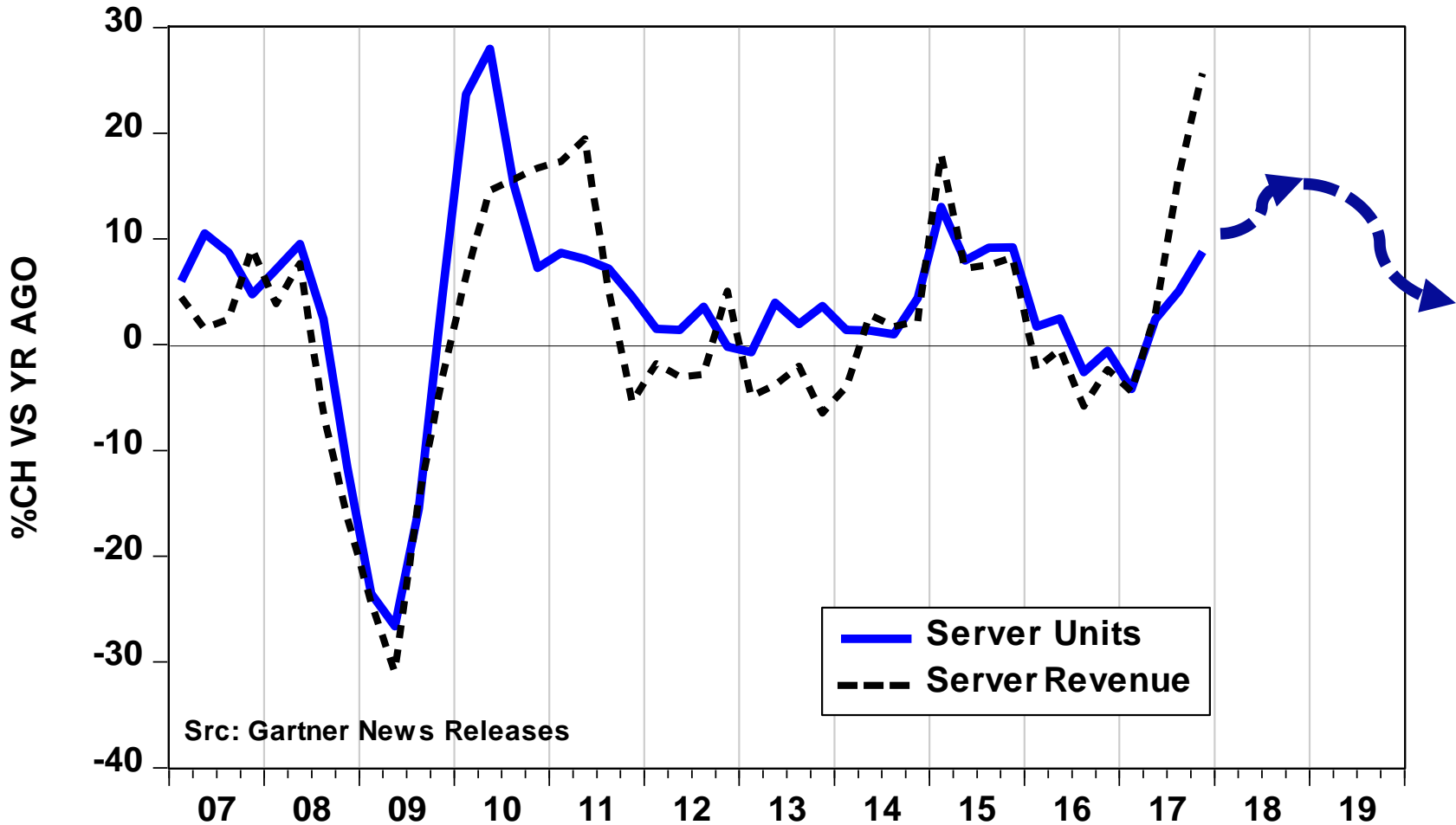
Billion 2010 US\$

Million Square Inches



Servers Now Providing a Boost to MSI

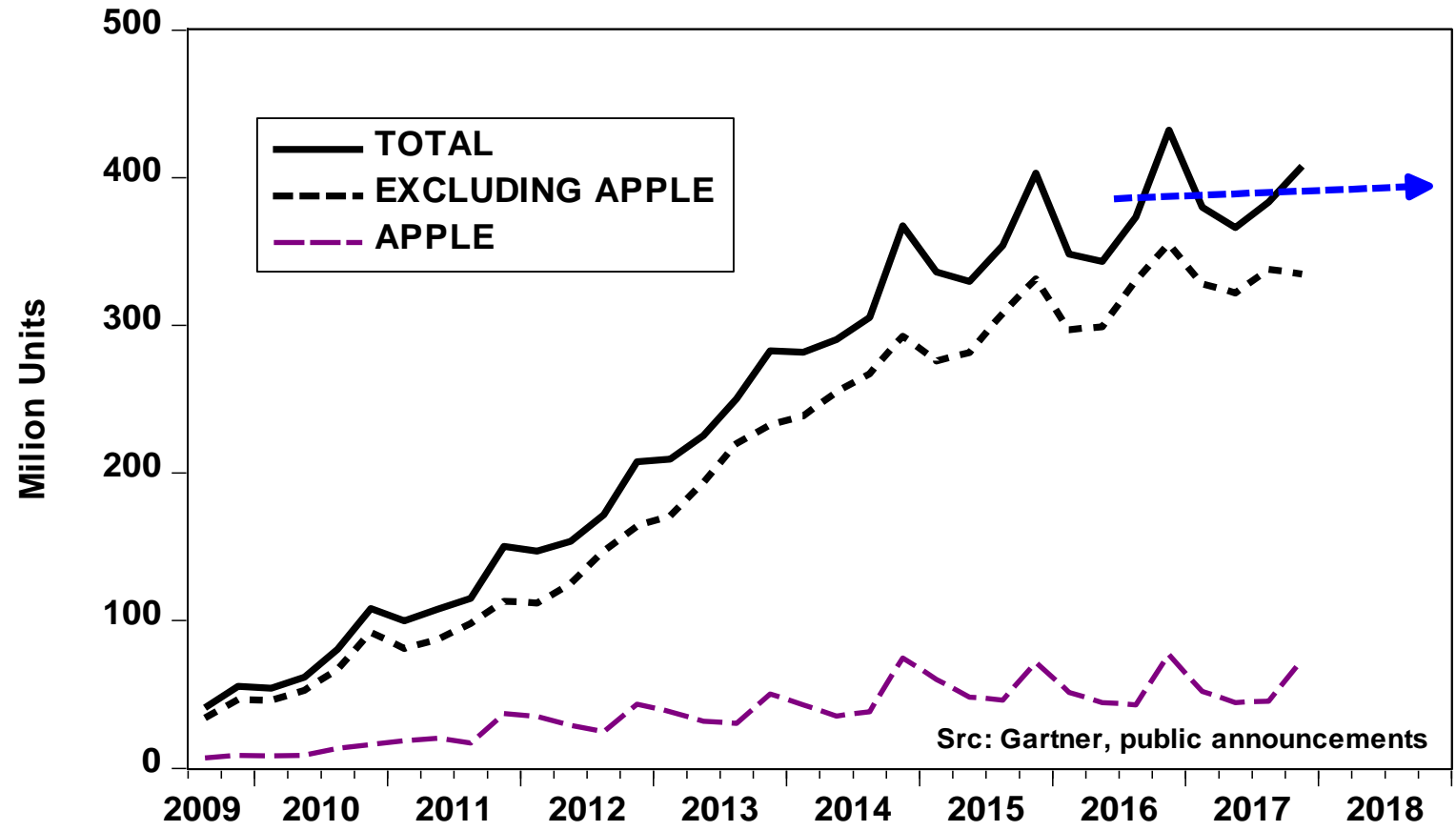
Growth pattern follows real investment pattern



Smartphones: Rapid Penetration Now Past

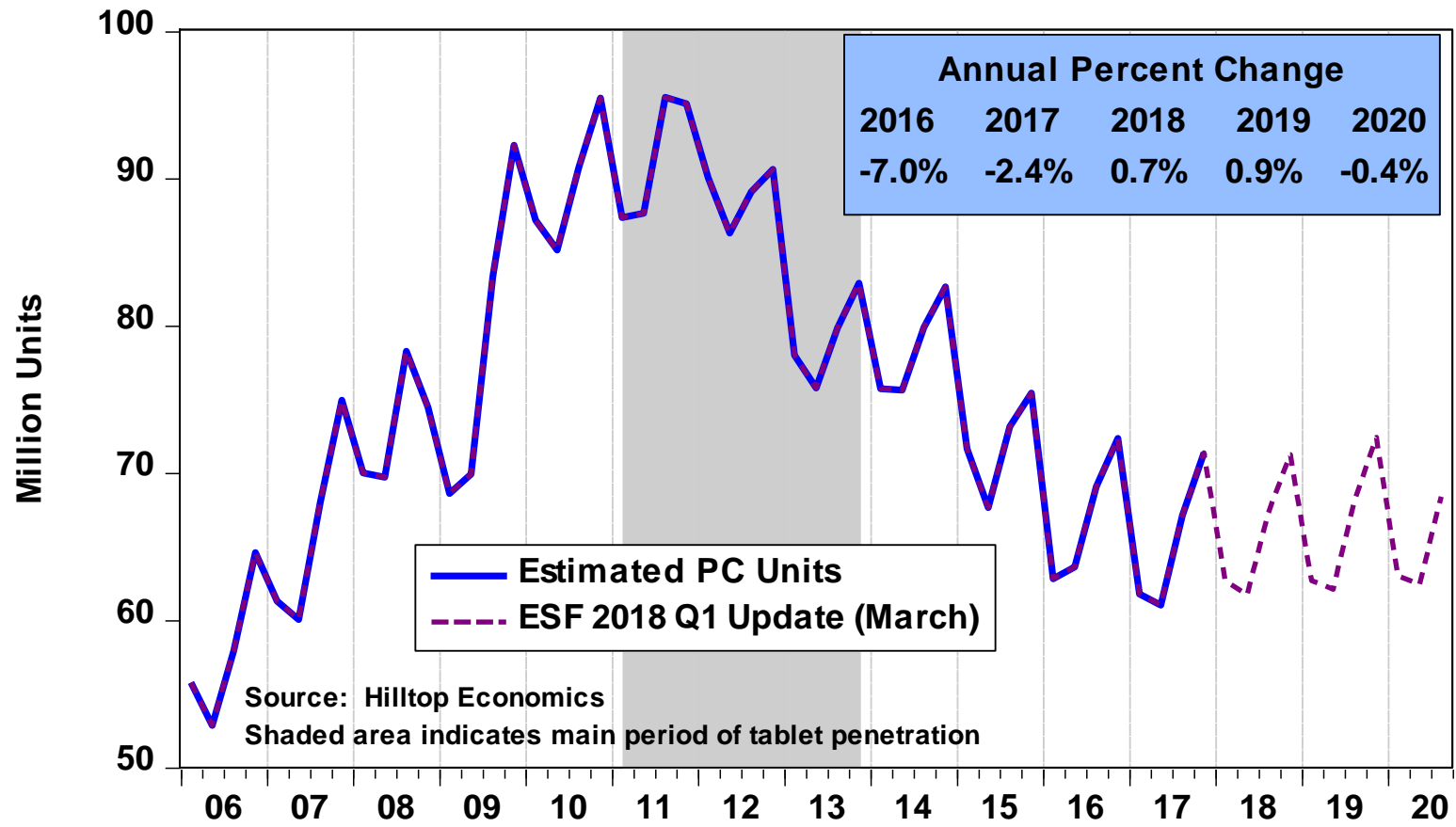
Outlook: low single digit growth in 2018, 2019

