

Global Economics: Into a Growth Slowdown (Does It Matter for Semiconductors?)

EMG/SMG MEETING 11 July 2024

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**Forecasts from Hilltop Economics LLC,
Based on Consensus Economics, Inc. CONSENSUS FORECASTS®*

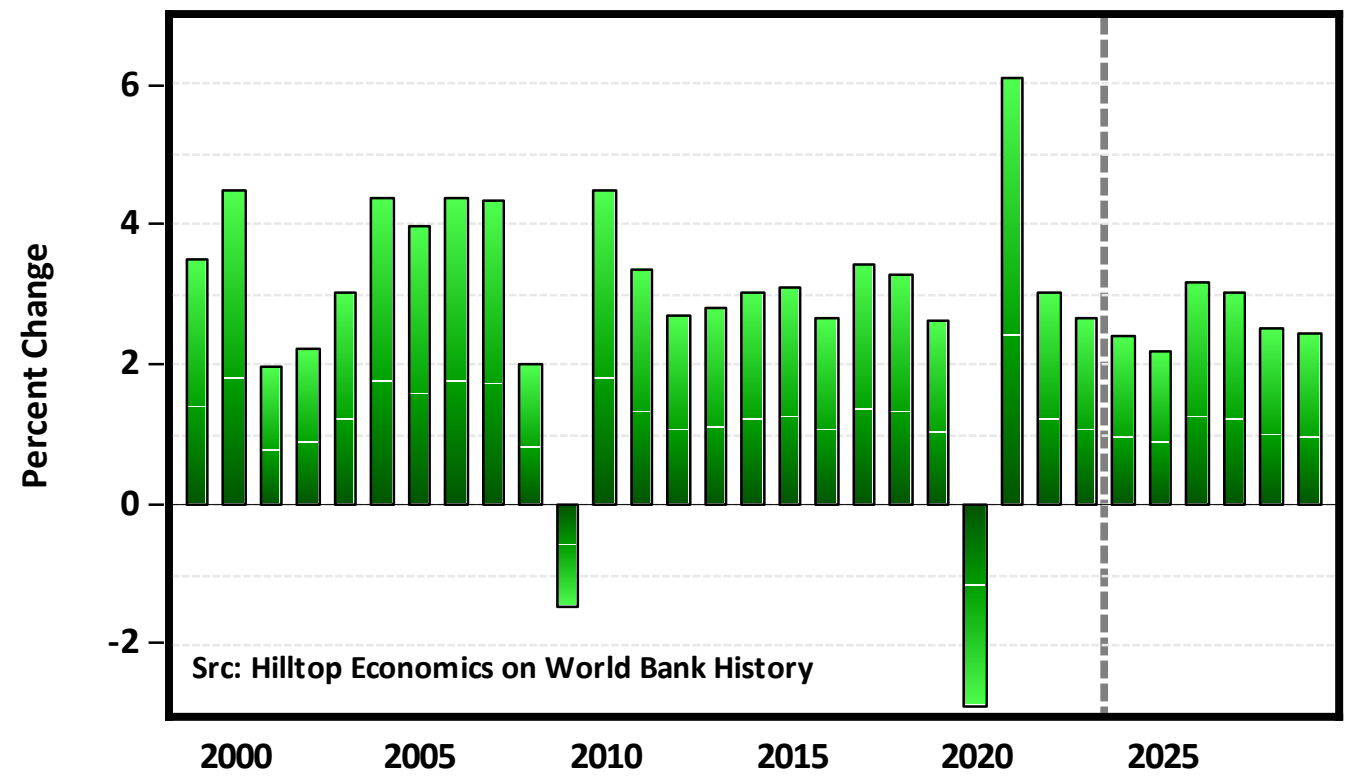
Outline

- **Key Economic Factors**
 - **Global economy grows at a slowing rate through 2025**
 - **Inflation dropping but remains higher than desired**
 - **Consumers still adjusting spending patterns**
 - **Investment growing, but not necessarily in a balanced way**
 - **Geopolitical risks may overwhelm economic forces**
- **Impact on semiconductors from final demand**
- **Make good from 2023 meeting**

2024-2025 Mild Growth Cycle

World Real GDP Growth

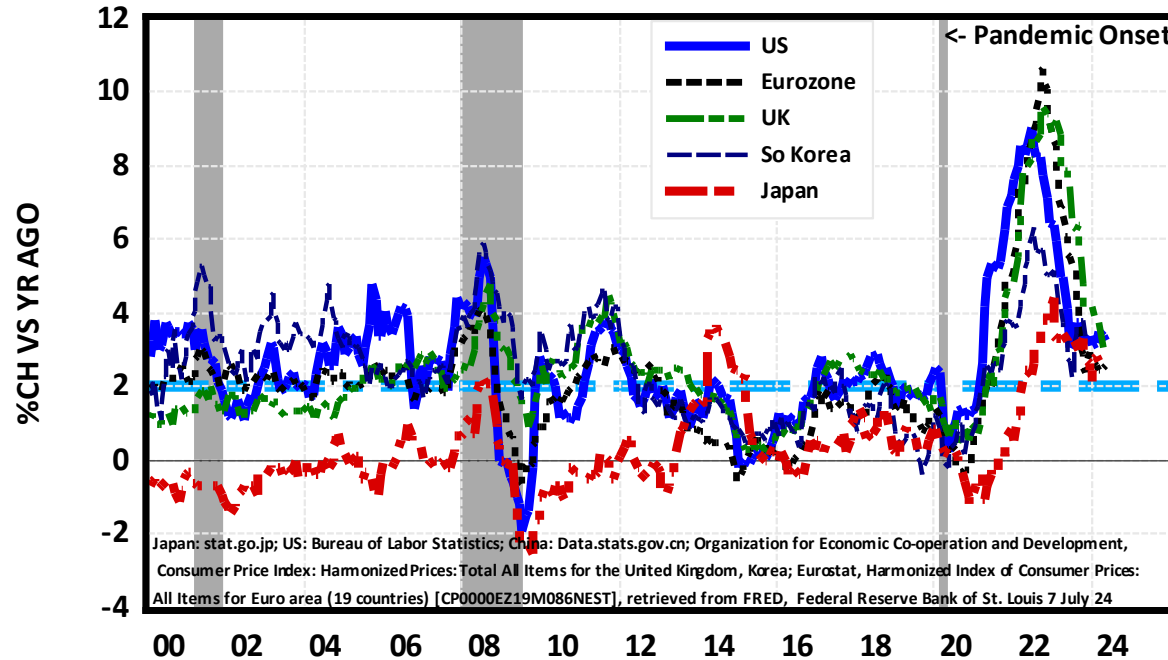
23: +2.7% 24: +2.4% 25: +2.2% 26: +3.2%



- Mild slowdown in growth similar to 2001-2002 period for real GDP percent change.
- Caused primarily by inflation fight and post-pandemic adjustments
- Long term trend up to half a percent per year slower in next ten year relative to past 25 years due to slower population/labor force growth, weaker productivity growth, and slower capital growth in a less-friendly investment environment.

Inflation and Policy Interest Rates Key Economic Factors

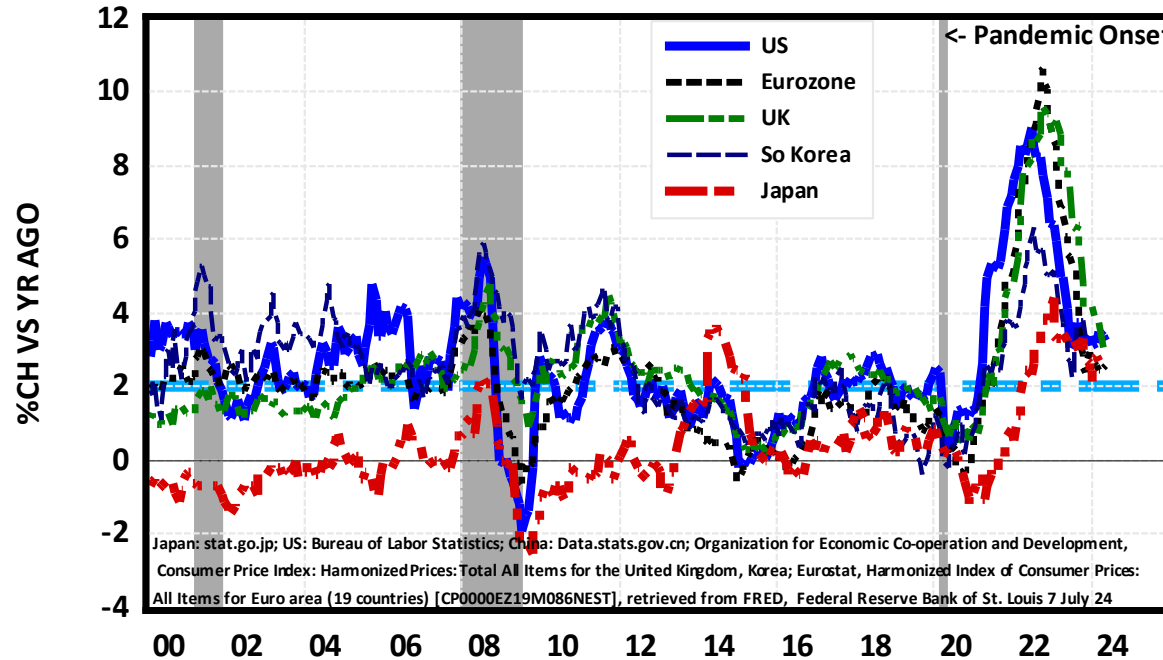
CPI Inflation



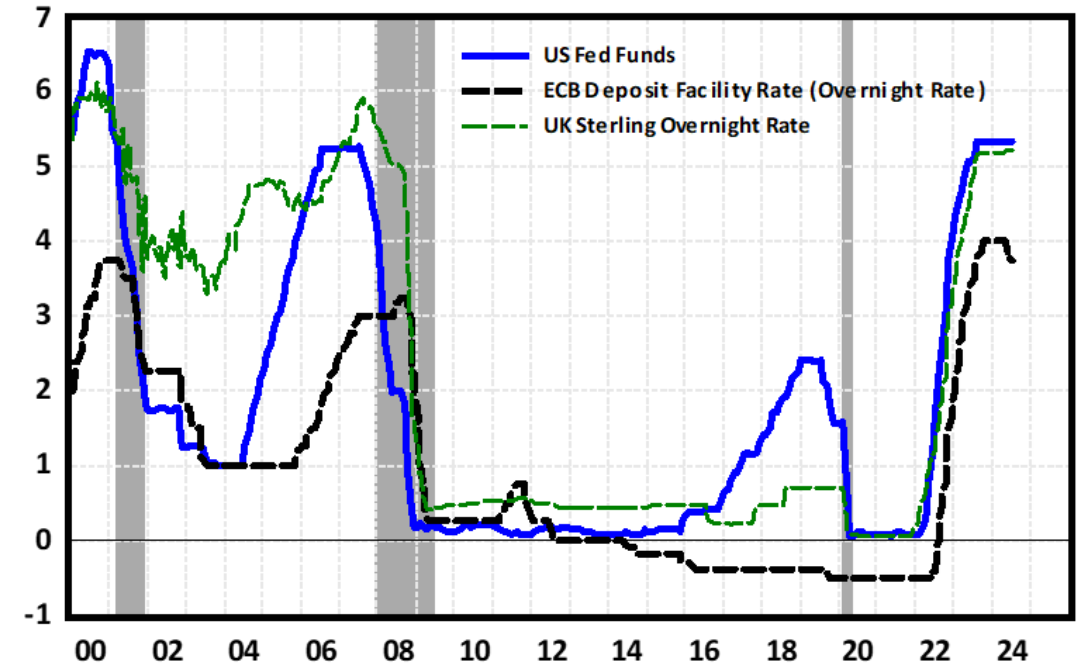
Inflation, temporarily twice its worst rates in previous 25 years, dropped in response to policy and to supply chain improvement. It is still higher than most central bank targets, especially in the U.S.

