Economic Trends Shaping Semiconductor Demand

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*Based on ESF 2022q4 November forecast & Consensus Economics, Inc. CONSENSUS FORECASTS®
Overview

• Macroeconomy backdrop
  – Pandemic crash & stimulated economic recovery
  – Inflation & central banks’ interest rate responses
  – Global economy on threshold of recession

• Inflation-costs altering household spending patterns

• Pandemic-drive demand for tech goods reversing

• Semiconductor industry is heading for a downturn
Pandemic Policies Shaped Today’s Economy
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- Consumer Spending
- Disposable Personal Income

Trillion US$
Pandemic Policies Shaped Today's Economy

1) Pandemic shut downs collapsed spending into early 2021
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2) Three major stimulus packages caused income to surge well above trend

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Trillion US$
Pandemic Policies Shaped Today’s Economy

1) Pandemic shut downs collapsed spending into early 2021

2) Three major stimulus packages caused income to surge well above trend

3) Stimulus worked: spending surging above trend when economy opens
Stimulus Worked: Final Demand Surged

Real Consumer Spending

-8 -6 -4 -2 0 2 4 6 8 10

U.S.
World*

*Hilltop Economics, 46 Consensus Economics countries
World Bank History, 2015 Constant US$ Nov 22
Household Saving Exploded 2020-2021H1
Supported recovery, but households now not saving to keep spending growing

U.S. Personal Saving Rate (%)

Saving behavior in 2022 similar to recession: not enough income to meet household needs
Consensus Forecasts a Sharp Slowdown in Spending in 2023

Real Consumer Spending

*Hilltop Economics, 46 Consensus Economics countries
World Bank History, 2015 Constant US$ Nov 22
Consumer Price Inflation – Highest in Decades, Began Taking Off Early 2021

Inflation: too much money chasing too few goods & services, or “Demand Exceeds Supply”

**CPI Inflation**

Eurostat, Harmonized Index of Consumer Prices: All Items for Euro area (19 countries) [CP0000EZ19M086NEST], retrieved from FRED, Federal Reserve Bank of St. Louis; 30 Nov 2022.
Central Banks Raising Rates To Weaken Demand: A Blunt Instrument

Fed began in mid-March 2022, ECB in mid-July – fastest increases since early 1980s, a year after inflation took off

Overnight Interest (Policy) Rates

- US Fed Funds
- ECB Deposit Facility Rate (Overnight Rate)
- Japan Central Bank Rake Less than 24 Hrs
- UK Call/Money Interbank Rate Less than 24 Hrs

DEMAND ISSUES: ~60% OF INFLATION
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High uncertainty about economic policy ("the rules of business") raises risk aversion, reduces business confidence and makes planning & forecasting even more difficult than it normally is.

Shaded area: when uncertainty about economic policies (monetary, fiscal, international, regulatory, etc.) is above this level, it has negatively impacted economic activity. It is a significant negative factor in the semiconductor MSI model equations.


POLICY UNCERTAINTY DAMPENS DEMAND
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Shaded area: when uncertainty about economic policies (monetary, fiscal, international, regulatory, etc.) is above this level, it has negatively impacted economic activity. It is a significant negative factor in the semiconductor MSI model equations.
U.S. Heading toward Recession in 2023, World Still Grows Weakly(?)

Real GDP
- U.S.
- World*

Percent Change


*Hilltop Economics, 85 Consensus Economics countries
World Bank History, 2015 Constant US$ Nov 22

DEMAND WEAKENS – INFLATION WILL ALSO
Covid Distorted Composition of Final Demand

The change in demand structure compounded the problems in producing and moving goods as well as providing services. Global supply chains were not set up for this radical a shift in demand structure.

Services vs Goods (Nondurable & Durable)

Src: US Bureau of Economic Analysis, through Sep 22

All Goods

All Services
Covid Distorted Composition of Final Demand

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Services vs Goods (Nondurable & Durable)

Src: US Bureau of Economic Analysis, through Sep 22
Altered Demand Stressed the Supply Chain, Contributing to Inflation

*Central Banks cannot fix supply chains directly, but slowing demand eases pressure*

**Global Supply Chain Pressure Index**

Src: NY Federal Reserve
Through October 2022
Pandemic Altered Consumer Spending Patterns

Inflation now causing a shift from durable-discretionary to nondurable-necessary, e.g. food and energy. Technology goods one of the negatively impacted categories.

Food & Energy VS Durable Goods

Percent of Consumer Spending

2018 2019 2020 2021 2022 2023

Food & Energy

Durable Goods
Pandemic Altered Consumer Spending Patterns

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Food & Energy VS Durable Goods
Inflation Further Changed Consumer Spending Patterns

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Food & Energy VS Durable Goods
Consumers Are Shifting Toward Pre-pandemic Preferences

As inflation took a toll on household budgets, it hastened the reversal in the desire for tech

Consumer Spending: Phones, PCs & Peripherals

Source: U.S. BEA Underlying Detail, data through September 2022
Consumers Are Shifting Toward Pre-pandemic Preferences

As inflation took a toll on household budgets, it hastened the reversal in the desire for tech.