Smartphones



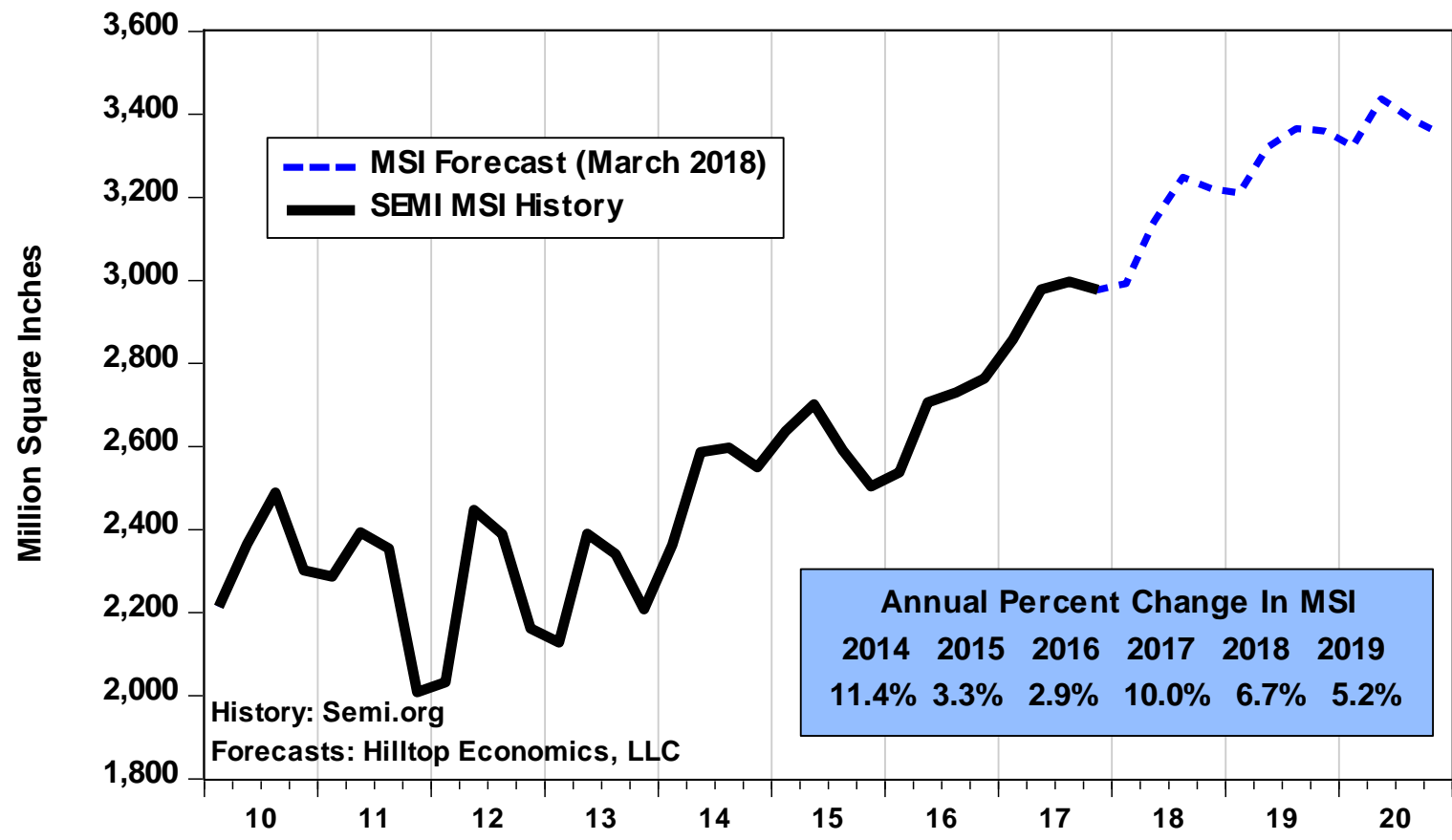
Stable PC Outlook, Minimal Growth

Estimated Global PC Sales



Healthy Final Demand Outlook Drives MSI

Semiconductor MSI Outlook



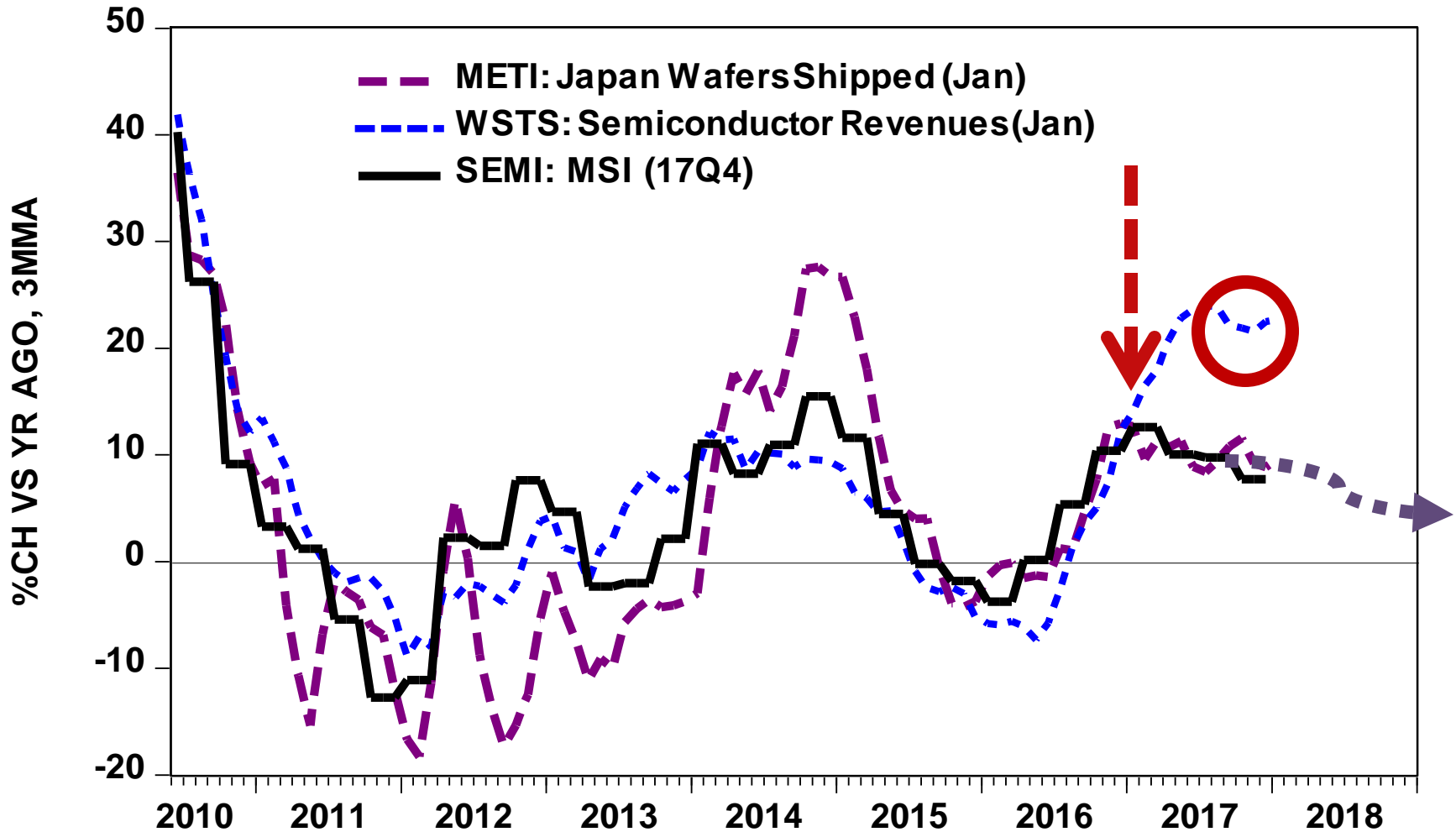
What Worries Me About Semiconductors

The factors that could disrupt the outlook

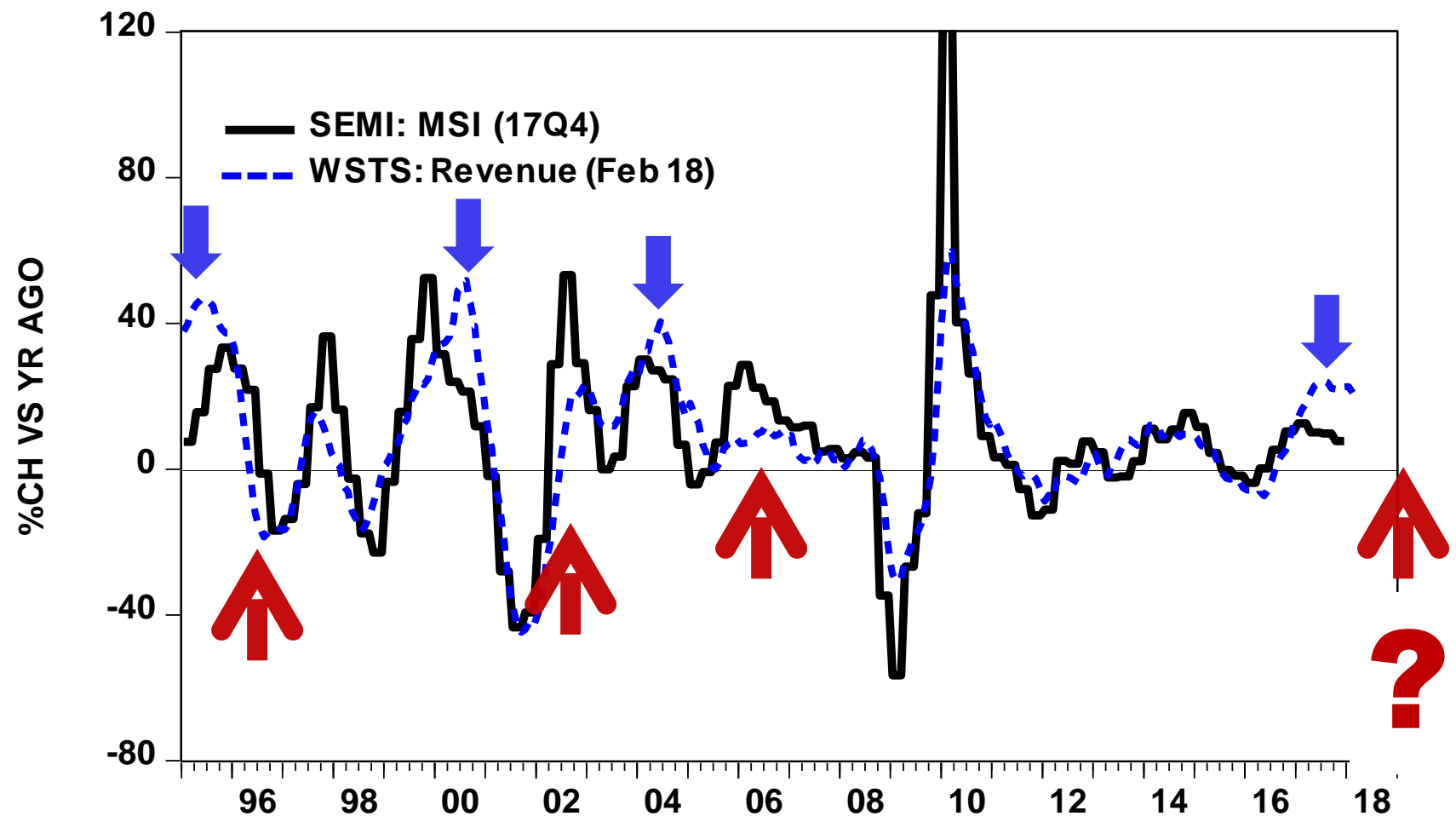
- Downside risks
 - Pricing/revenue reversal
 - Excess capacity (see pricing reversal)
 - Wafer supply
- Upside risks
 - A new penetration leg (with 5G, AI, even more ubiquitous semiconductors)