Inflation and Policy Interest Rates Key Economic Factors

CPI Inflation



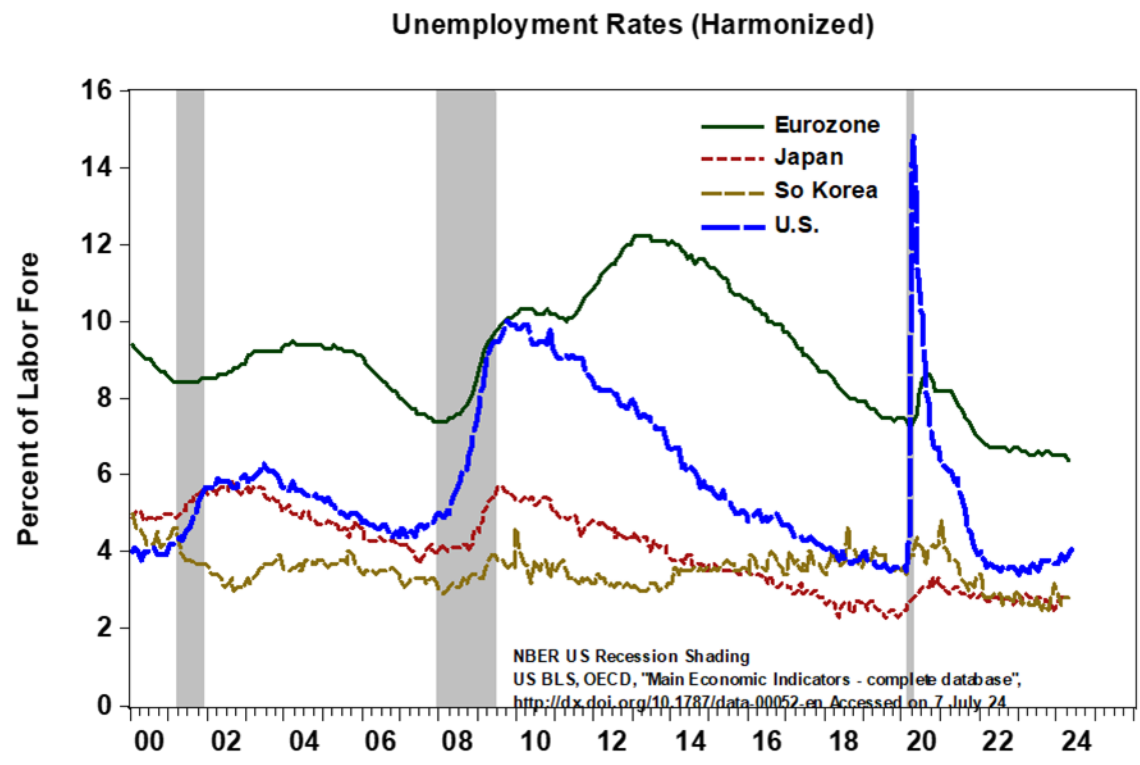
Overnight Interest (Policy) Rates



Inflation, temporarily twice its worst rates in previous 25 years, dropped in response to policy and to supply chain improvement. It is still higher than most central bank targets, especially in the U.S.

Key policy interest rates were raised to extreme levels, which helped lower inflation by damping demand. Only the ECB has begun to cut as of early July. Expect one to two cuts in US and ECB for remainder of year.

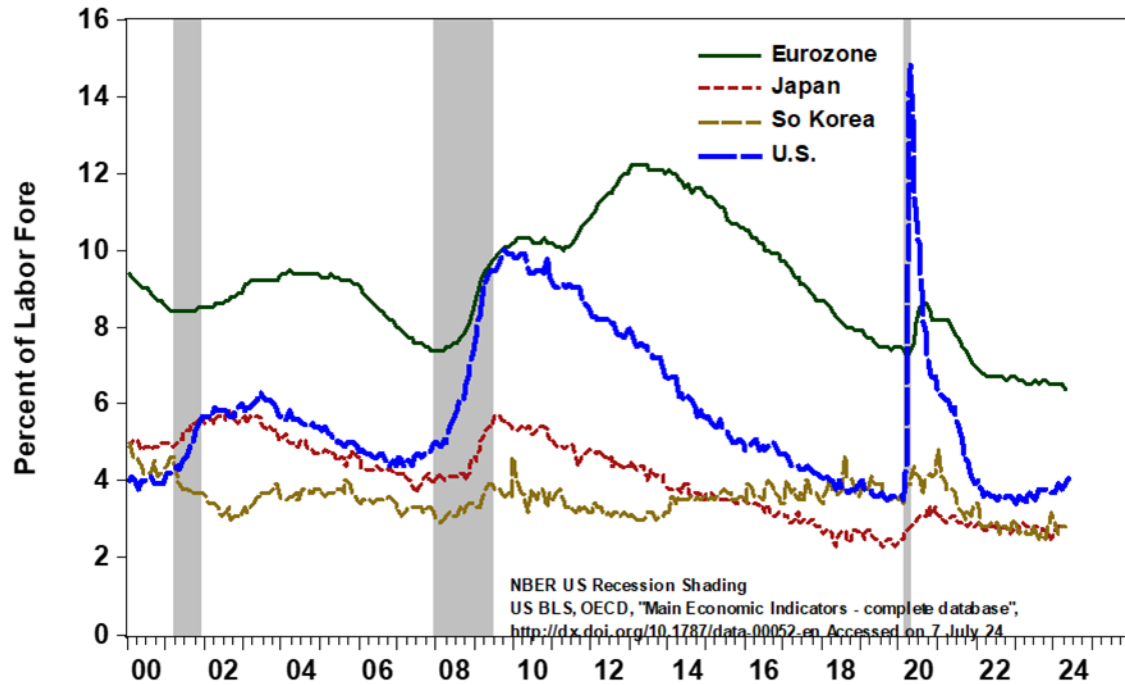
Consumer Spends as Long as Jobs Available



Pandemic labor distortions most severe in U.S.; A risk to the global soft landing scenario: the gentle uptrend in unemployment deteriorates rapidly as it did in 2001 and 2008-09.

Consumer Spends as Long as Jobs Available

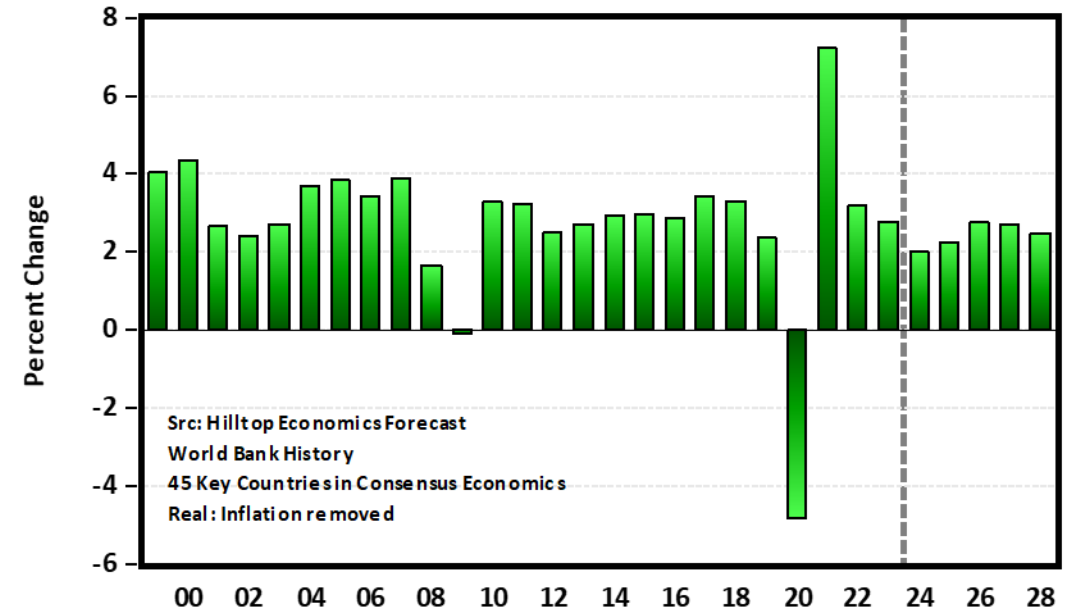
Unemployment Rates (Harmonized)



Pandemic labor distortions most severe in U.S.; A risk to the global soft landing scenario: the gentle uptrend in unemployment deteriorates rapidly as it did in 2001 and 2008-09.

World Real Consumer Growth

23: +2.7% 24: +2.0% 25: +2.2% 26: +2.8%

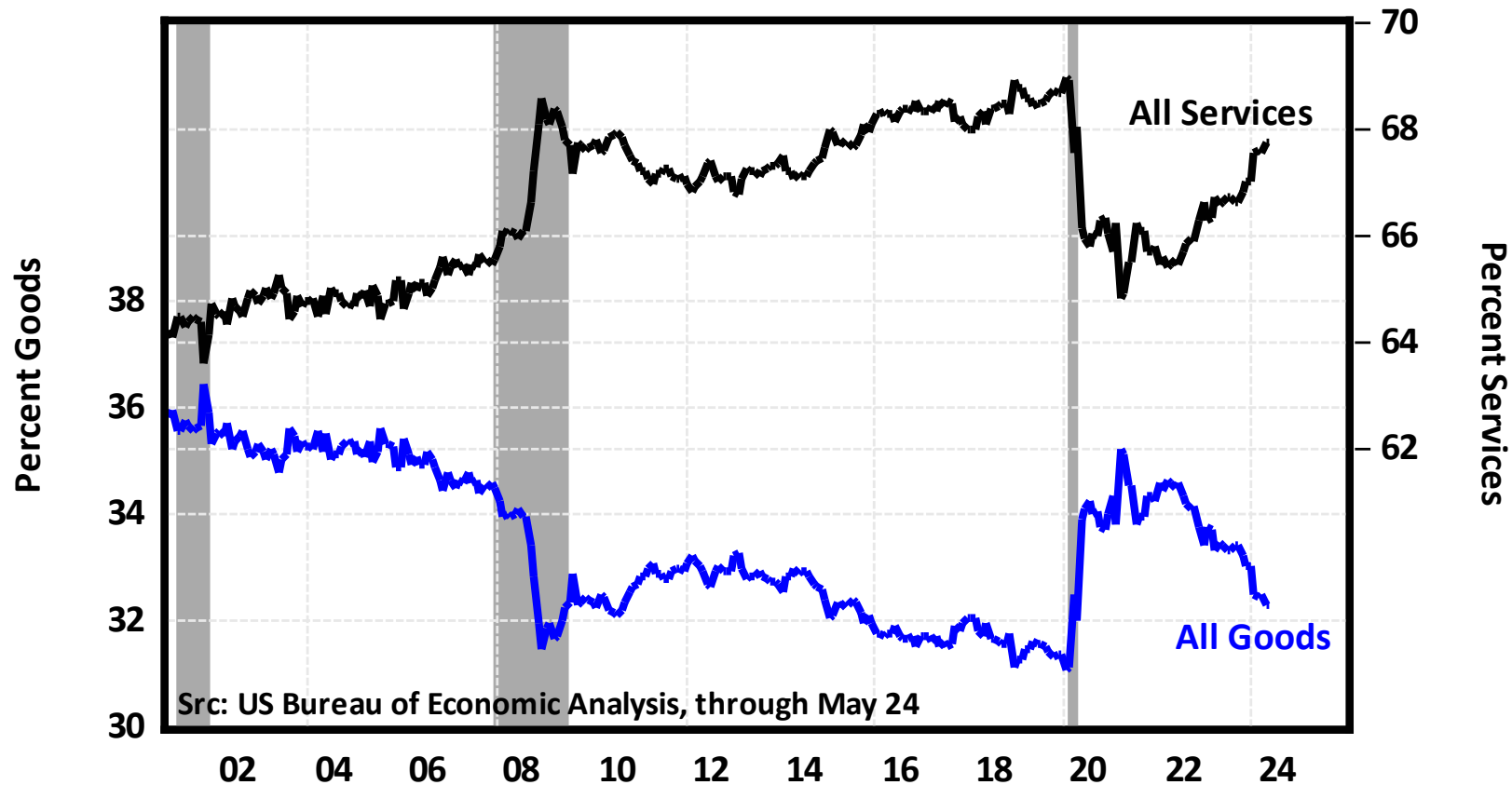


Spending growth outlook: as long as unemployment doesn't soar sharply upward, spending growth weakens like 2001-2002 cycle, but does not decline like financial crisis or pandemic.