Source: U.S. BEA Underlying Detail, data through September 2022
Businesses Have Already Shifted To Pre-pandemic Preferences

**Business Investment: Technology Goods**

Shade d are as: NBER Recessions

Source: U.S. BEA Underlying Detail, data through 2022 Q3
Key Global Markets for Semiconductors in Rapid Decline

More consistent with demand reversion/weakening narratives than supply chain narratives (exc China phones)

Global PC Sales

Global Smartphone Sales

<table>
<thead>
<tr>
<th>Unit</th>
<th>%CH VS YA</th>
<th>21Q1</th>
<th>21Q2</th>
<th>21Q3</th>
<th>21Q4</th>
<th>22Q1</th>
<th>22Q2</th>
<th>22Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCs</td>
<td></td>
<td>55.6</td>
<td>15.0</td>
<td>4.2</td>
<td>0.4</td>
<td>-5.0</td>
<td>-14.7</td>
<td>-16.4</td>
</tr>
<tr>
<td>Smartphones</td>
<td></td>
<td>25.3</td>
<td>13.3</td>
<td>-5.9</td>
<td>-3.2</td>
<td>-8.9</td>
<td>-8.7</td>
<td>-9.6</td>
</tr>
</tbody>
</table>
Downstream Industries and IC Inventories Rising to Extreme Levels

*Now above “just in case” levels, highest index in ten years*

NET RISING INVENTORIES: Electronics & Semiconductors

Hilltop Economics based on data from government sources
Japan, So Korea, Taiwan, US - through Sep 22

Source: Hilltop Economics November 2022 Economic Watch Dashboard
Revenue-based Leading Indicator of MSI Volume

Source: Hilltop Economics November 2022 Economic Watch Dashboard
Leading Indicator Momentum Hits MSI Decline Threshold

Leading indicator signaled a shift in MSI momentum in late 2021

Source: Hilltop Economics November 2022 Economic Watch Dashboard
Heat Map Shows IC Output Declining Everywhere Except Taiwan

### Monthly Performance Semiconductors

<table>
<thead>
<tr>
<th>Monthly Performance Semiconductors</th>
<th>AVE %CHYA</th>
<th>Percent Change vs Year Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Production/Volume except WSTS (Revenue)</td>
<td>Prior 5 Yrs</td>
<td>2022M01 2022M02 2022M03 2022M04 2022M05 2022M06 2022M07 2022M08 2022M09 2022M10</td>
</tr>
<tr>
<td>WSTS Revenue (3MMA)</td>
<td>10.1%</td>
<td>26.8% 26.2% 23.0% 21.1% 17.7% 11.9% 7.3% (0.2%) (3.0%)</td>
</tr>
<tr>
<td>U.S. IP (SA) Semiconductor and other electronic components</td>
<td>7.4%</td>
<td>7.4% 9.3% 7.5% 2.8% 0.8% 3.6% 2.3% 0.4% (1.4%) (3.8%)</td>
</tr>
<tr>
<td>China Integrated Circuits Output (100 million units)</td>
<td>24.1%</td>
<td>7.6% 7.6% (2.0%) (9.5%) (7.9%) (6.6%) (13.8%) (22.9%) (14.1%) (25.2%)</td>
</tr>
<tr>
<td>Korea IP (SA) Mfg of Semiconductor</td>
<td>18.7%</td>
<td>28.3% 33.4% 26.4% 35.3% 24.7% 23.6% 17.1% (0.1%) (3.7%)</td>
</tr>
<tr>
<td>Taiwan IP 2611: Integrated Circuits</td>
<td>15.4%</td>
<td>24.0% 19.9% 2.1% 25.0% 21.2% 7.7% 23.7% 29.1% 6.5%</td>
</tr>
<tr>
<td>Japan IP All Integrated Circuits</td>
<td>4.8%</td>
<td>21.0% 28.7% 30.7% 10.2% 7.6% 34.7% 4.1% (5.6%) (3.1%)</td>
</tr>
<tr>
<td>Singapore IP Semiconductors (3344)</td>
<td>21.3%</td>
<td>(5.5%) 26.7% 11.2% 6.3% 33.3% (3.4%) (3.2%) (7.3%) (8.7%)</td>
</tr>
</tbody>
</table>

Number of Rising Indicators: 22 22 19 21 19 18 16 10 8 0
Number of Falling Indicators: 3 3 6 4 6 7 9 15 17 2
Net (Rising minus Falling): 19 19 13 17 13 11 7 (5) (8) (2)

Source: Hilltop Economics November 2022 Heat Map Report
Weak Final Demand Pulls SEMI MSI Down 10% in 2023

Source: Linx-Consulting Inc. Econometric Semiconductor Forecast ESF 2022Q4, November
October 2022 Economic Watch Dashboard: Recession Risk High

Interest rates, confidence, prices point to recession; real measures (output, employment) still ok

- Yield Curve (inverted)
- Interest Differentials (US-EU gap wide)
- Business Earnings
- Global Consensus Forecast (weakening rapidly)
- Global Consumer confidence measures (recession levels)
- Economic Policy Uncertainty (war impact, interest rates)
- Equities (showing outlook concern)
- Global Inflation & Oil Prices
- Output momentum (growth holding up)
- Employment (strong, but hints the labor market is easing)

Hilltop Economics Economic Watch Dashboard: leading indicators that may help identify turning points that precede a downturn in the next 6 to 24 months. Available monthly.