Semiconductor Volume Momentum Starting to Ease

Momentum in MSI Peaked in Q1, revenue momentum peaking now

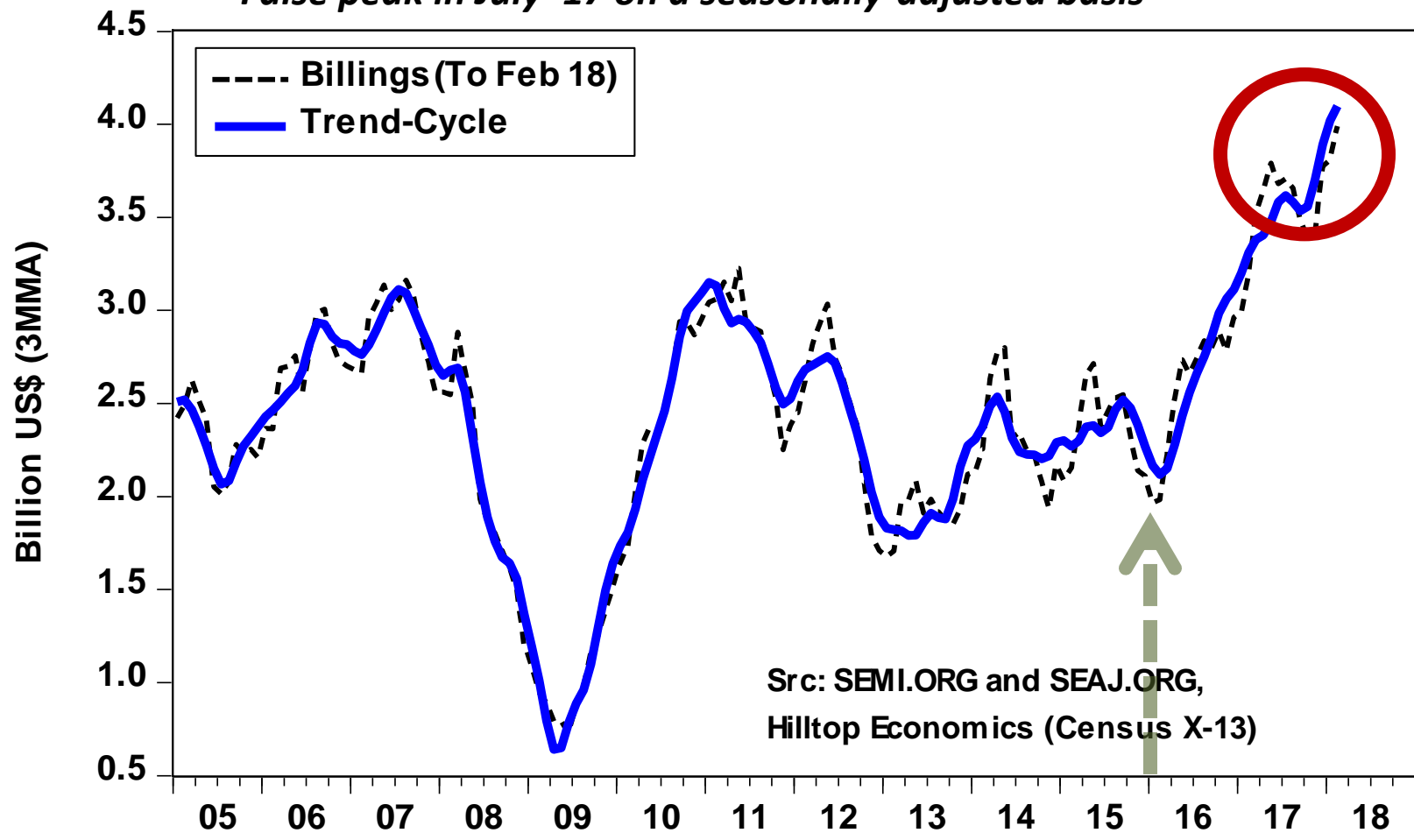


Revenue Growth Does Not Deviate from Volume for Long – And Overshoots Have Been Followed by Undershoots



Equipment Billings Continue to Set New Record Levels

False peak in July '17 on a seasonally-adjusted basis



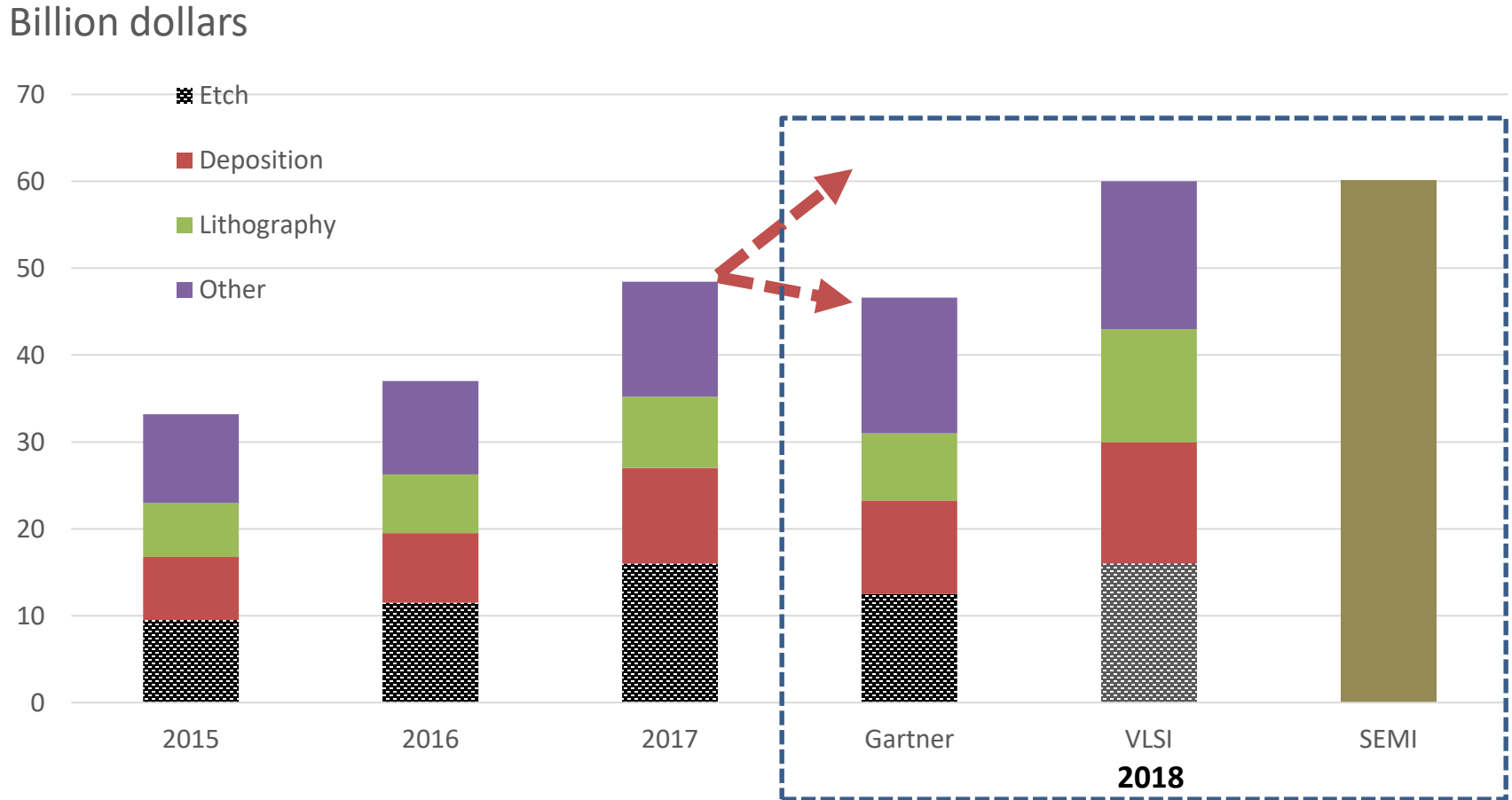
Src: SEMI.ORG and SEAJ.ORG,
Hilltop Economics (Census X-13)

North American & Japanese Semiconductor Equipment Billings

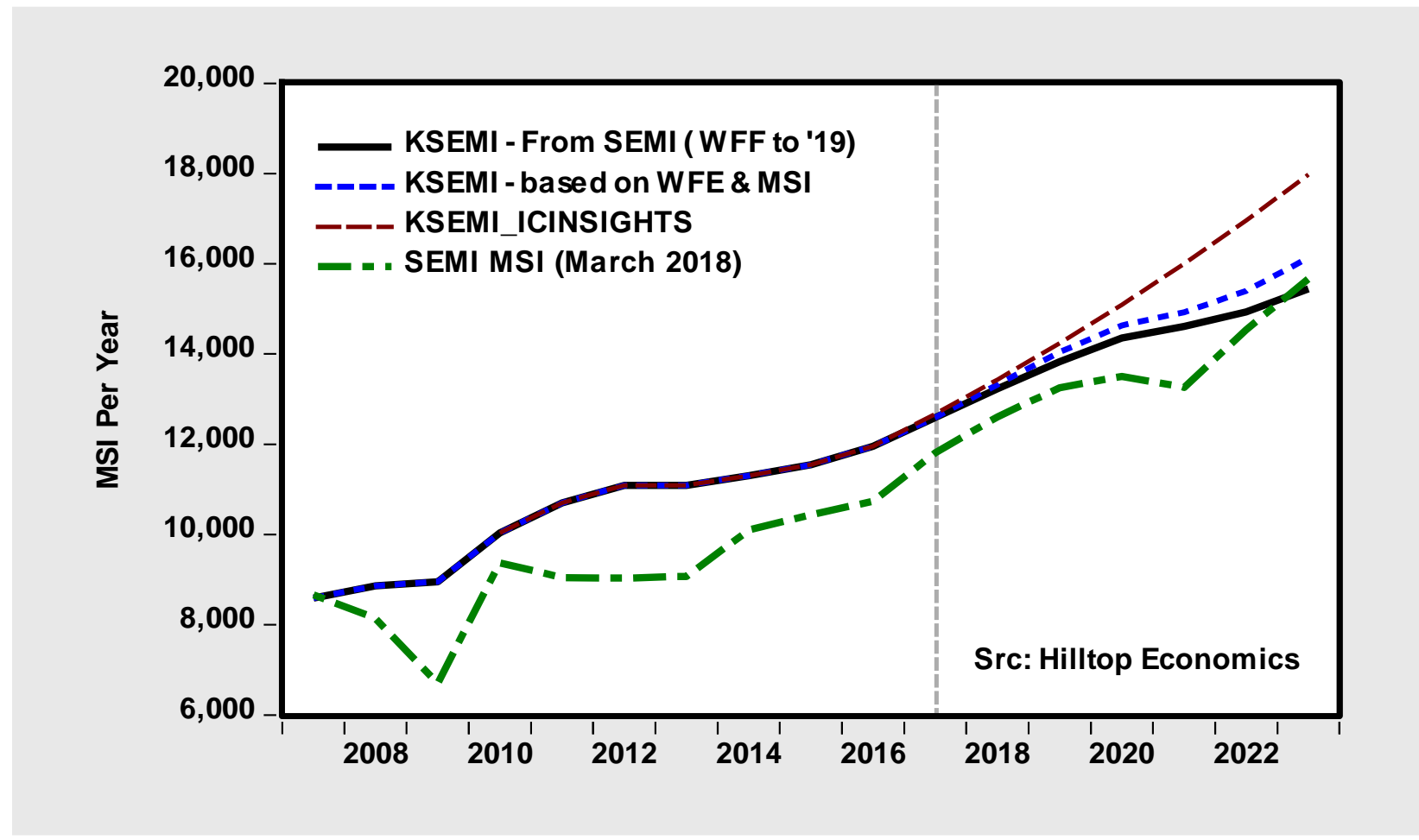
Wafer Fab Equipment (50% of Capex)