Consumer Spending Important; What They Buy is More Important

Pandemic distorted purchasing patterns; recovery approaches historical patterns late 2025

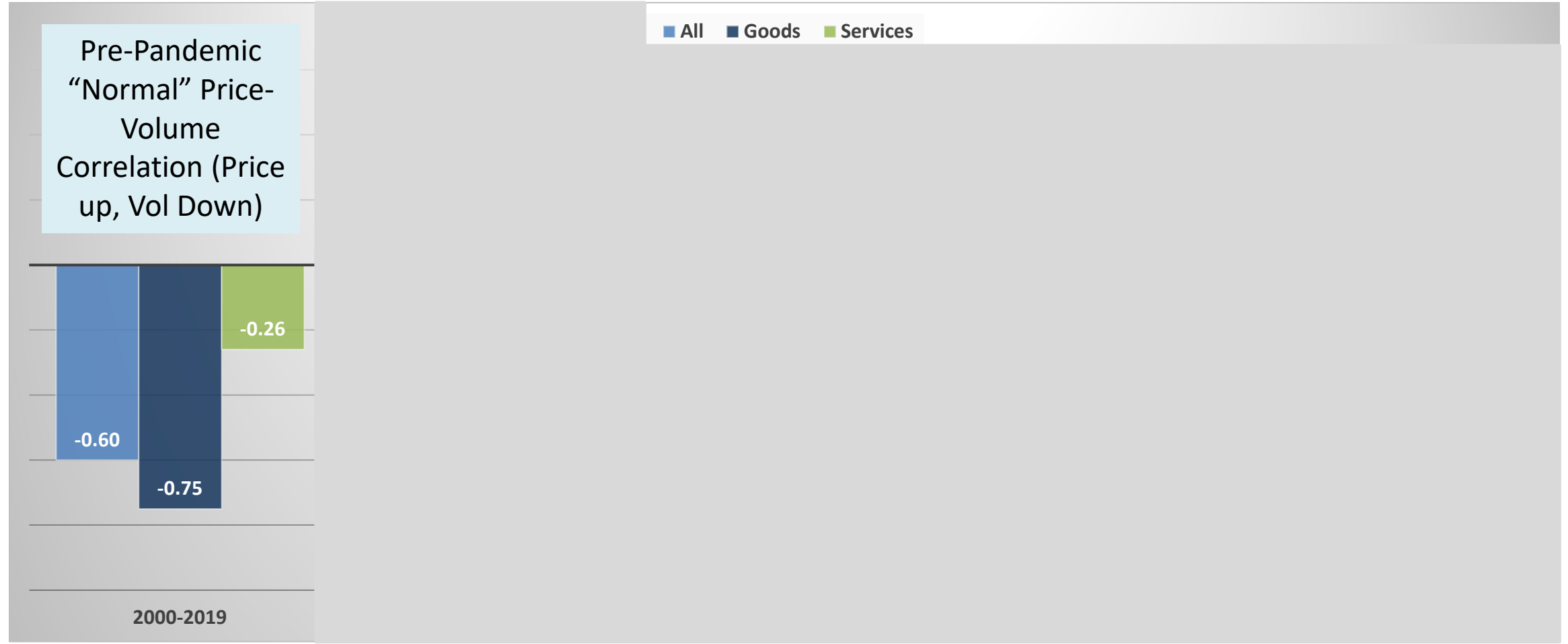
Services vs Goods (Nondurable & Durable)



Src: US Bureau of Economic Analysis, through May 24

U.S. Consumer Price-Volume Relationships Still Distorted

Correlation between Price and Volume changes in 215 separate consumer spending categories
Services causing most of the issue; still more positive relationships between price increases and volume increases



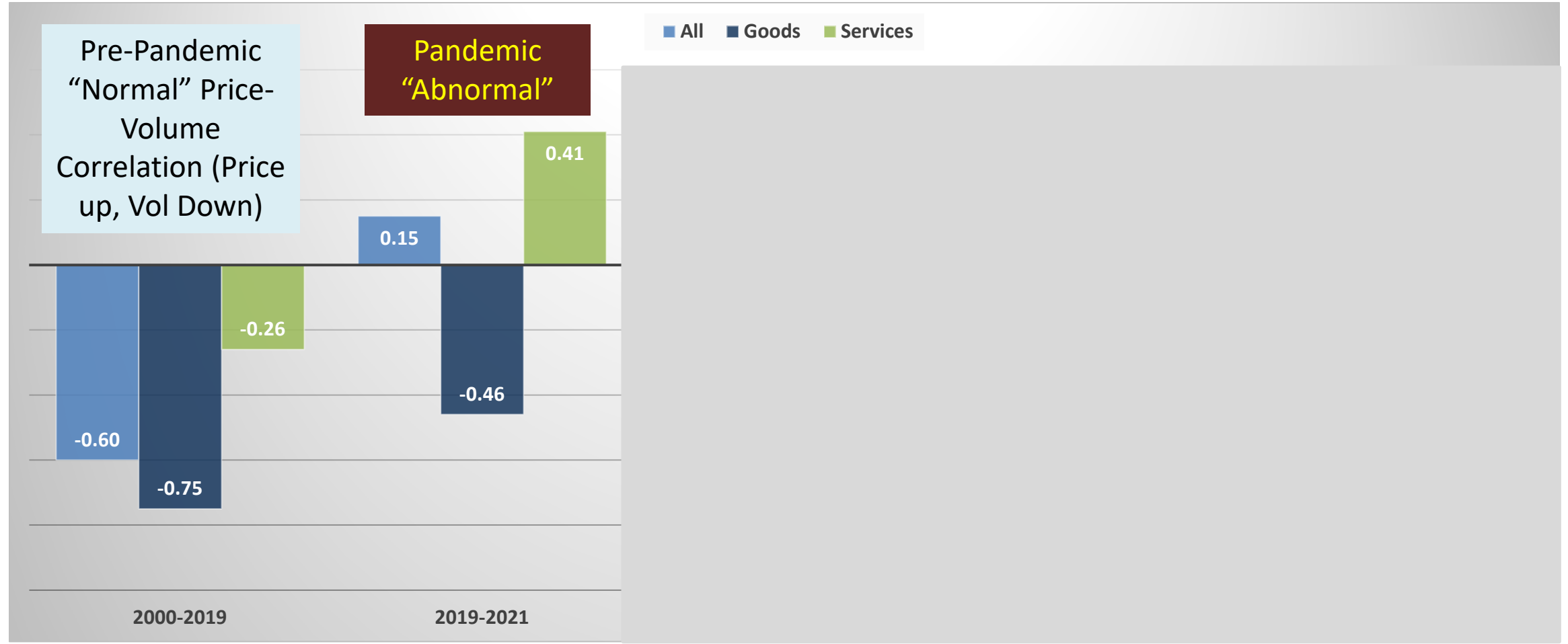
Src: Hilltop Economics Consumer Study May 24; BEA Underlying Detail tables 244, 245, excludes NPISHs

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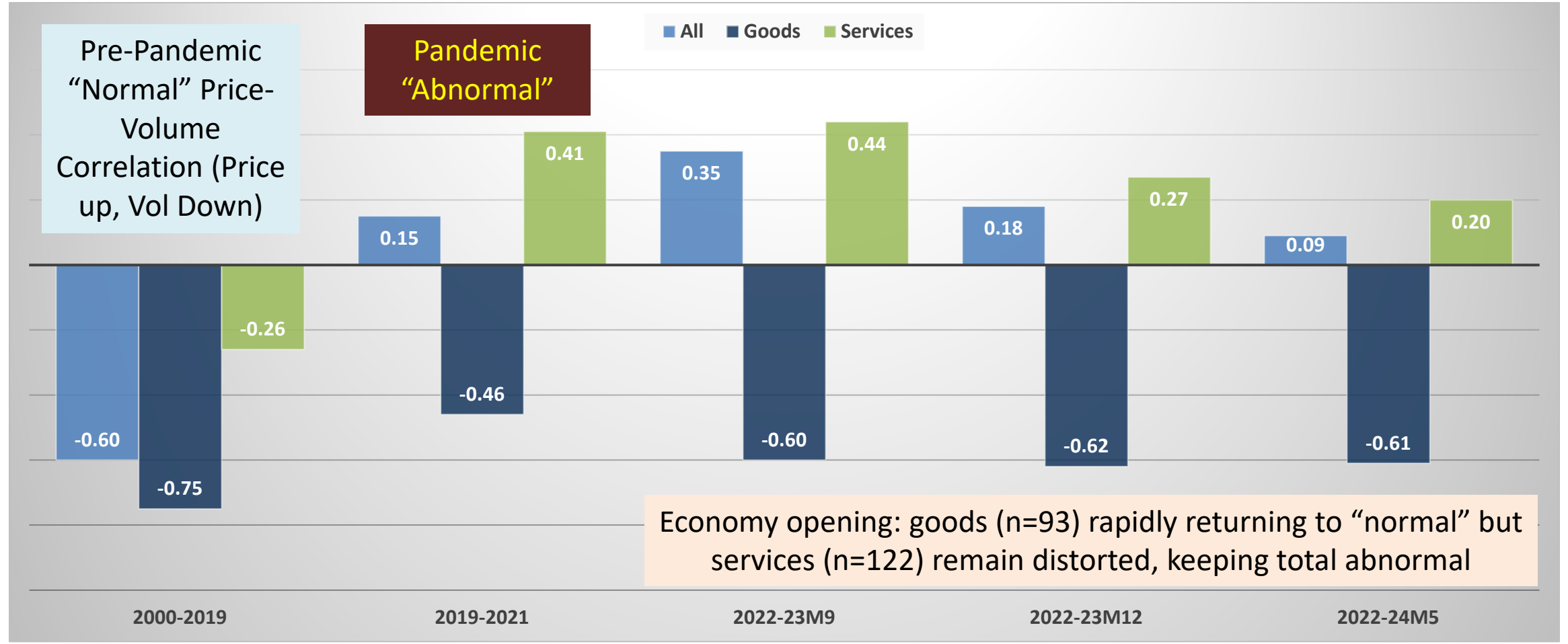
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U.S. Consumer Price-Volume Relationships Still Distorted

Correlation between Price and Volume changes in 215 separate consumer spending categories
 Services causing most of the issue; still more positive relationships between price increases and volume increases



Economy opening: goods (n=93) rapidly returning to “normal” but services (n=122) remain distorted, keeping total abnormal

