A Consensus Outlook of the Global Economy
And What It Implies for Semiconductors

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

• Why the semiconductor industry should care about the broader economy (real GDP)
• Global outlook and how we got here
• Semi MSI outlook (ESF March 2016)
• Risks in the economy
Semiconductor Industry Measure: SEMI.ORG’s MSI

Million Square Inches

Semi MSI Trend
93 - 15
6.3%/year
MSI = Real GDP Since the Recession

Chips are so pervasive in the economy, demand is now driven by the economy

Million Square Inches

Billion 2010 US$

Semi MSI
World Real GDP (Rt Scale)

93-15Q4
95% correlation
MSI Multiple: 2.1X

Total real (inflation-removed) spending on finished goods and services by businesses, governments and consumers in 85 of the largest economies: highly correlated with Semi MSI
World Real GDP Growth Below Par 2012 - 2017

World* Par ~3.2%/Year
2014: +2.6% 2015: +2.4% 2016: +2.4% 2017: +2.8%

*World: 85 major economies,
Forecast: Hilltop Economics based on
IMF & Consensus Forecasts, Mar 16
Why Slow and Will It Continue?

• Governments changed the “Rules”
• Consumer and business aversion to risk skyrocketed
• Demand did not recover to pre-crisis growth rates once the crisis passed (by 2010)
Why Slow and Will It Continue?-I

• Governments changed the “Rules”
  – Economic policies & regulations to “fix” the financial system
  – Monetary policy: low interest rates, oceans of money
  – Economic policies to cope with demand collapse
  – Creating high economic policy uncertainty as policies & regulations continue to adjust

• Expect policies to SLOWLY stabilize but...

• Economic policy uncertainty will remain high until the preponderance of policies stabilize

• Watch: Economic Policy Uncertainty Indexes
Unprecedented Period of Uncertainty After 2008

Economic Policy Uncertainty

Source: Scott Baker, Nicholas Bloom and Steven J. Davis at www.PolicyUncertainty.com
Shaded areas indicate official recessions
Uncertainty In Key Economies Remains A Dampening Factor on Growth: Expect Very Slow Improvement

Economic Policy Uncertainty


<- Financial Crisis
Why Slow and Will It Continue?- II

• Consumer and business aversion to risk skyrocketed
  – Stopped borrowing to spend
  – Paid down debt even as governments took on debt
  – Raised cash

• Risk aversion should recede slowly:
  – As jobs recover
  – As businesses begin to perceive growth opportunities

• Forecast Risk: potential for permanent change in consumer, business and government behavior with all the negative feedbacks (e.g. the Depression Generation, part II)
U.S. Household Debt Drops as Government Rises

% OF GDP

Household Debt
Federal Debt

Src: Federal Reserve; Bureau of Economic Analysis Through 15Q4
Why Slow and Will It Continue? - III

• Demand did not recover to pre-crisis growth rates
  – Consumers remain cautious
  – Investment remains very weak
    • Slow real GDP + low inflation = weak topline growth
    • High uncertainty
    • Excess capacity (until output gap closes all the way)
  – Cheap capital (low interest rates) not enough to stimulate investment or consumption.
    • Stimulates M&A activity

• Demand is forecast to recover by 2017-2018
What the Global Economy Can Produce: Much Slower Growth Since the Financial Crisis

Potential Output

IMF, US CBO, 21 Countries
Hilltop Economics calculations

~4%/YR
~2%/YR
Slower Potential Growth Has Closed the Output Gap Giving Support to the Forecast for Investment in 2017

The gap is FINALLY starting to close
Global Investment Continues To Grow Too Slowly

World* Real Investment

2016 now forecast to be even weaker than 2015

World: Key 40 Countries
Src: IMF, Consensus Forecasts,
Hilltop Economics Mar 16 Forecast

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SPCC April 19-20 2016
Real Investment Critical for Semiconductors

Final spending on fixed investment – plant, equipment & structures - is even more highly related to MSI over the past 23 years than total real GDP

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Semiconductor MSI Outlook Summary