Big Disagreement in 2018 Forecasts (& 17 History)

Forecasts estimated from ISS 2018 Presentations

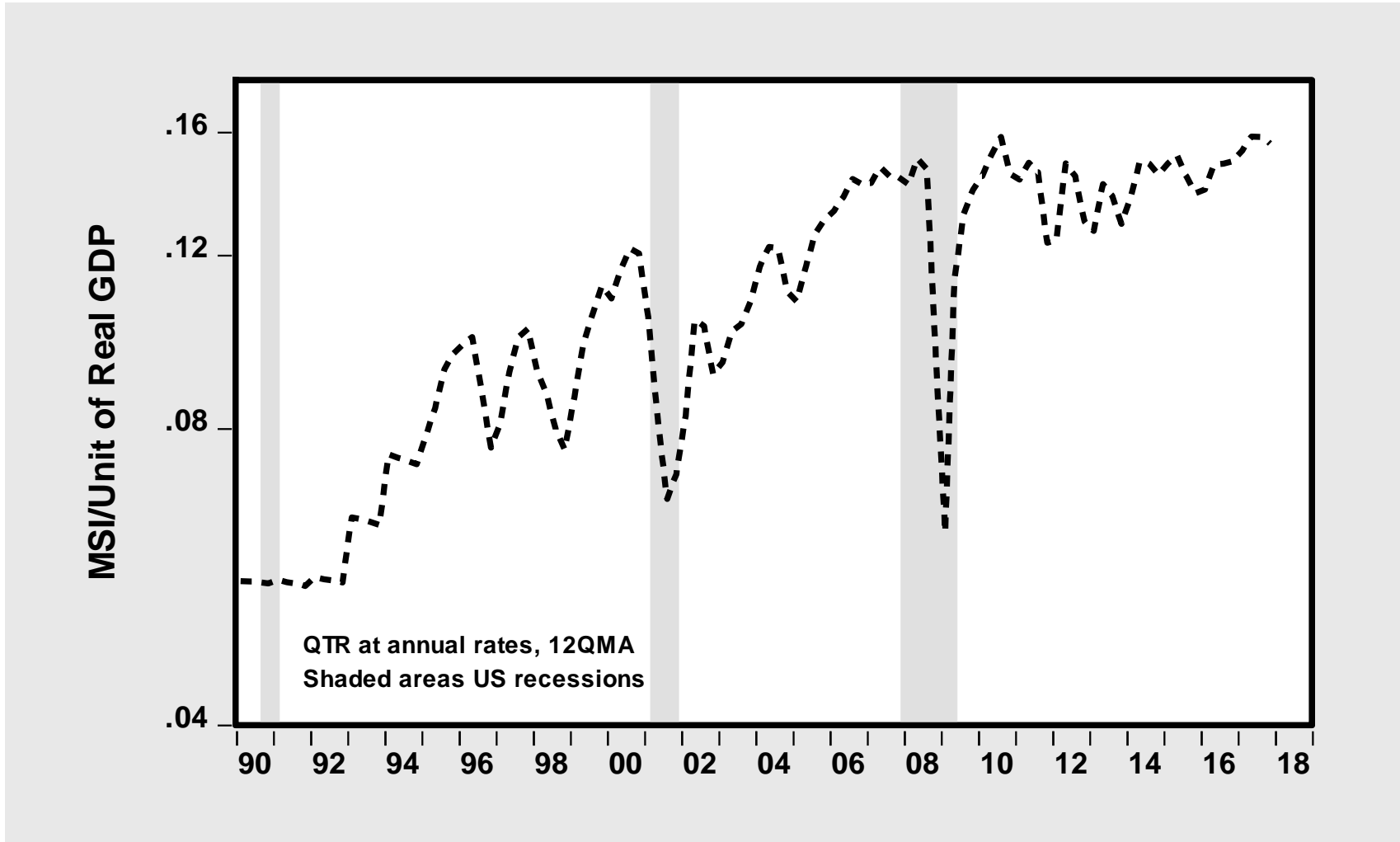


Long-run Demand VS Capacity Forecasts (Annual Models)

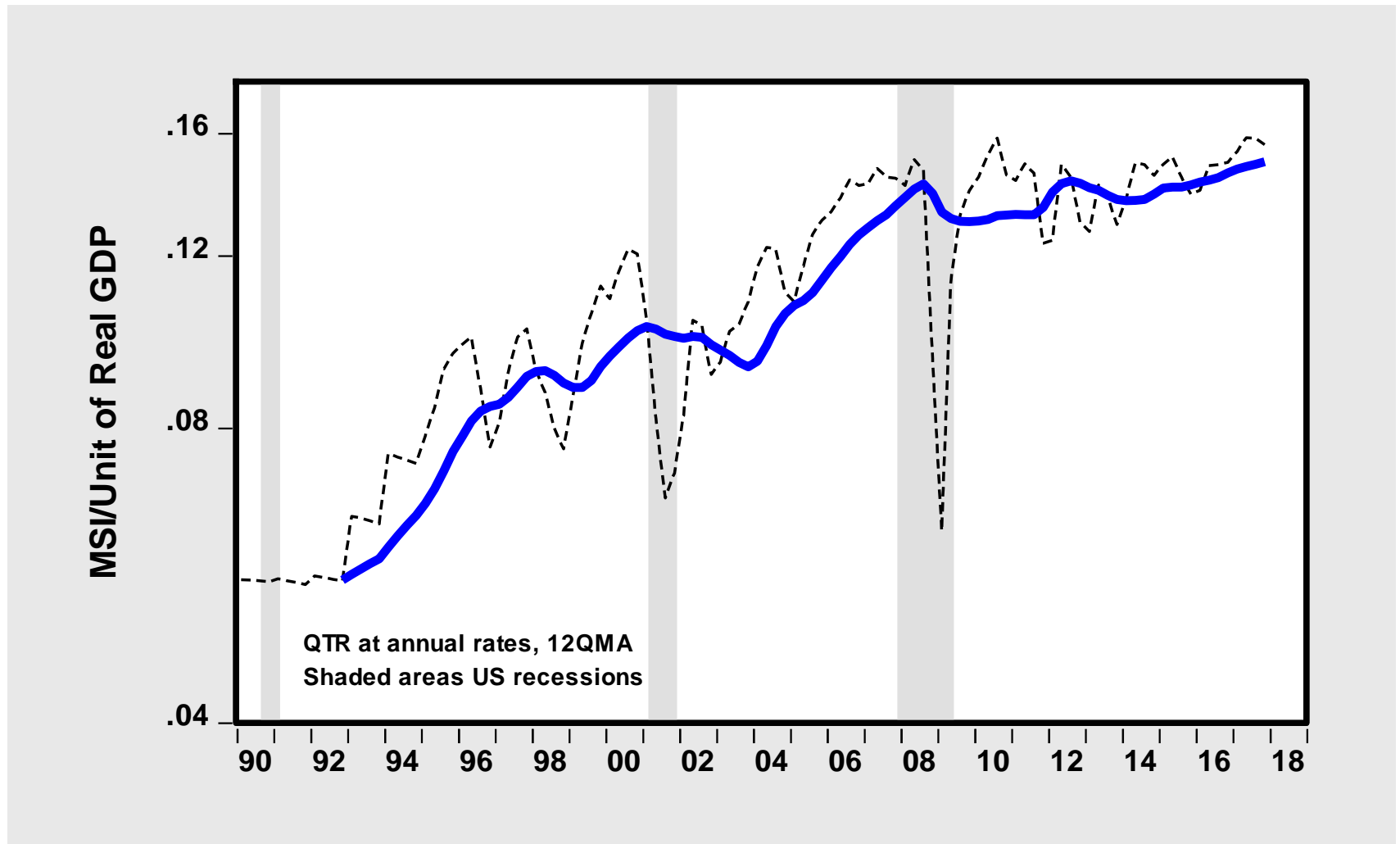


Src: Hilltop Economics

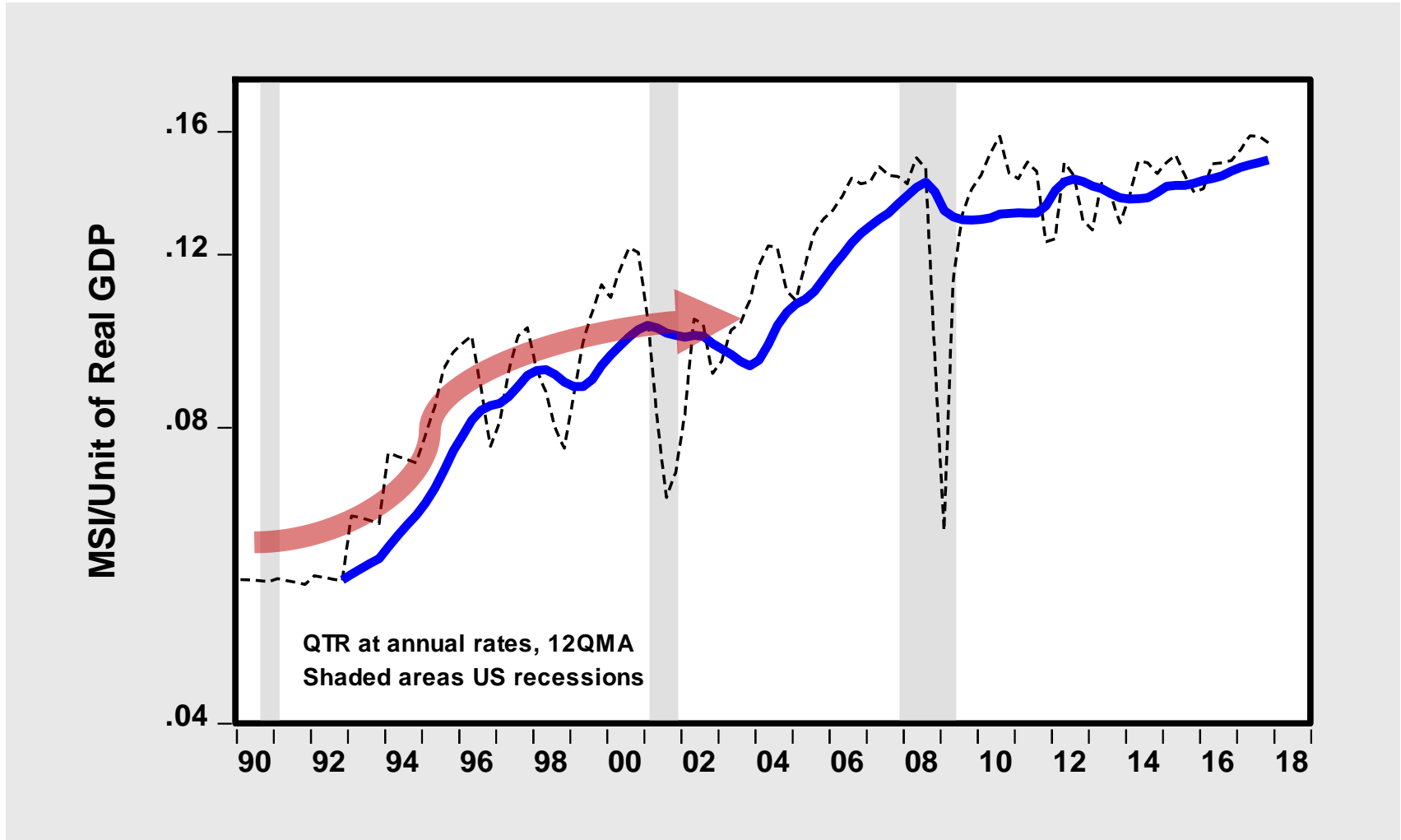
Semiconductor Penetration of the Global Economy