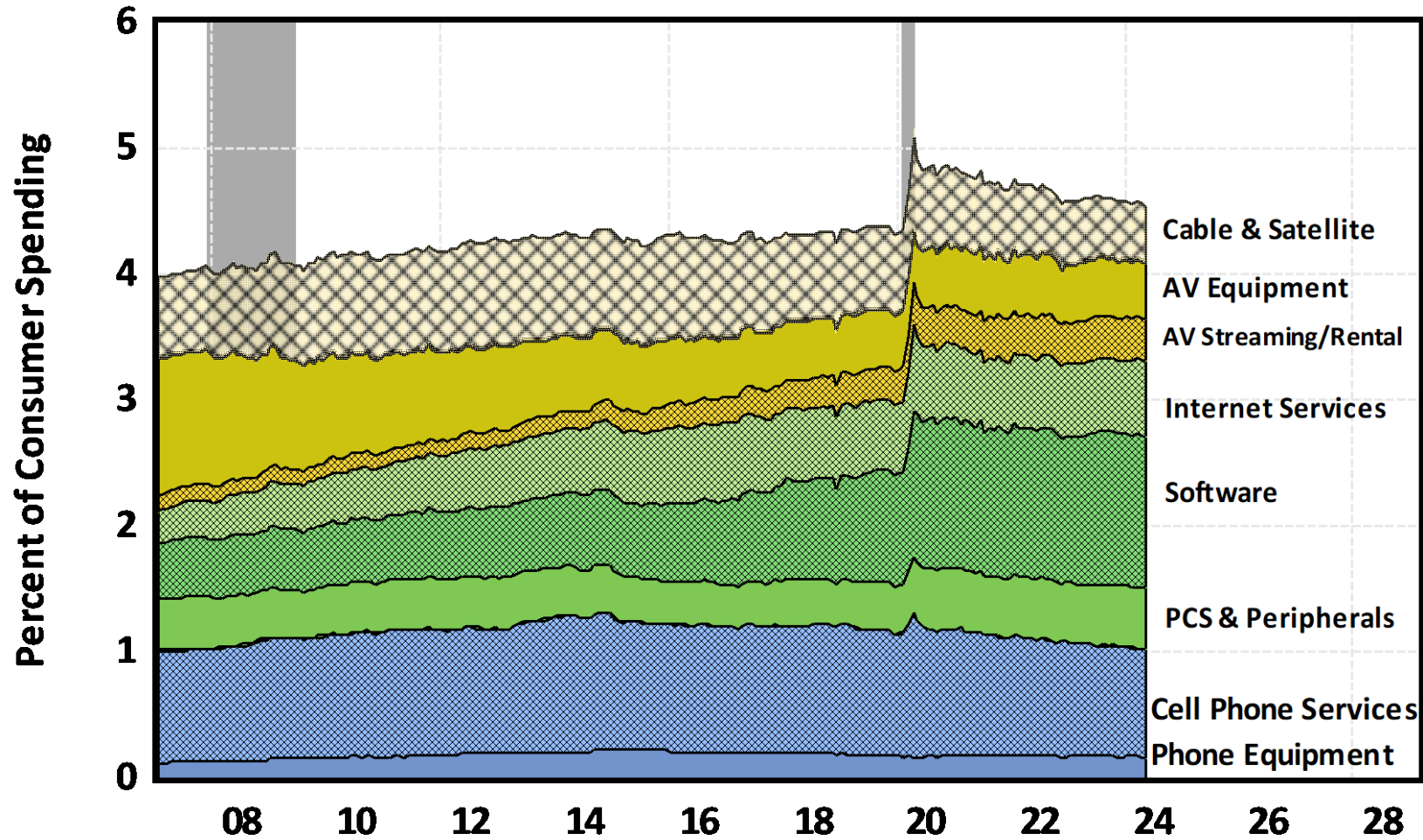
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Consumer Spending Important; What They Buy is More Important

Total Tech Spending Down from Peak but above pre-pandemic share



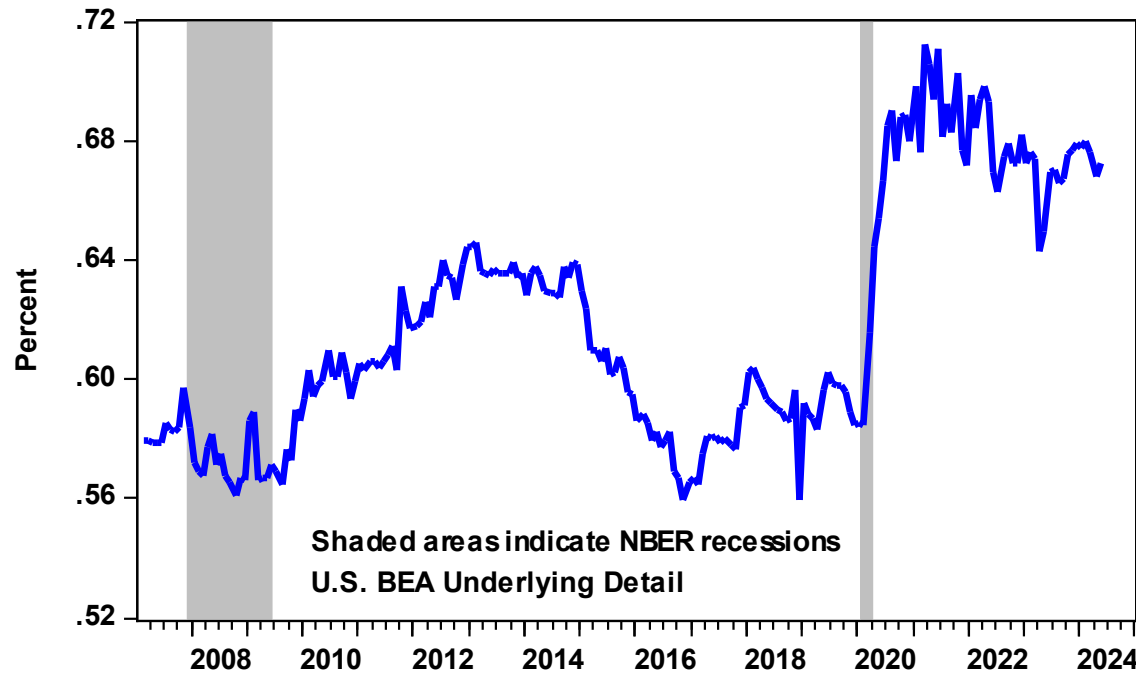
Consumers Spending: Detailed Tech Categories

Goods (PCs, Phones, A/V) "normal"; Services still mixed (Internet vs Cell Phone Svc)

Key semiconductor markets getting a declining share of consumer total spending, as prices continue to fall (propping up volume). Only PCs retained share of spend in Jan 22 - May 24 period.

Post-pandemic period: tech goods spending supported by aggressive price declines to sustain volume growth.

Share of U.S. Consumption Spent on Technology Goods



Percent Change Annual Rate	Price	Volume
All Consumption	3.5	2.2
Phones	-12.5	18.5
TVs	-10.5	15.9
PCs	-4.2	10.8
Cell Phone Svc	-4.3	5.9
Internet Svc	3.8	3.8
Video Streaming	3.9	1.9
Cable & Satellite	4.7	-8.8

41 categories declining, 175 rising in price. Cell phones declining in price the most of all 216 subcategories; TV/AV the next fastest declining category. All Tech Goods as a category showing the most rapid decline in price. Price and volume measured as trendline growth percent per year rates of change Jan 22-May24

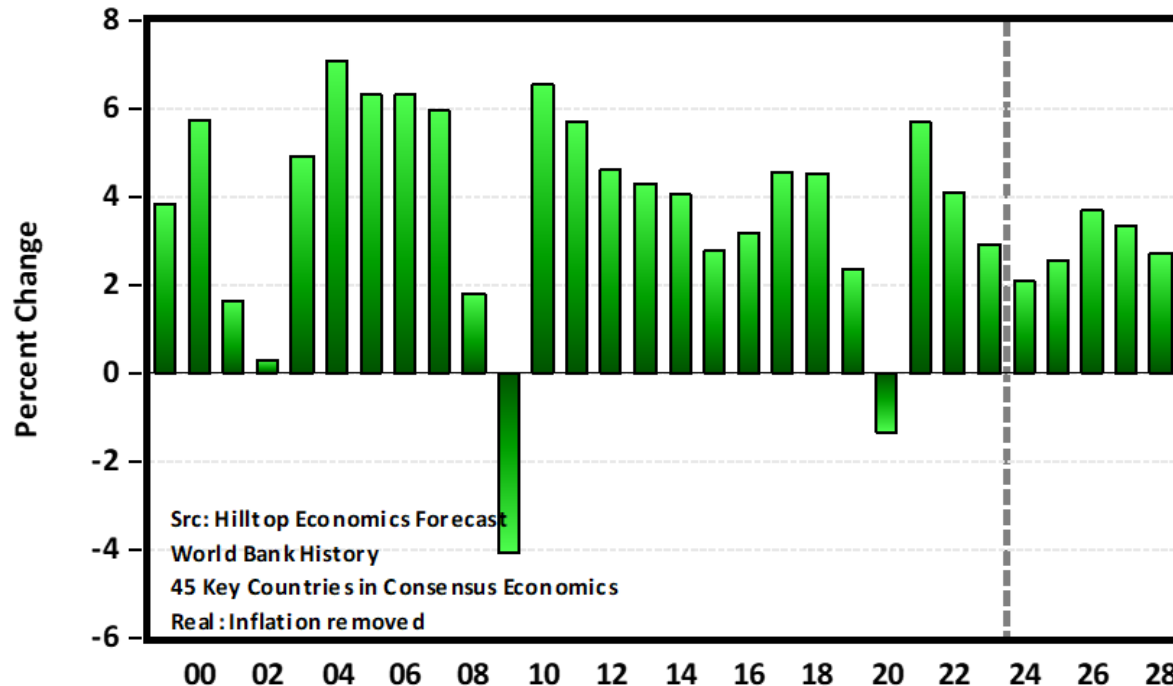
Consumers

- **Slower growth in aggregate consumer spending**
- **Preferences for all goods & services continue to return to “normal” over the next one year**
- **Demand for tech goods & services continues to move back to “normal” from pandemic-high of 5% to about 4¼% of total spending for US consumers.**
- **Final demand for key tech GOODS as a share of consumer spending may continue to slide a little, although product volumes increase as prices continue to fall relative to other goods and services, a net positive for semiconductors.**

Private Sector Investment Grows in Soft Landing

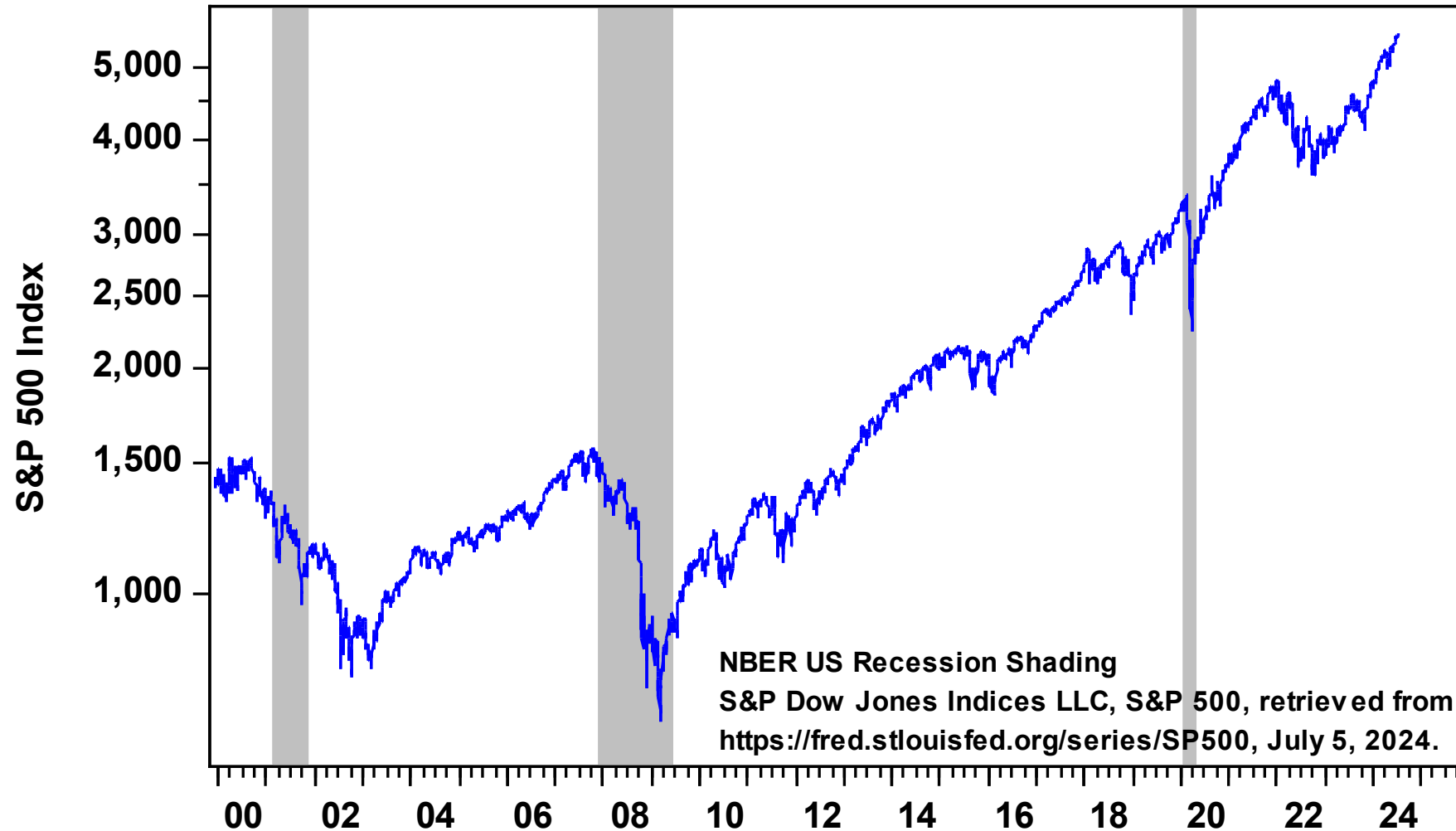
But Trend Outlook Weaker Than Pre-Pandemic Period