- **MSI**: Flat in 16 on poor investment outlook, snaps back in 2017, falls to around trend in 2018
- Global final demand grows marginally in 2016, better in 2017 & 2018
  - Real GDP should increase in 2016, reach “trend” by 2017
  - Business investment stalls in 2016, begins to recover in 2017
  - Consumer spending rises back toward trend of 3%
  - PC unit sales down sharply in 2015; down modestly in 2016; increase slightly in 2017
  - Mobile phone sales growth slows
  - No major new markets

<table>
<thead>
<tr>
<th>March Update to ESF 2016 Q1</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
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<tr>
<td>MSI</td>
<td>10,097</td>
<td>10,434</td>
<td>10,465</td>
<td>11,264</td>
<td>11,744</td>
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<tr>
<td>%Change</td>
<td>11.4%</td>
<td>3.3%</td>
<td>0.3%</td>
<td>7.6%</td>
<td>4.3%</td>
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Linx-Consulting Econometric Semiconductor Forecast (ESF)

The First ESF Quarterly Forecast:
Overforecast Actual MSI by 0.4% (13 Qtr Trend)

Forecast VS Actual 12Q4-15Q4
ESF 12Q4 MSI: 7.4%/yr trend
Actual MSI: 7.0%/yr trend
Real GDP: 2.9%/yr
Actual: 2.4%/yr
Forecast Performance for ESF
Three Years, Real Time

Final demand approach provided superior forecasts. Longer term error attributed to over-forecasts of economic growth, not model error. Pervasiveness of semiconductors key to success of the “final demand” approach to forecasting semiconductors.

<table>
<thead>
<tr>
<th>Cumulative Error on LEVELS</th>
<th>1 Quarter Ahead</th>
<th>2 Quarters Ahead</th>
<th>3 Quarters Ahead</th>
<th>4 Quarters Ahead</th>
<th>8 Quarters Ahead</th>
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<tr>
<td>Ave Percent Error</td>
<td>-0.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>-0.1%</td>
<td>0.8%</td>
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<tr>
<td>Mean Absolute Percent Error</td>
<td>2.5%</td>
<td>2.8%</td>
<td>3.0%</td>
<td>2.9%</td>
<td>2.6%</td>
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<tr>
<td># Forecasts</td>
<td>13</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>

Does the “final demand” forecast modeling technique work?
Things to Watch: Risks

• Yield Curve (expected to stay near current levels)
• Federal Reserve interest rate increases impact on financial markets
  – (forecasters don’t expect more than two in 2016)
• Magnitude of oil price increase (expected to gradually rise)
• Value of the Dollar (expect to strengthen modestly)
• Inflation
  – (expected to slowly rise to ~2% in US, lower in other parts of the developed world)
• Jobs keep growing and unemployment rates hold
  – (forecasters expect unemployment rate in US to stay in the range of 4.5% and 4.9% in 2016)
• Forecasts getting lowered in a systematic fashion through the year
The Best Single Recession Predictor: Treasury Yield Curve Inverts (Short Rates > Long Rates)

Shaded areas official NBER recession periods
Stock Market:
One Place All the Money Went
Steady reduction in ‘15 and ‘16 forecasts

Global Consensus Real GDP Forecasts

Forecast for Year By Month in 2015 the Forecast Was Made

Forecasts always seem to expect “next year” to be back to “normal”
Steady reduction in ‘16 and ‘17 forecasts
Global Consensus-based Real GDP Forecasts

Forecasters continue the trend: “next year” gets closer to “normal” but 2017 already below “normal” 3+% trend
Oil Prices Rise a Little

Modest demand growth plus plenty of supply limit increases

Source: EIA, St Louis Federal Reserve Economic Database (FRED)
NBER - Recession dating
Forecast: Hilltop Economics based on Consensus Forecasts Mar 16

Current: $43 (Brent)
Consumers Globally Benefit From Low Energy Prices
(U.S. consumers alone gained almost 2% of disposable income since the end of 2013: almost $250 BN)

Src: US BEA Underlying Detail
Shaded areas indicate official NBER recessions
Recent Dollar Retreat Expected to Reverse

U.S. Interest rates are rising, key trading partners (Europe, China, Japan) are keeping rates steady or cutting: capital will flow to U.S., pushing dollar stronger

Dollar Strong VS Yen and Euro
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