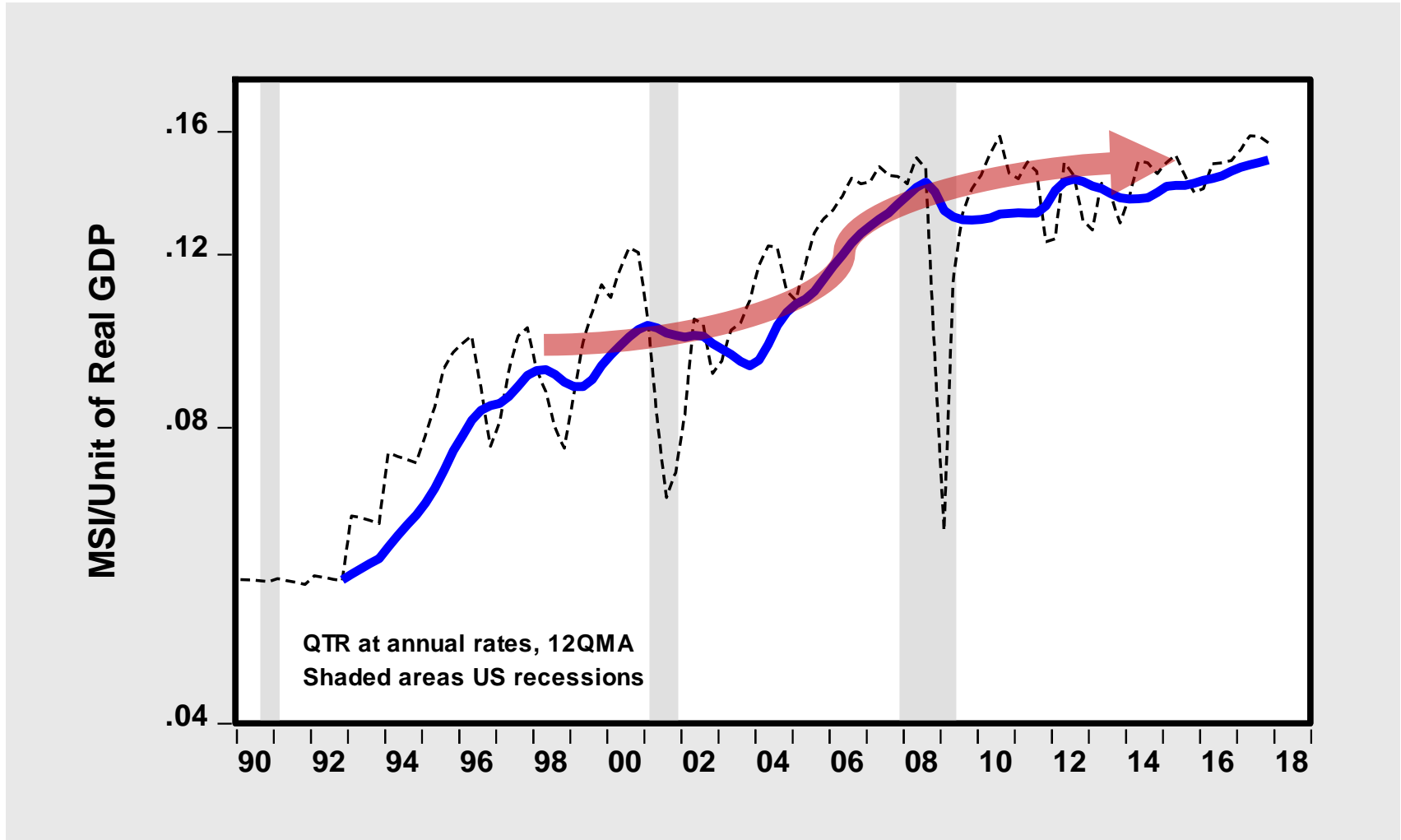
Semiconductor Penetration of the Global Economy



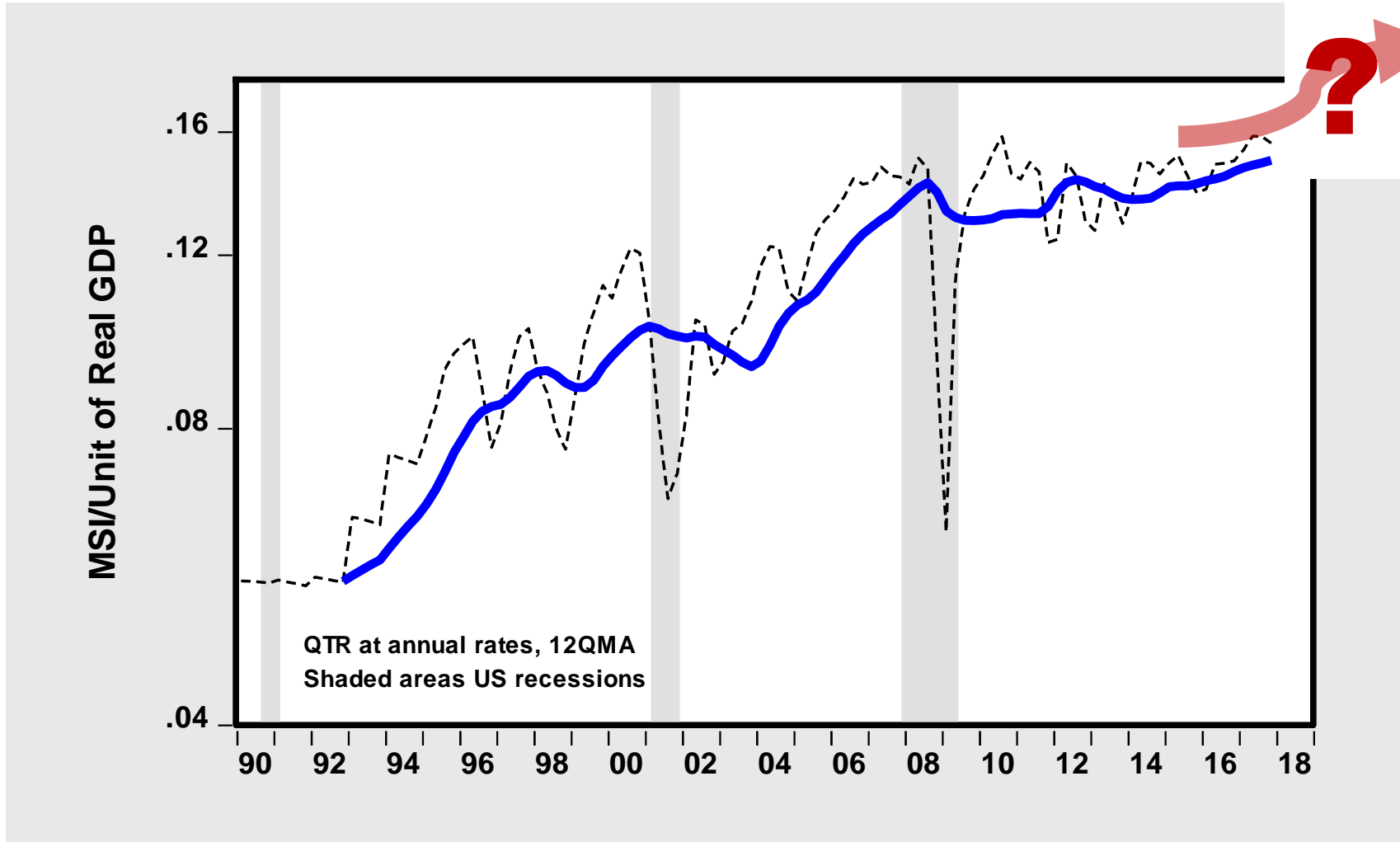
Semiconductor Penetration of the Global Economy



Semiconductor Penetration of the Global Economy



Semiconductor Penetration of the Global Economy



Summary – 2017-19

- The world economy has moved into an accelerating phase of the business cycle.
- Semi MSI growth peaked in 2017, remains above trend in 2018 & 2019 on strong investment-related demand.
- Semiconductor revenue forecasts are chasing actual data up – watch for an adjustment downward later this year.
- Semi equipment demand momentum booming through 2017, healthy growth in 2018, flattens in 2019
- Growth Rates:

	2016	2017	2018	2019
World GDP	2.3	3.1	3.2	3.1
SEMI MSI	2.9	10.0	6.7	5.2
WFE	9.3	35.8	10.0	3.0