World Real Investment Growth
 23: +2.9% 24: +2.1% 25: +2.6% 26: +3.7%



- Revenue growth challenges (demand growing more slowly, pricing becoming more difficult)
- Uncertainty: increased risk aversion
 - Politics; greater interference in investment decisions
 - International cross-border relations (wars; immigration; “rules & behavior” organizations e.g. IMF, WTO, World Bank, UN receding influence; less contract enforcement; tariffs)
- Profitability: slower gains
 - productivity lower, anticipating improvement
 - labor costs higher
 - inflation less of a factor
- Capital costs: increasing challenge
 - Interest rates higher
 - Govt financing needs greater (potential crowding out)

Stock Prices Reflect Investor Optimism



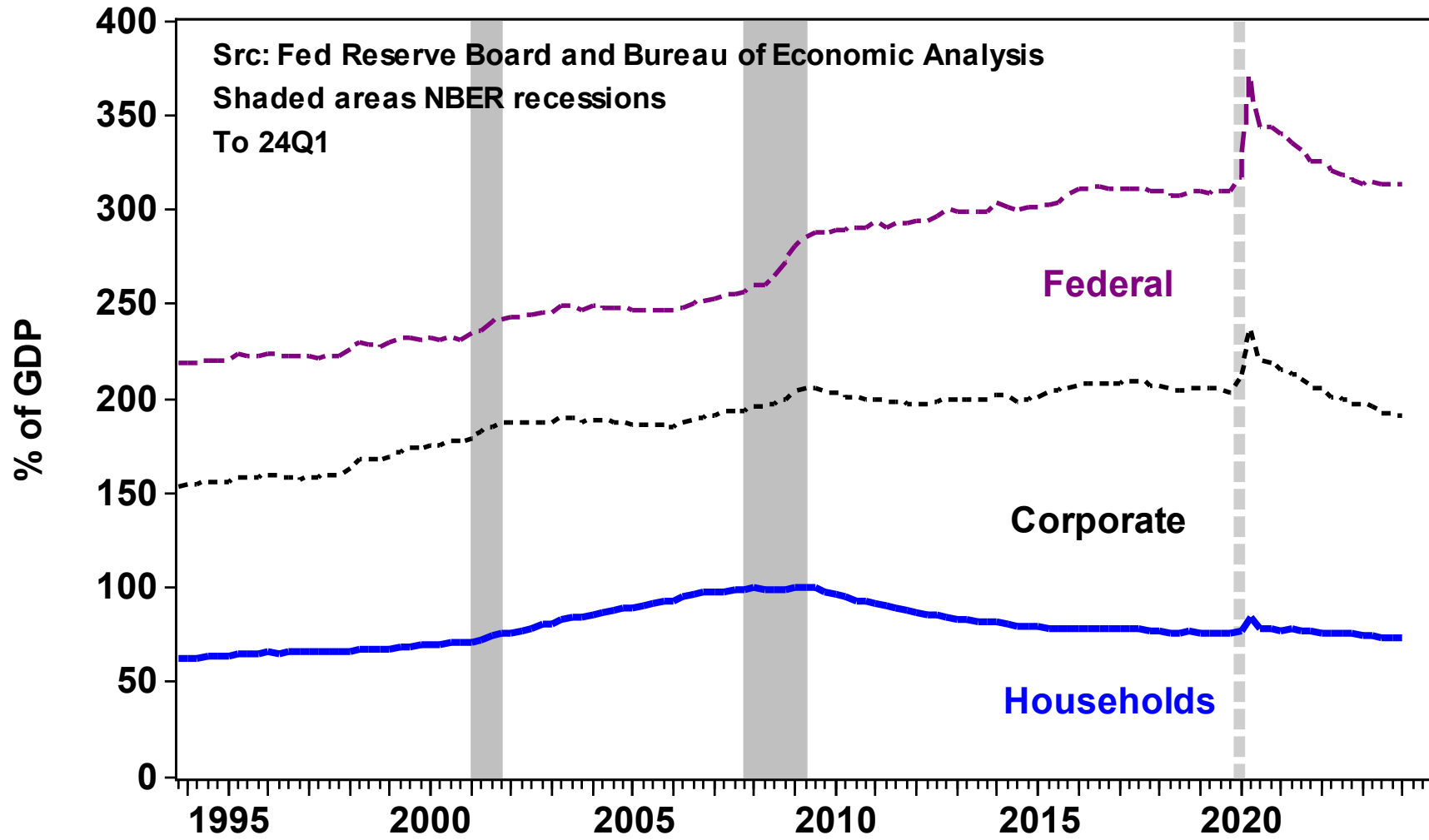
Stock market anticipates:

- *interest rate cuts,*
- *plenty of available financial capital,*
- *healthy profit growth (productivity),*
- *no serious changes to geopolitical and international relations arrangements.*

Many economists (like me) are a bit less optimistic about the overall investment picture.

Total Debt Needs Down Since Pandemic in the US

Debt By Major Sector - U.S.



...But Governments Need More Financing Since the Pandemic

A US Deficit of 6.5% represents a \$1.8+ Trillion financing need

FISCAL MONITOR: FISCAL POLICY IN THE GREAT ELECTION YEAR

Table 1.1. General Government Fiscal Balance, 2019–29: Overall Balance
(Percent of GDP, unless noted otherwise)

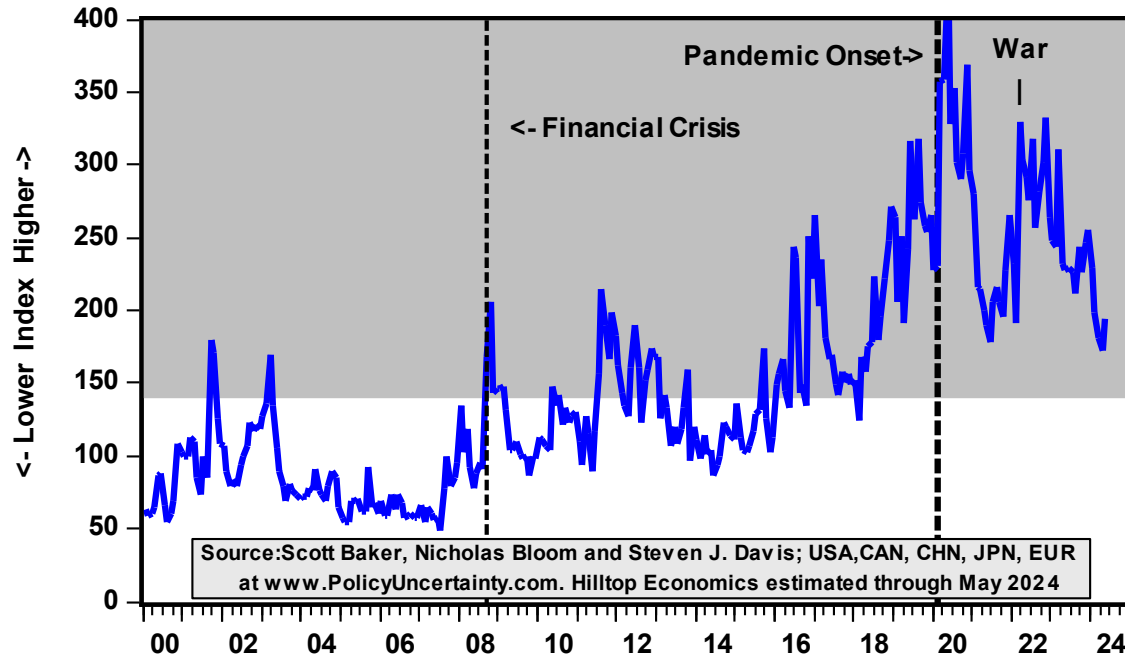
	2019	2020	2021	2022	2023	Projections			
						2024	2025	2026	2027
World	-3.6	-9.5	-6.3	-3.9	-5.5	-4.9	-4.7	-4.5	-4.4
Advanced Economies	-3.0	-10.2	-7.2	-3.1	-5.6	-4.4	-4.2	-3.9	-3.8
Advanced Economies excl. US	-1.1	-7.6	-4.4	-2.4	-3.0	-2.7	-2.0	-1.8	-1.7
Canada	0.0	-10.9	-2.9	0.1	-0.6	-1.1	-0.9	-0.7	-0.7
Euro Area	-0.6	-7.0	-5.2	-3.7	-3.5	-2.9	-2.6	-2.5	-2.4
France	-3.1	-9.0	-6.5	-4.8	-5.5	-4.9	-4.9	-4.4	-4.3
Germany	1.5	-4.3	-3.6	-2.5	-2.1	-1.5	-1.3	-0.9	-0.7
Italy	-1.5	-9.4	-8.7	-8.6	-7.2	-4.6	-3.2	-3.0	-2.9
Spain ¹	-3.1	-10.1	-6.7	-4.7	-3.6	-3.1	-3.0	-3.2	-3.3
Japan	-3.0	-9.1	-6.1	-4.4	-5.8	-6.5	-3.2	-2.9	-3.1
United Kingdom	-2.5	-13.1	-7.9	-4.7	-6.0	-4.6	-3.7	-3.7	-3.6
United States ²	-5.8	-13.9	-11.1	-4.1	-8.8	-6.5	-7.1	-6.6	-6.2
Other Advanced Economies	-0.1	-4.8	-1.1	0.8	-0.1	0.0	0.2	0.4	0.5
Emerging Market and Developing Economies	-4.4	-8.5	-5.0	-4.9	-5.4	-5.5	-5.3	-5.2	-5.1
Emerging Market and Middle-Income Economies	-4.4	-8.7	-5.0	-4.9	-5.5	-5.6	-5.4	-5.3	-5.2
Emerging Markets excl. China	-3.2	-7.8	-4.0	-2.8	-4.2	-4.3	-3.7	-3.4	-3.3
Excluding MENA Oil Producers	-4.6	-8.8	-5.3	-5.7	-6.0	-6.1	-5.8	-5.7	-5.6
Asia	-5.7	-9.6	-6.3	-7.2	-6.7	-6.9	-7.0	-7.1	-7.0
China ³	-6.1	-9.7	-6.0	-7.5	-7.1	-7.4	-7.6	-7.8	-7.8
India	-7.7	-12.9	-8.6	-9.2	-8.6	-7.8	-7.6	-7.3	-7.0
Vietnam	-0.4	-2.9	-1.4	0.3	-1.6	-2.4	-2.4	-2.5	-2.5

Table 1.2. General Government Debt, 2019–29
(Percent of GDP)