**Duncan Meldrum
Chief Economist
Hilltop Economics, LLC**

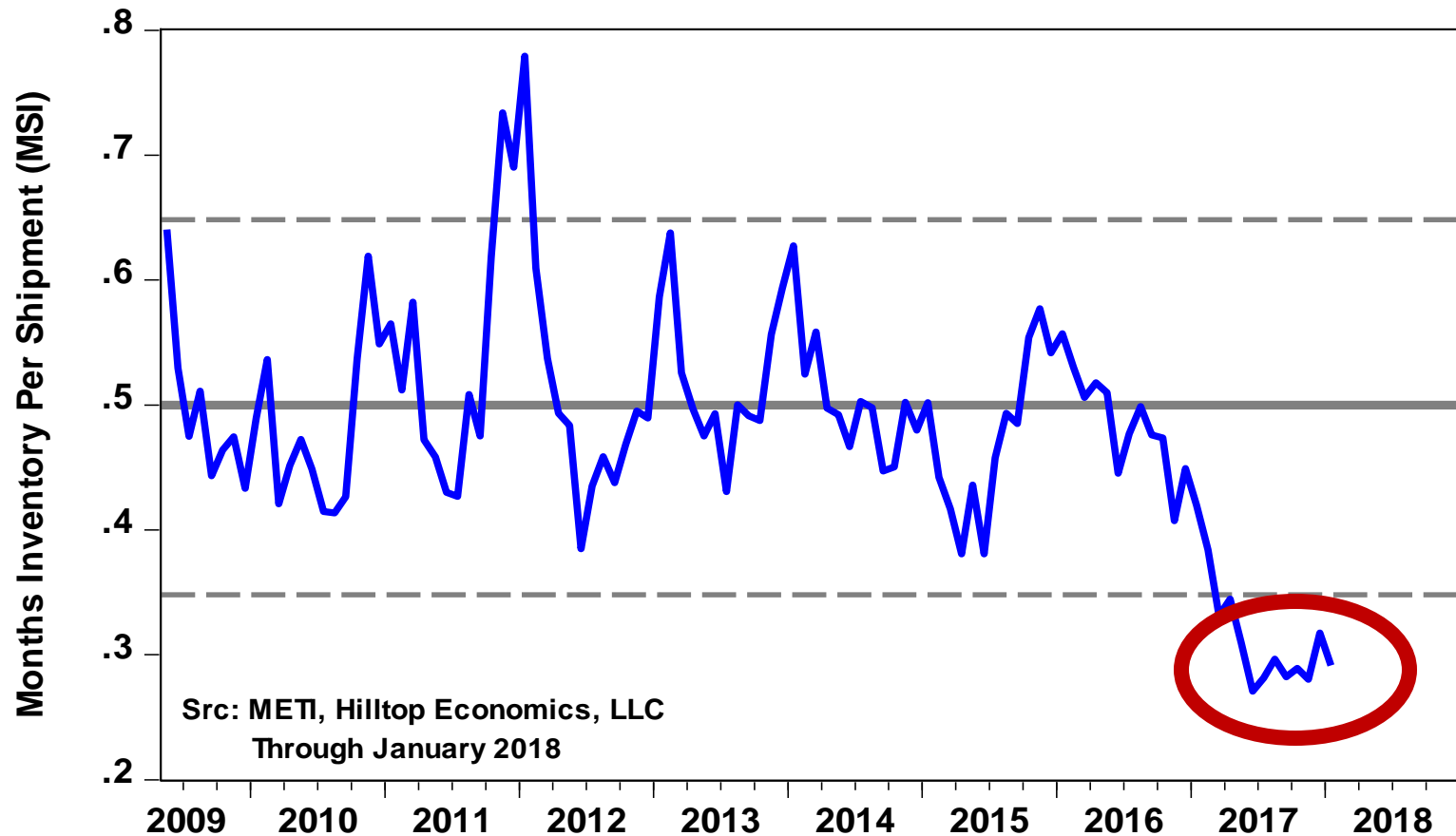
duncan.meldrum@hilltopeconomics.com

610.709.7951

Wafer Supply-Chain Tightness

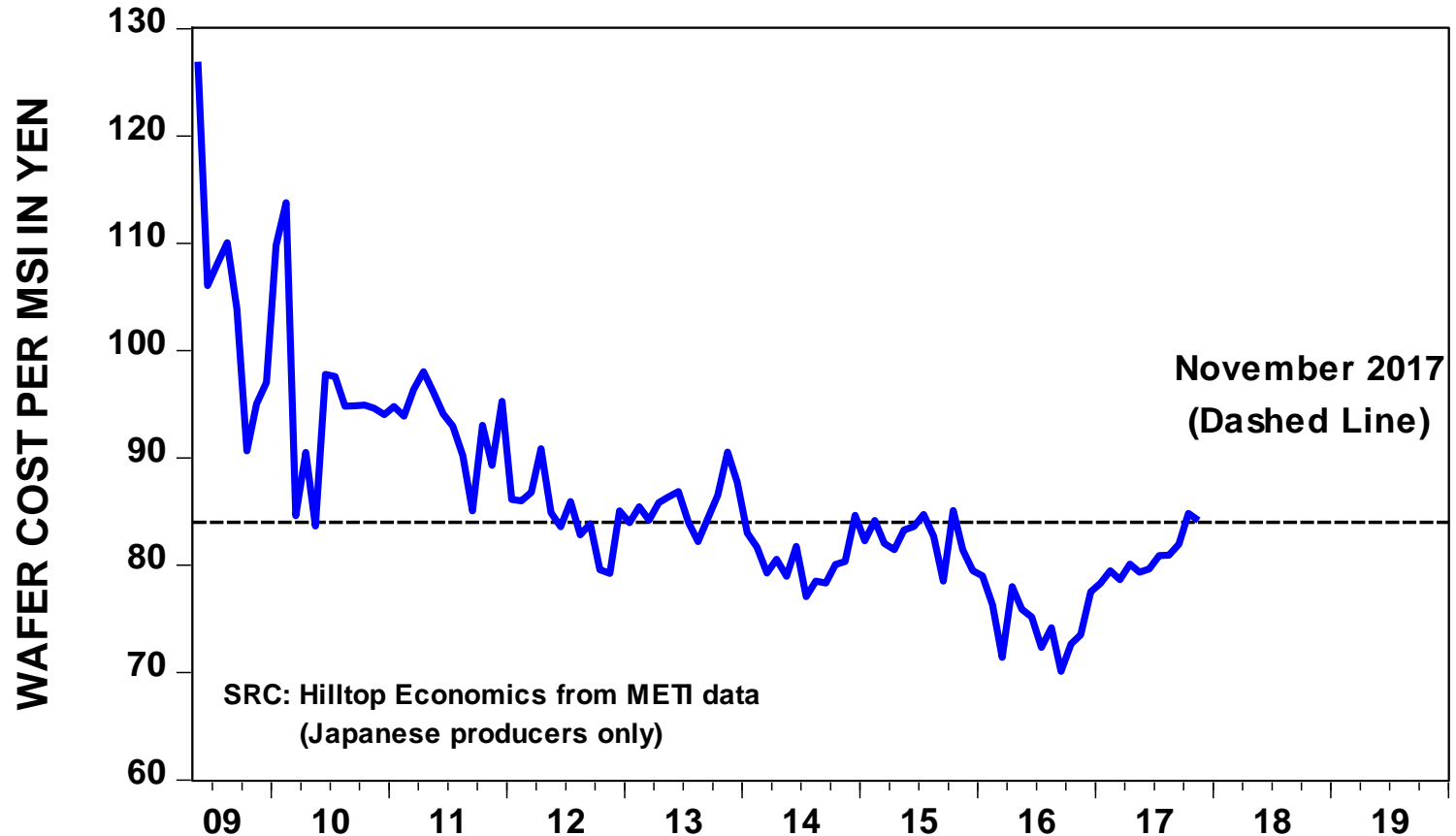
Excessively tight by inventory control measures: more than two standard deviations below post-financial crisis average since April 2017

Japan (METI) Wafer Data Inventories Divided by Shipments



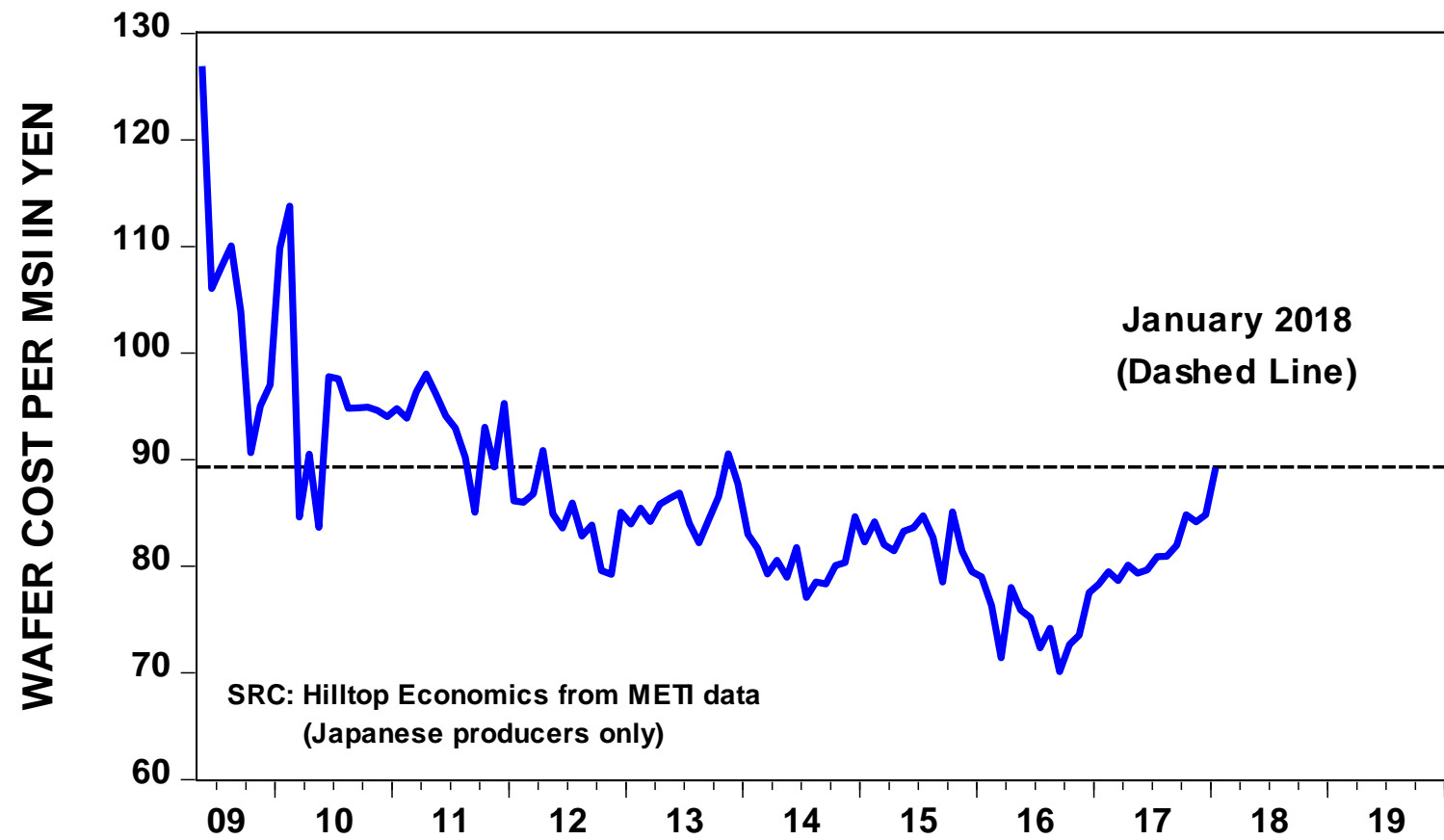
Wafer Tightness Not Reflected in Pricing?

WAFER PRICE



Wafer Tightness Finally Reflected in Pricing?

WAFER PRICE





Total Equipment Spend Outlook Comparison

Hilltop Econ estimates based on public sources of information

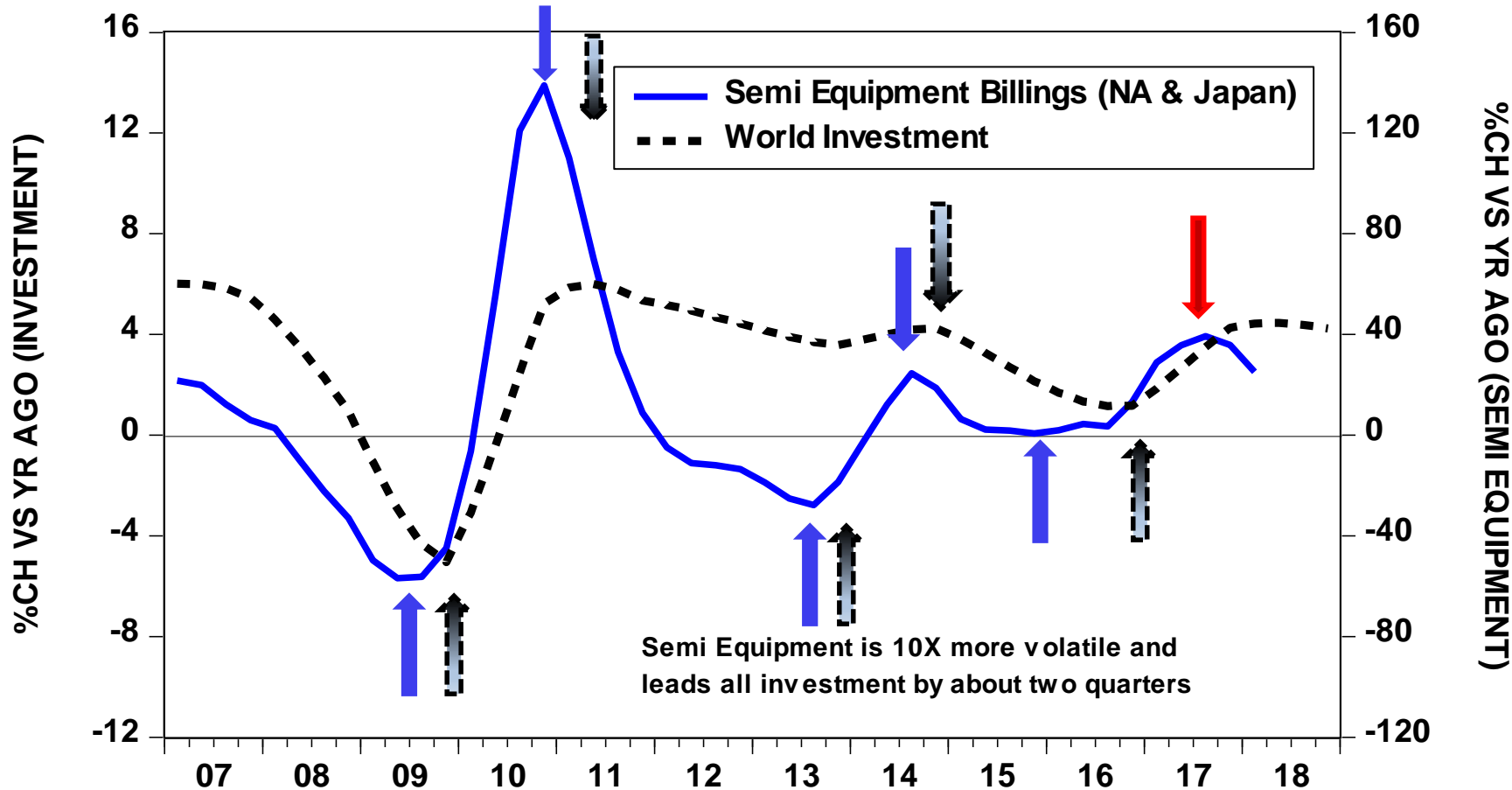
Percent Change / Forecaster:	2017	2018	2019	2020	2021
Annual (Japan & NA Eqpt)*	+36	+20	+7	-3	-17
Hilltop Econ (NA Equipt)	+41	+12	-2	+1	
Gartner (at ISS 2018)	+32	-3			
IHS Markit (All, at ISS 2018)		+5			
SEMI (All Equipment)	+38	+9	+5		
VLSI (WFE at ISS 2018)		+20			
“Consensus”	+38	+10	+3	(-)	

*Hilltop Economic Japan & NA Equipment annual model:

A function of MSI, capacity utilization and the yen-\$ exchange rate in a simple dlog equation

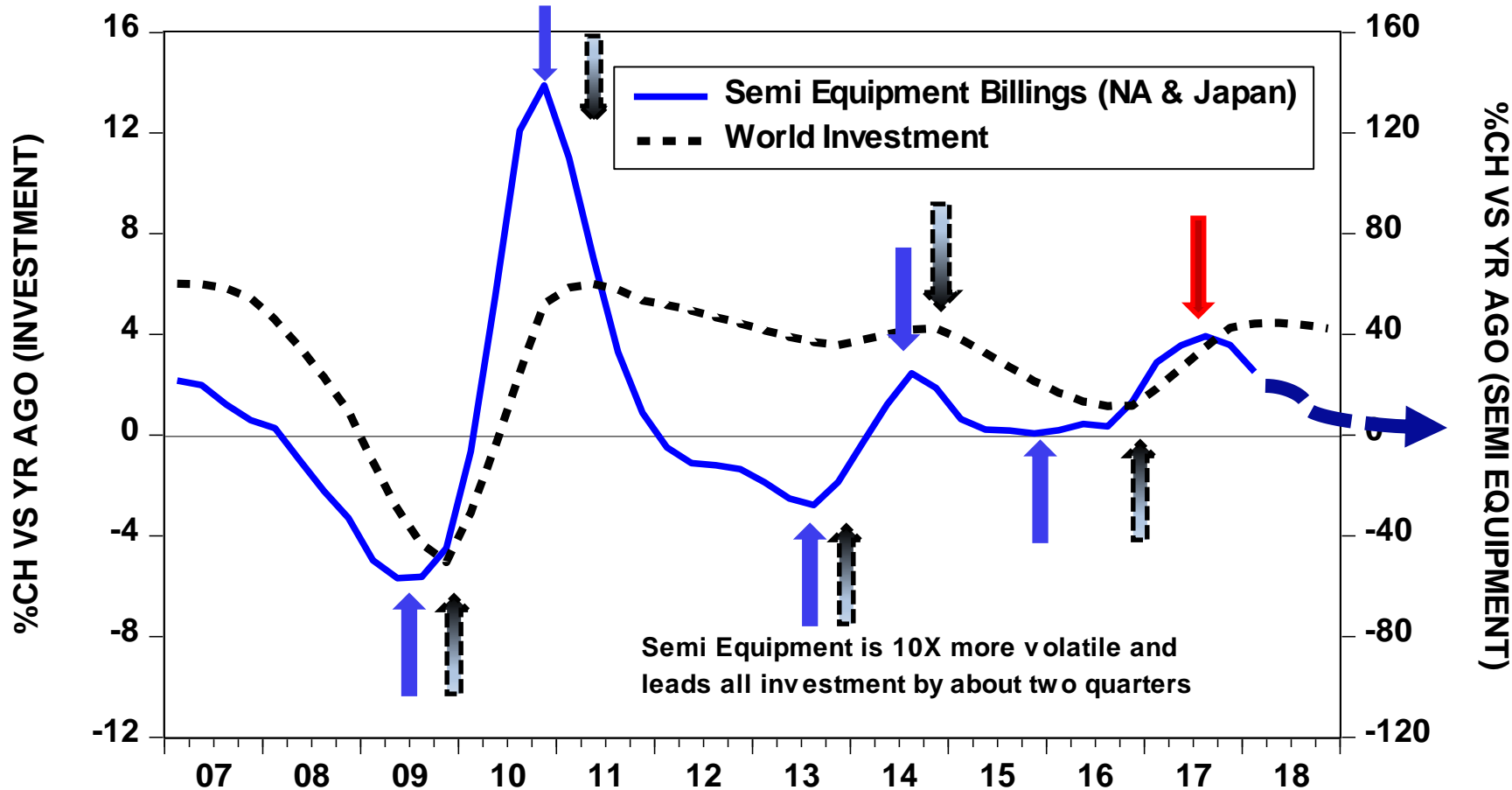
Equipment Billings Lead Global Investment

Usually turning 2-3 quarters earlier than total investment



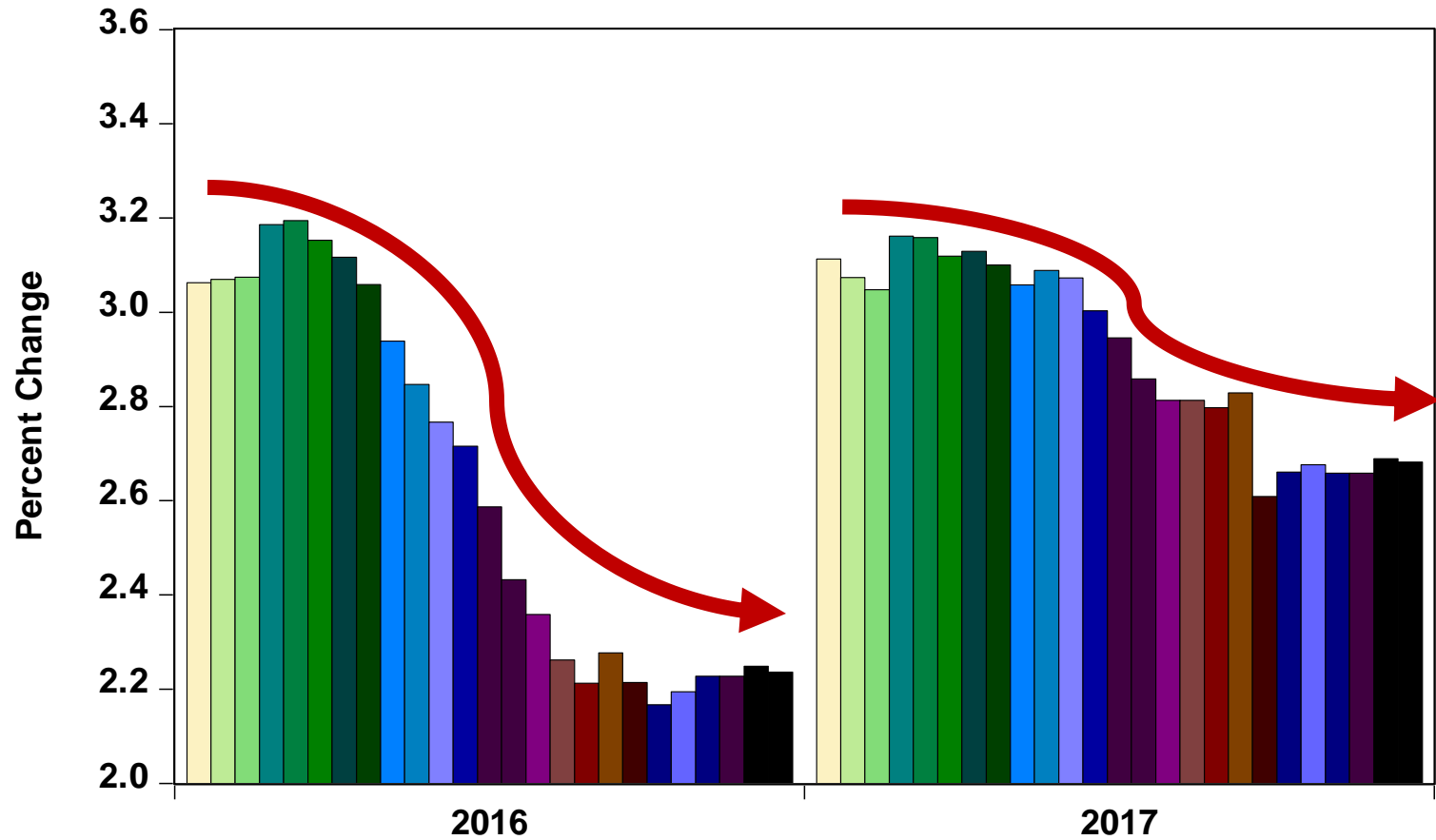
Equipment Billings Lead Global Investment

Usually turning 2-3 quarters earlier than total investment



Steady reduction in '16 and '17 forecasts

Global Consensus Real GDP Forecasts

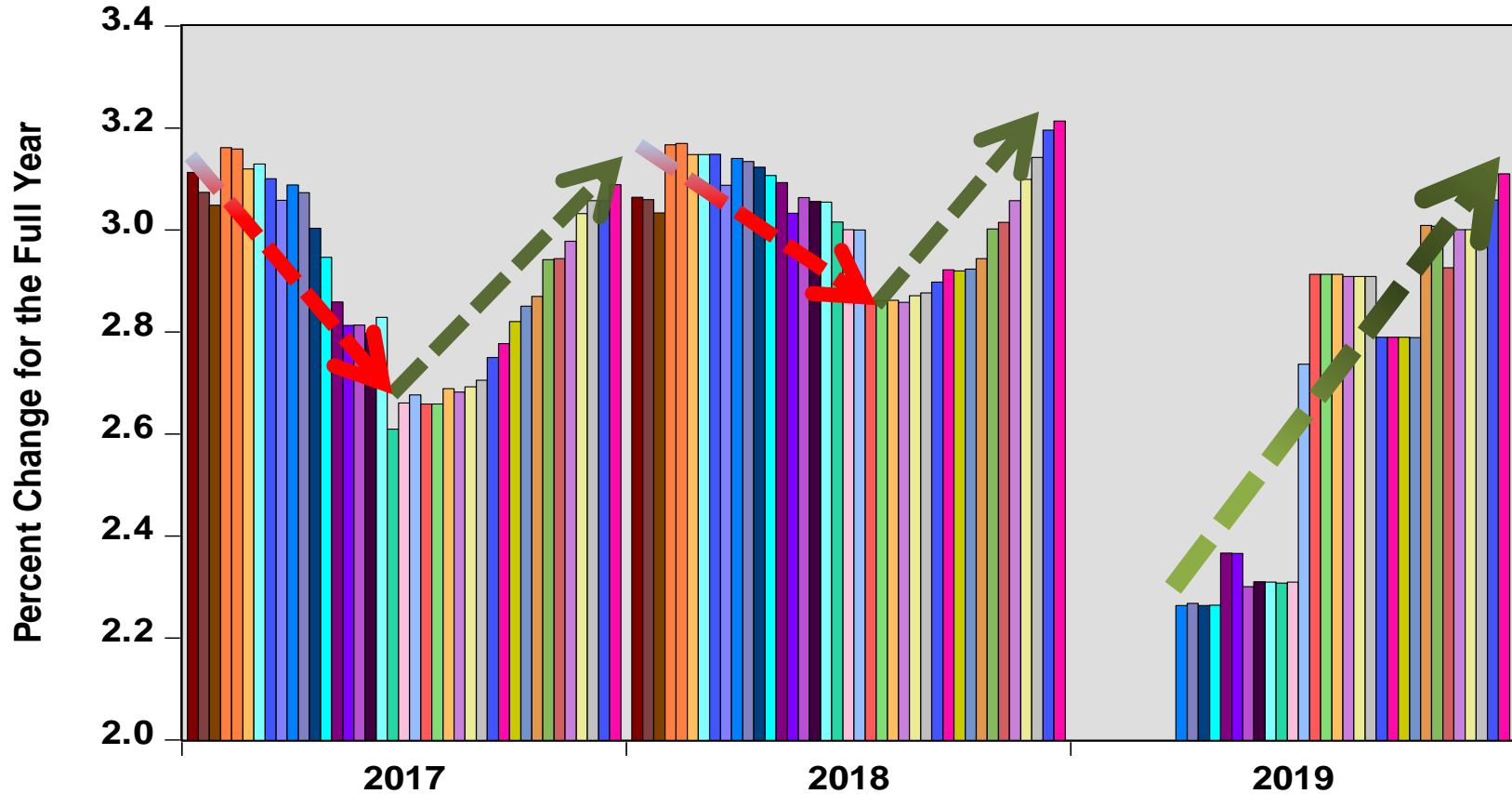


Forecasts from Jan 15 to Jan 17 (left to right)