	2019	2020	2021	2022	2023	Projections			
						2024	2025	2026	2027
Gross Debt									
World¹	84.2	99.4	94.7	91.3	93.2	93.8	95.1	96.3	97.1
Advanced Economies	103.9	122.4	116.2	111.2	111.0	111.2	112.4	113.4	114.0
Advanced Economies excl. US	100.9	115.6	110.0	104.2	102.0	101.3	100.9	100.7	100.3
Canada ²	90.2	118.2	113.5	107.4	107.1	104.7	102.1	100.2	98.6
Euro Area	84.1	97.2	94.7	90.8	88.6	88.7	88.3	88.2	87.9
France	97.4	114.7	113.0	111.8	110.6	111.6	112.8	113.4	114.1
Germany	59.6	68.8	69.0	66.1	64.3	63.7	62.3	61.0	59.8
Italy	134.2	154.9	147.1	140.5	137.3	139.2	140.4	142.6	143.1
Spain	98.2	120.3	116.8	111.6	107.5	106.3	104.9	105.0	105.1
Japan	236.4	258.3	253.9	257.2	252.4	254.6	252.6	251.3	251.0
United Kingdom	85.7	105.8	105.2	100.4	101.1	104.3	106.4	107.3	108.3
United States ²	108.1	132.0	125.0	120.0	122.1	123.3	126.6	128.9	130.7
Emerging Market and Developing Economies	55.0	64.6	63.9	64.0	68.0	69.4	71.3	73.3	75.0
Emerging Market and Middle-Income Economies	55.7	65.5	64.7	64.8	68.9	70.3	72.5	74.6	76.5
Emerging Markets excl. China	52.1	61.5	58.4	55.0	57.7	56.7	57.0	57.3	57.5
Excluding MENA Oil Producers	57.3	67.0	66.5	67.4	71.7	73.2	75.5	77.7	79.6
Asia	59.5	69.7	70.9	74.2	79.0	82.4	85.4	88.2	90.9
China ³	60.4	70.1	71.8	77.1	83.6	88.6	93.0	97.5	101.8
India	75.0	88.4	83.5	81.7	82.7	82.5	81.8	80.9	79.9
Vietnam	40.8	41.1	39.0	34.6	34.0	33.5	32.9	32.6	32.4

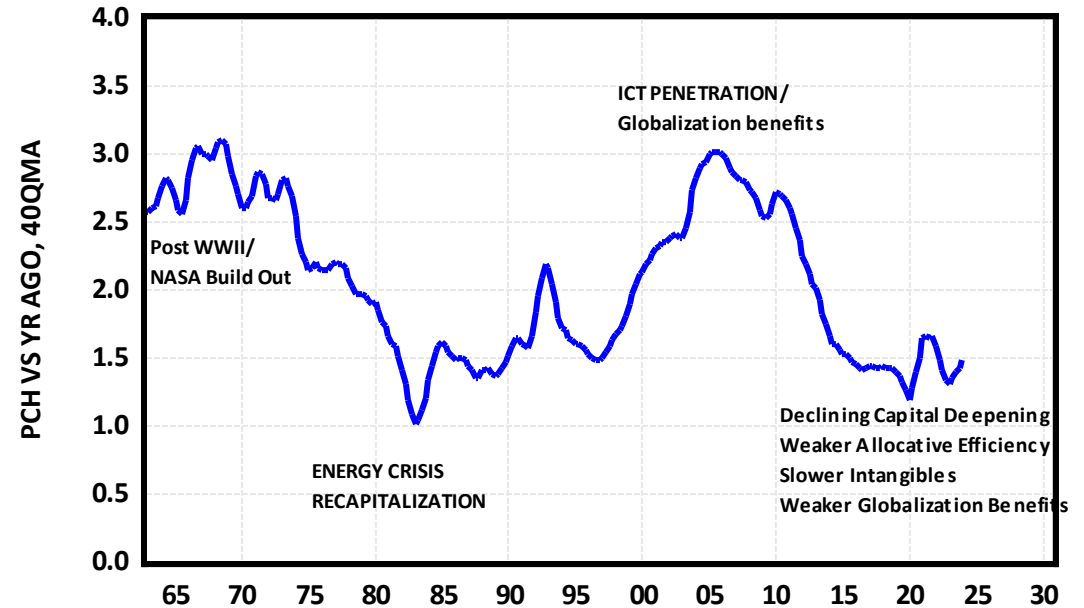
Key Risks to Investment Outlook

Global Economic Policy Uncertainty



Current outlook assumes policy uncertainty (fiscal, monetary and international) continues to trend lower. Lower uncertainty coincides with stronger investment. Risk: any increased conflicts, any further deterioration or reversal in rules-based policy-making or rules-based international relationships.

Labor Productivity (US)

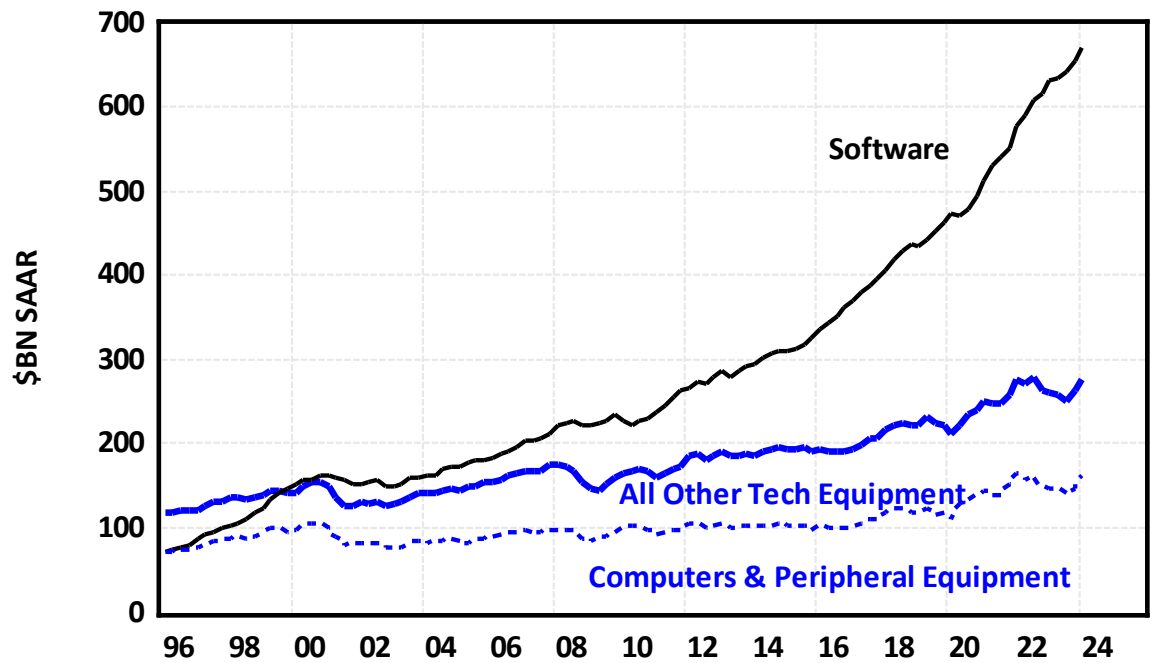


Current outlook assumes productivity trends higher as investment growth offsets higher labor costs, weaker demographics, and greater cross-border friction to produce higher profitability. Risk: productivity languishes, profitability slides, investment then stagnates.

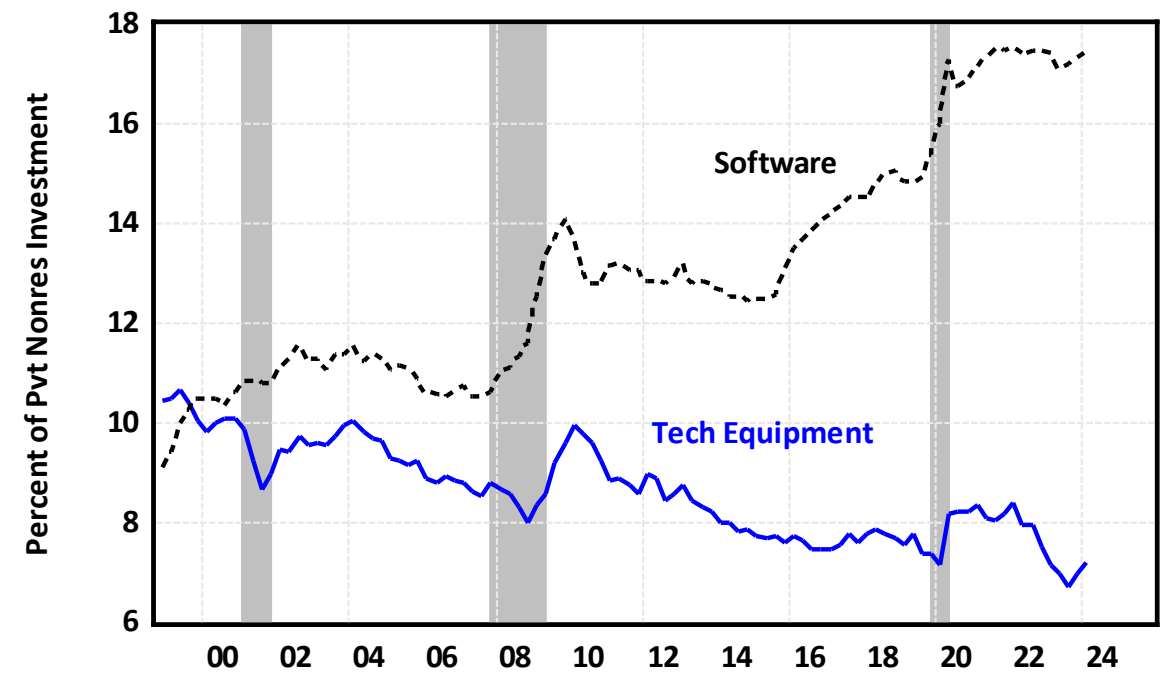
Tech Investment by Business

Software driven by AI; Tech goods reverted to pre-pandemic share;

Total Tech: 25% of Private Nonresidential Fixed Investment. Computer spending ticked up in 24Q1 as AI and datacenter beginning to show in macro-investment data.



Tech Equipment: Long-run downward share broken for three years by pandemic, but now back on downtrend. Note: BEA includes embedded software in equipment measures, not separately as software.



AI & Related Investment Needs

Surging AI-related investment occurring in an era when overall private investment squeezed

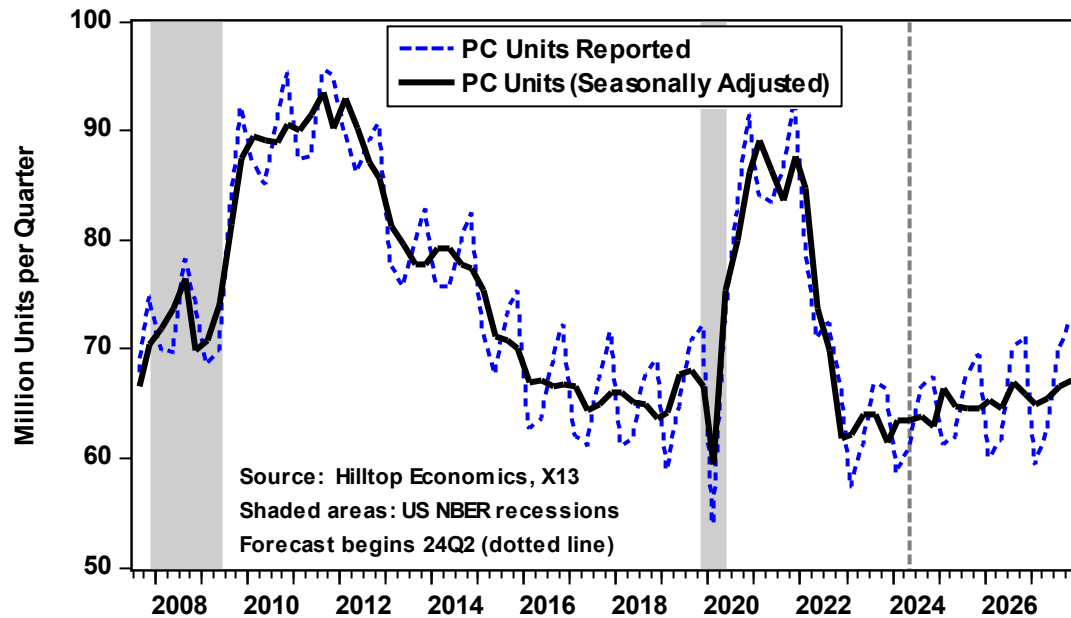
- New Fabs
 - SIA: \$2.3 Trillion for new fabs to 2030 (p11 Emerging Resilience in the Semiconductor Supply Chain, May 2024)
 - McKinsey: \$4-\$6 Trillion CAPEX needed (including energy for Data Centers) by 2030 (McKinsey)
- New Software Investments
 - Meta+Google+Microsoft+Amazon: ~\$180Bn/year CAPEX currently
 - VC firms: ~\$200-225 bn annual rate, with large focus on AI (per Bloomberg 7-3-24)
 - AI software-models expensive and returns as yet not sufficient (scale required if an AI model is to become profitable; but costs are declining and opportunity costs of NOT adopting rising within industries)
- New Power
 - Forecasts suggest data center power demand 8-10% of global electricity consumption by 2030 (*McKinsey GenAI – the next S-curve for the semiconductor industry; June 18th 2024*).
 - After just 0.2%/yr growth 2008-2023, electricity demand in US grows about ~2.5%/Yr for the next 15 year (Goldman Sachs). Almost 1%/Yr just due to datacenters and 0.6%/yr due to transportation (EV) needs.
 - Current US electricity investment is \$162 BN, or roughly 4% of nonresidential investment of \$3.8 Trillion (2024Q1 annual rate US BEA). Goldman estimates an additional \$50BN needed through 2030

Macro Implications for Key Semiconductor Markets

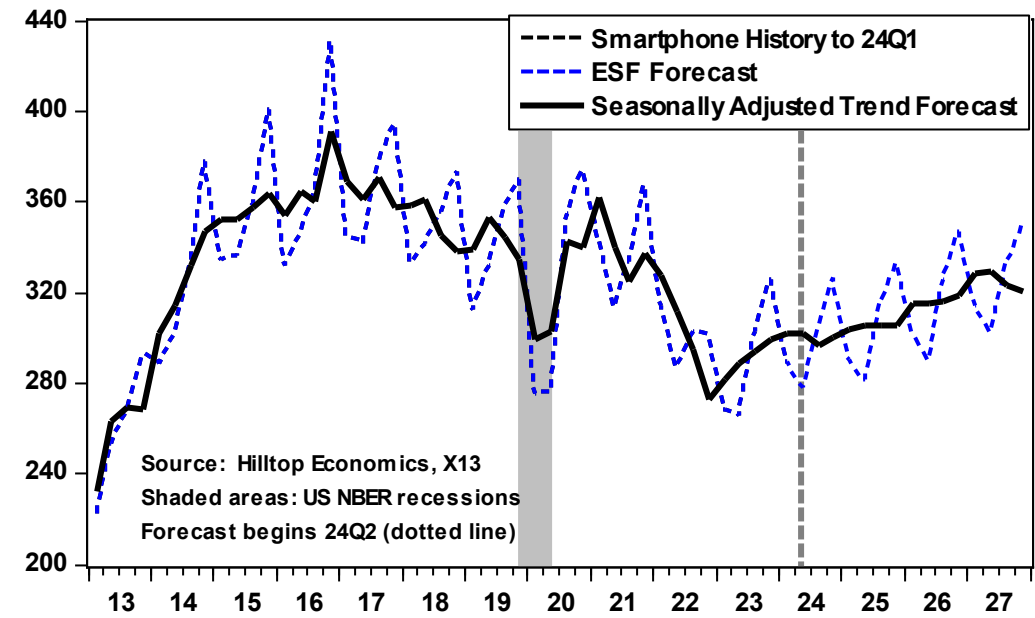
Sales stable, with a marginal upward trend. Business demand from edge AI a potential mixed driving force.

Price declines encourage replacement, but growth remains in low single digits.

Estimated Global PC Shipments



Estimated Global Smartphone Shipments

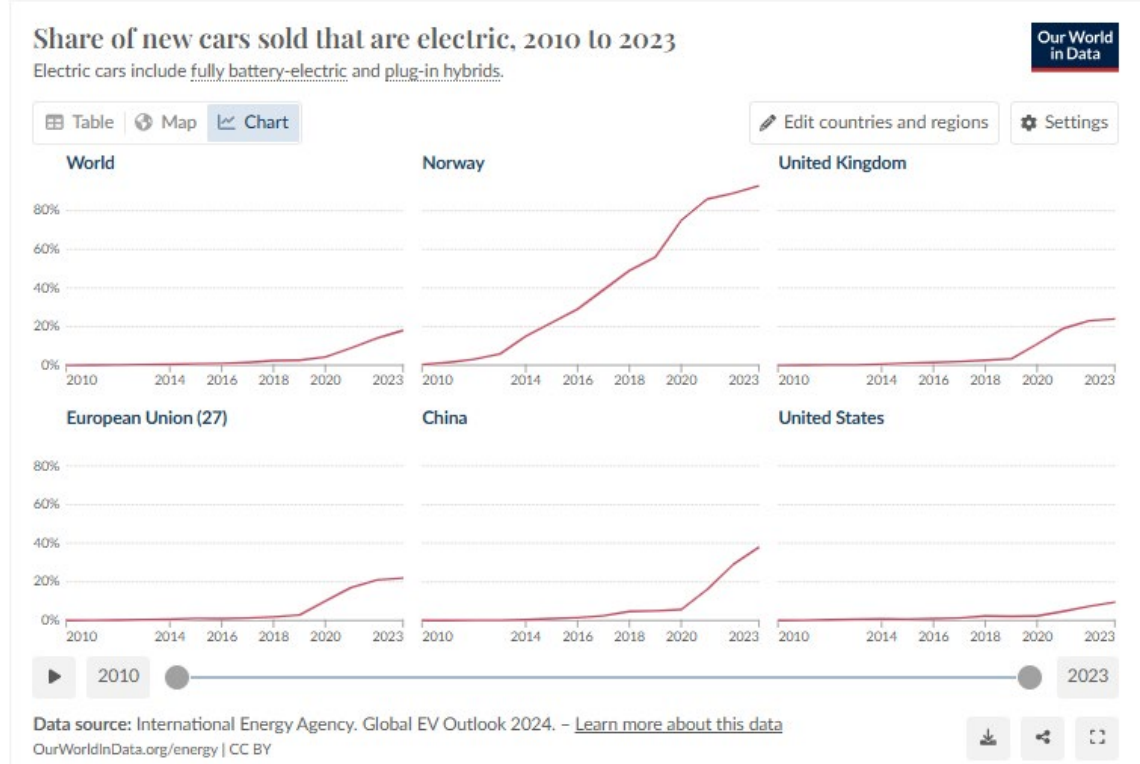
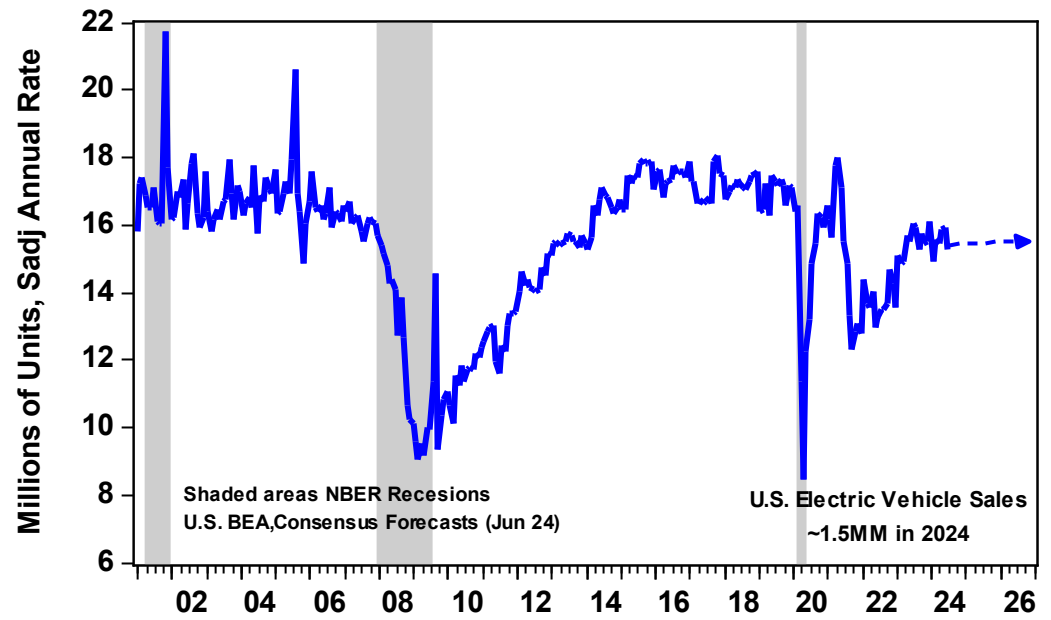


Light Vehicle Market Moves Sideways

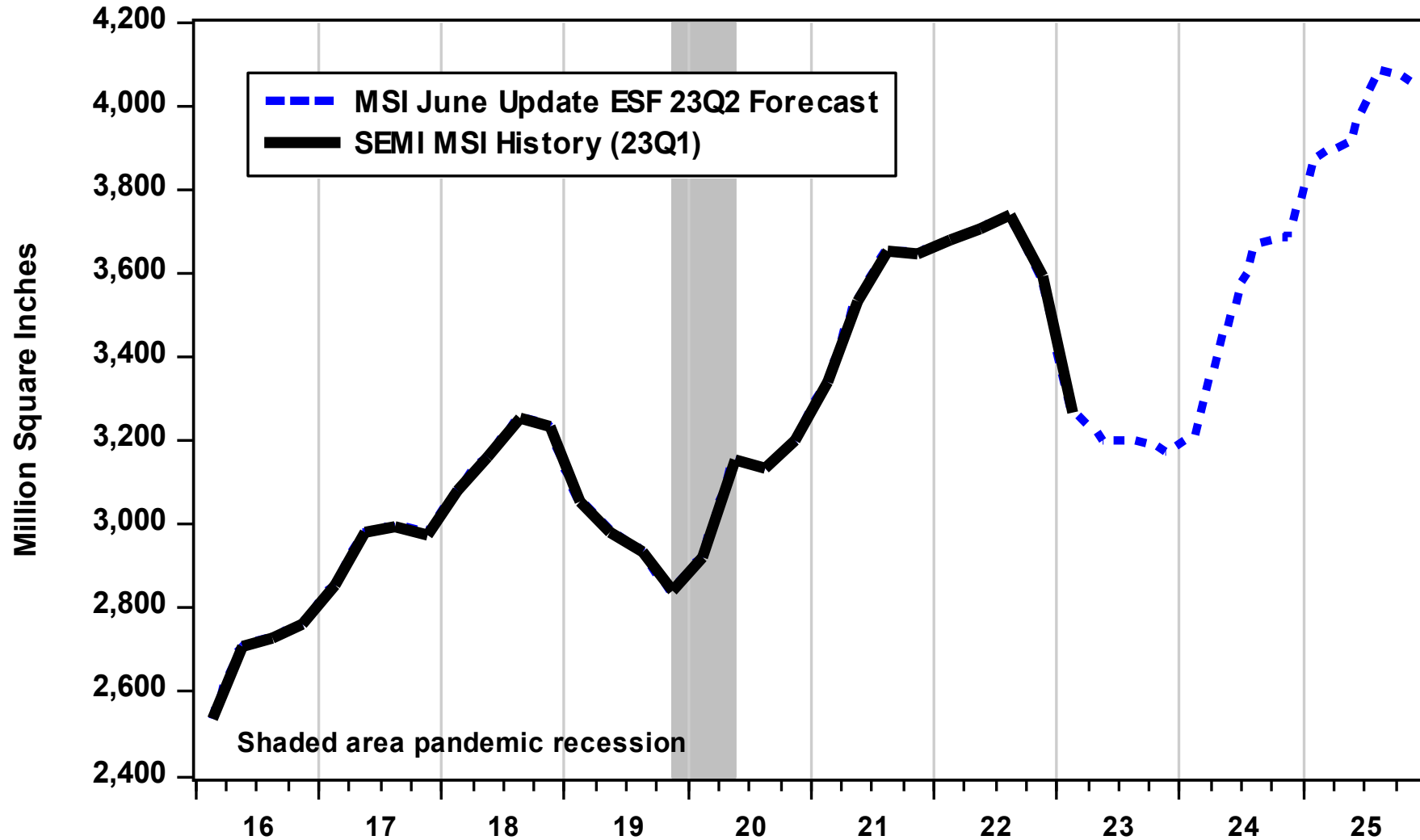
Job growth very modest, financing remains expensive, relative pricing favors small vehicles