Back to "Trend" Expectations: ~3 – 3¼%/YR

Global consensus forecasts chasing the data up since early 2017

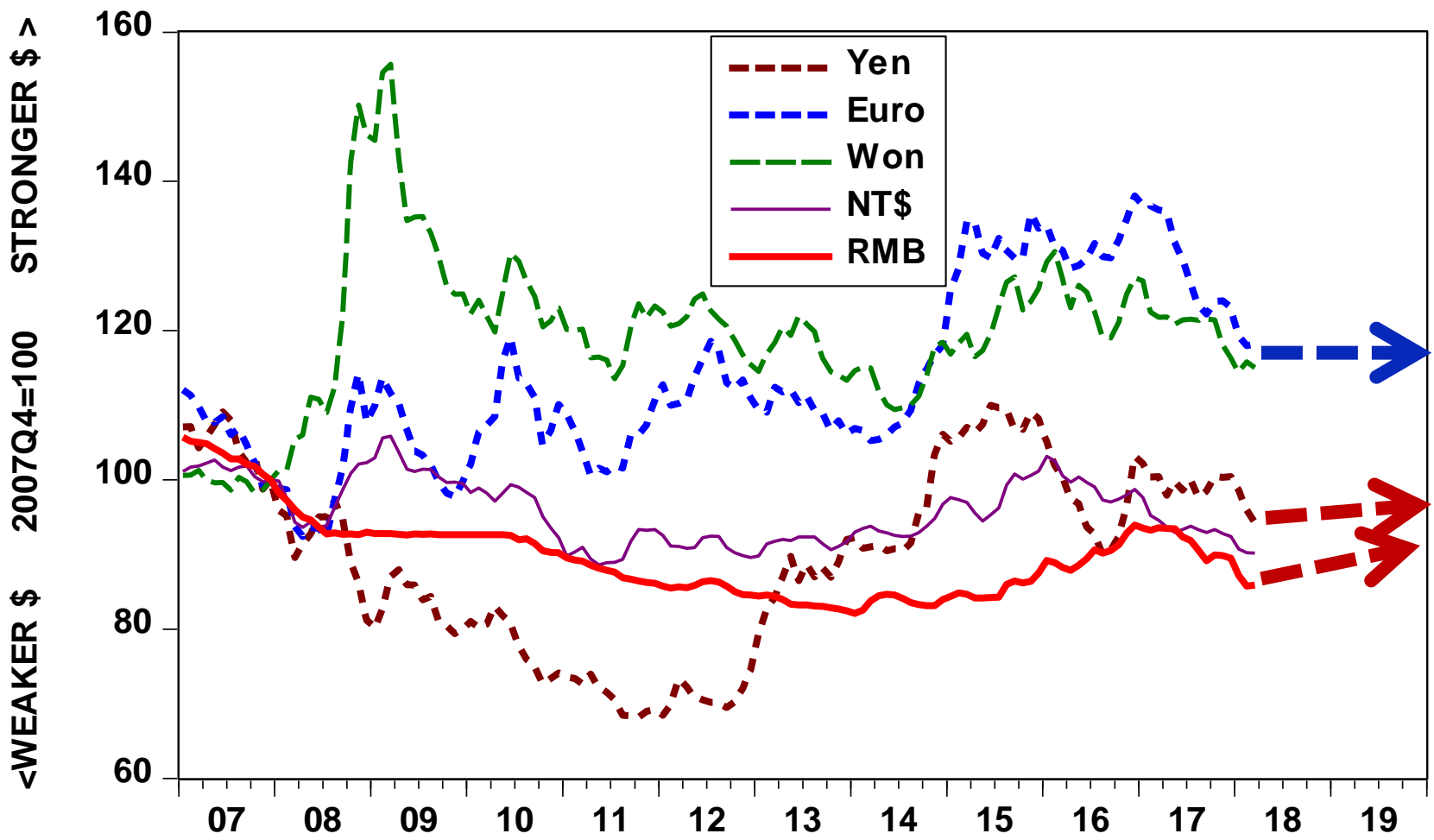
World Real GDP Forecasts



**Bars Are Each Month the Forecast Was Released
From January 2015 to March 2018**

Dollar Weakened, Trade War an Issue

Currencies Per U.S. Dollar

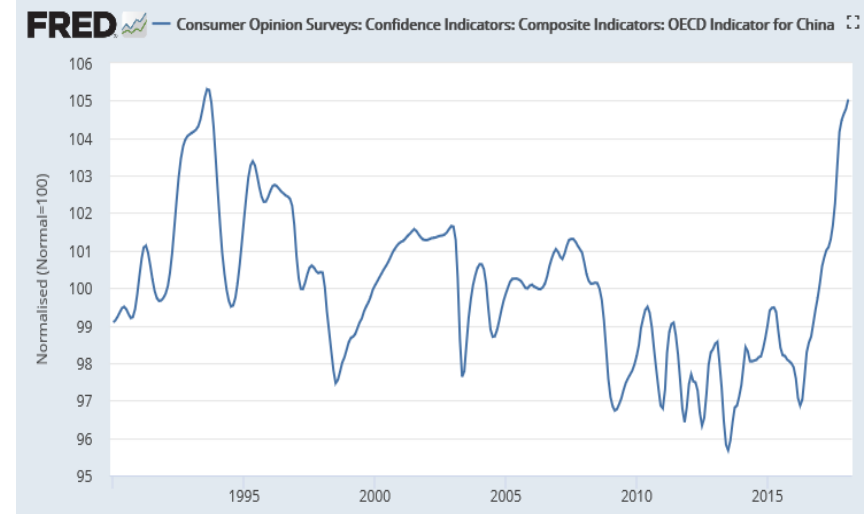
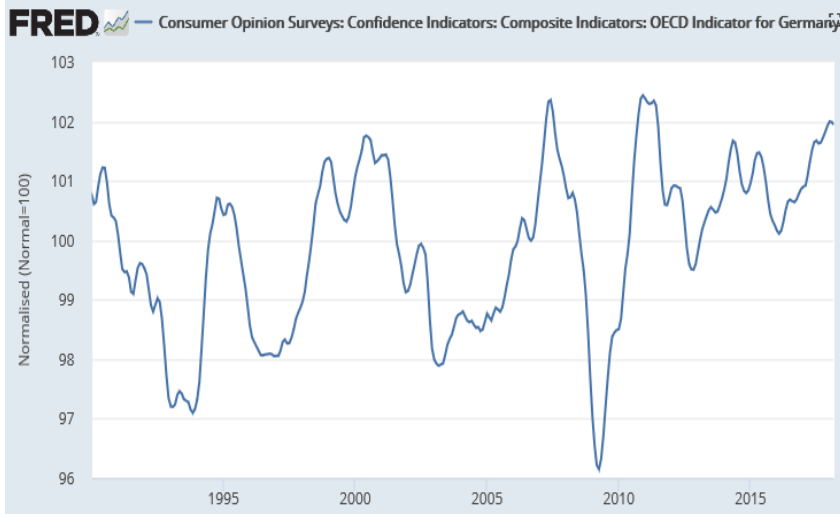
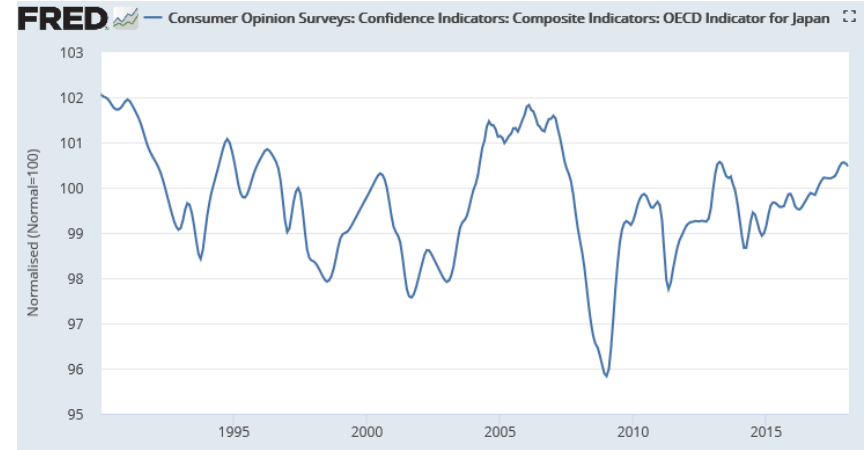
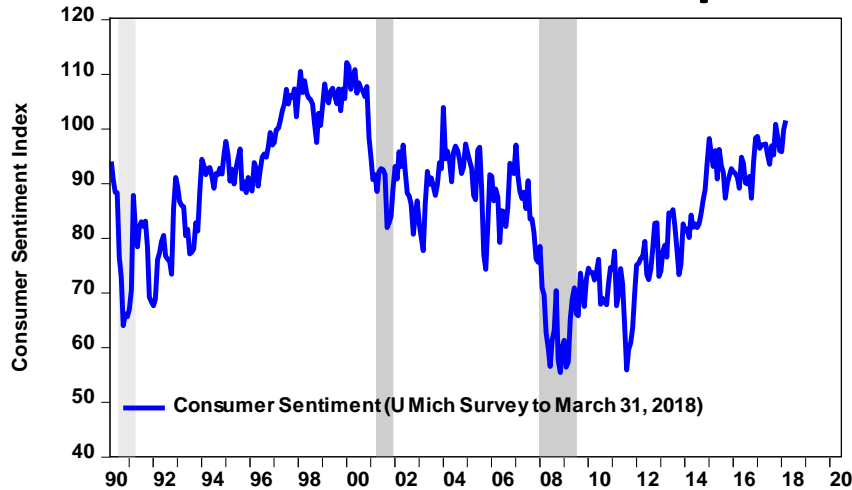


Global Consumer Outlook

- Economies are growing
- Unemployment rates are coming down
- Wages are at least stable
- Inflation is low
- Oil prices are not a big problem
- Consumer debt is under control
- Risks (interest rates, trade wars, policy) are not immediate
- Confidence is high

Consumer Confidence Indexes Are High

US – Japan – Germany - China



Duncan Meldrum
SPCC April 11, 2018

Oil Prices