Global Vehicle Sales: 90M in 2023 growing to 92M in 2024 (~2.5%) then 94M in 2025 (~2%); US: +0.5 in 2024 then +2.6% in 2025

Global EV share of sales rising from 20% in 23 to ~25% by 27. In US, dropped from 8% in 23Q3 to 7% in 24Q1

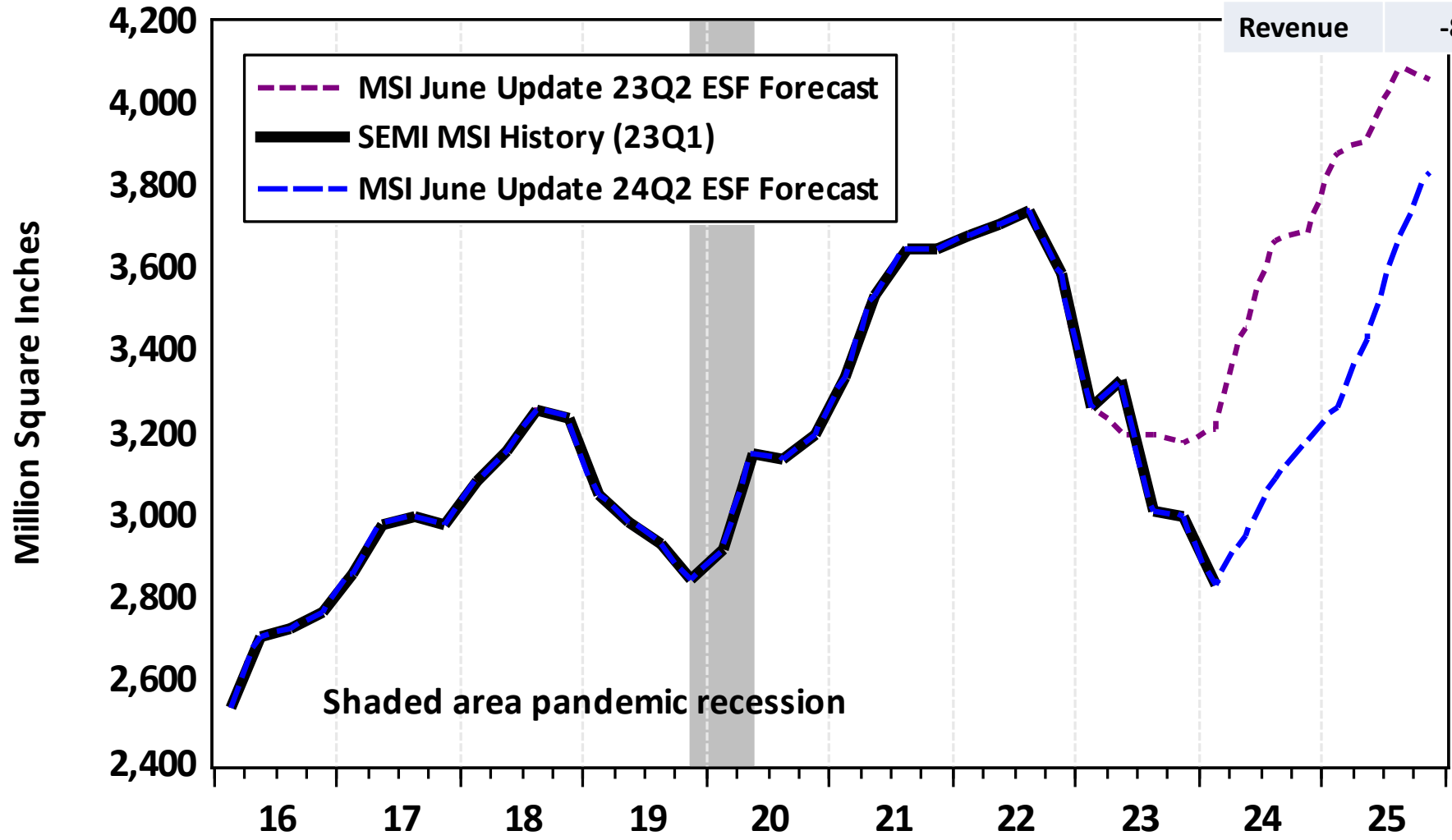


Semiconductor MSI Outlook



Semiconductor MSI Outlook

%Change	2023	2024	2025
MSI	-14.4	-4.3	17.7
Revenue	-8.2	11.8	8.8



2023 MSI: over-forecast
4qtrs 23Q2-24Q1 by 5.4%.

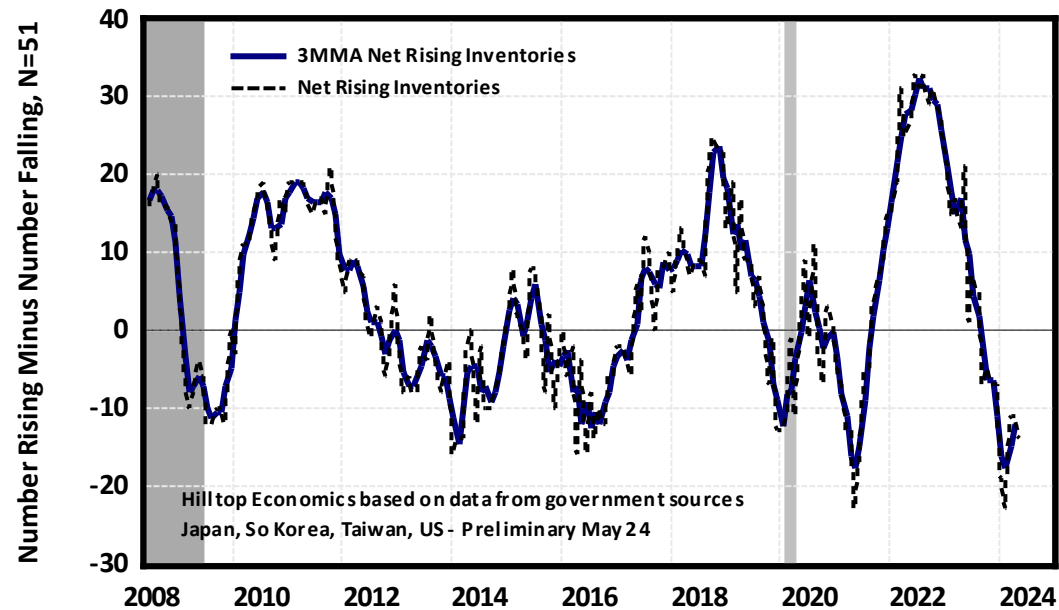
Error by qtr (%):
23Q2: -4.0
23Q3: +6.3
23Q4: +6.0
24q1: +13.4

Primary source of error:
underestimate of wafer
inventory cycle

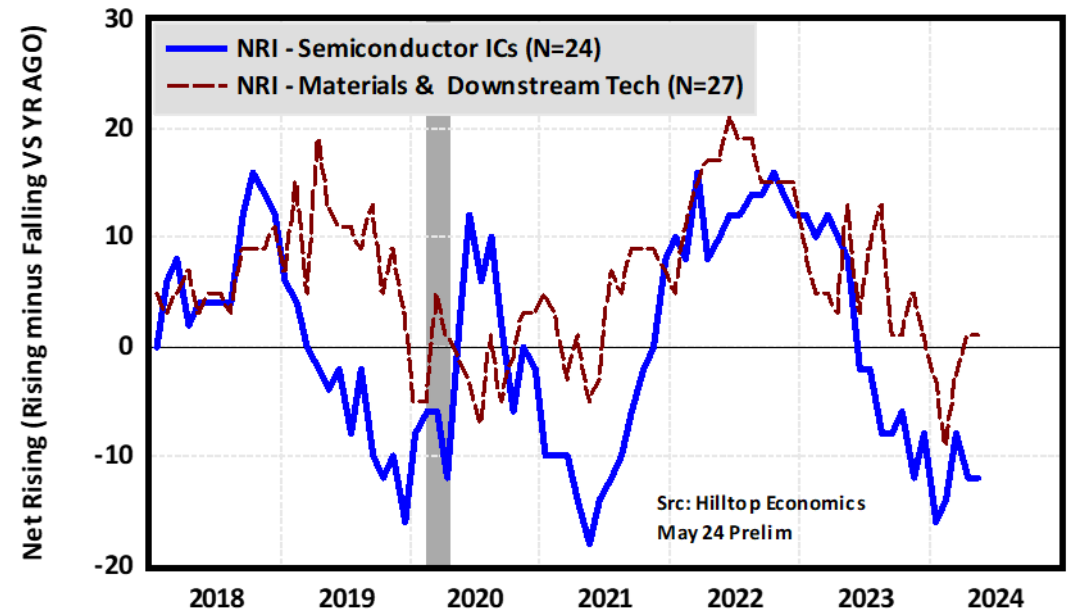
An Unusually Sharp Inventory Cycle (Pandemic Distortions)

Today: Downstream Inventory OK, Semiconductors Still Contracting

NET RISING INVENTORIES: Electronics & Semiconductors



Net Rising Inventories: ICs vs Products



2024 Summary: Slow Growth Economy (Soft Landing)

Inflation fight finally ends, but still a risk of recession

- **Inflation subsides to acceptable levels by late 2024/early 2025**
 - Demand patterns still altered by inflation and the residual from the Covid disruptions
 - Supply chains now close to normal (not a contributor to inflation any longer, but Red Sea risk remains)
 - Geopolitical shocks the main risks to the global economy (war, government interference in markets)
- **Key central banks continue to emphasize inflation, now watching employment more carefully**
 - High rates still damping aggregate final demand
 - ECB has already begun to cut. Fed likely to begin cutting in September. China cut, as demand remains weaker than expected.
 - There remains a probability of recession, now due to policy mistake of not cutting fast enough.
- **Semiconductors in industry recession in 23, recovering in 24, getting back to trend in 25.**
 - Final Demand for technology goods stabilized at close to a pre-pandemic level for many key products. AI-related demand the key strong driver of 2024-2025 recovery.
 - Inventory imbalances in the semiconductor supply chain improved downstream and at semiconductor stage, but still an issue for Semi MSI wafers.
 - Long term outlook for healthy growth remains in place. Final demand will become more important for semiconductors as the inventory cycle passes.

Risks to Soft Landing Outlook

- Interest rate reductions too few, too late
 - Unemployment rises (US labor markets now shows more signs of weakness)
 - Interest rate sensitive markets drop further (credit pressures on households, housing, autos, investment)
- Inflation stays high or moves higher
- Financial market distress from rising debt pressures
 - Inverted yield curve still signals trouble (short term interest rates still exceed long-term rates)
 - Government needs
 - Private sector (e.g. rising delinquencies, stress in low-mid income household finances)
- Geopolitical risk
 - War(s)
 - China-Taiwan; China- Philippines
 - Trade-tariff disruptions
 - Decline of dispute-resolution organizations e.g. WTO
- Domestic politic risks
 - Major policy changes with change in governments, e.g. UK, France, potential in US.
 - China supply-side measures for housing vs need for consumer demand-side support

2023 Summary: Slow Growth Economy (Soft Landing)

Inflation fight continues, giving a high risk of recession

- **Inflation beginning to subside, but remains a more difficult issue than forecasters anticipated**
 - Supply chains now close to normal (not a contributor to inflation any longer)
 - Demand patterns still altered by inflation and the residual from the Covid disruptions
 - Geopolitical shocks the main risks to the global economy (war, government interference in markets)
- **Key central banks continue to emphasize inflation control**
 - US Fed still raising rates, ECB and UK catching up. Markets FINALLY beginning to believe policy makers.
 - China is moving in an opposite trajectory, as demand remains weaker than expected.
 - High rates will reduce aggregate final demand – investment & (to a lesser extent) consumer spending
 - There remains a high probability of recession, although the Consensus Forecasts do not predict one.
- **Semiconductors in industry recession in 23, recovering in 24.**
 - **Final Demand for technology goods continues to drop due to post-pandemic retrenchment and inflation-driven substitution**
 - **Inventory imbalances in the semiconductor supply chain show signs of improvement downstream, but were still unhealthy at semiconductor stage of production as of May data**
 - **Long term outlook for healthy growth remains in place**

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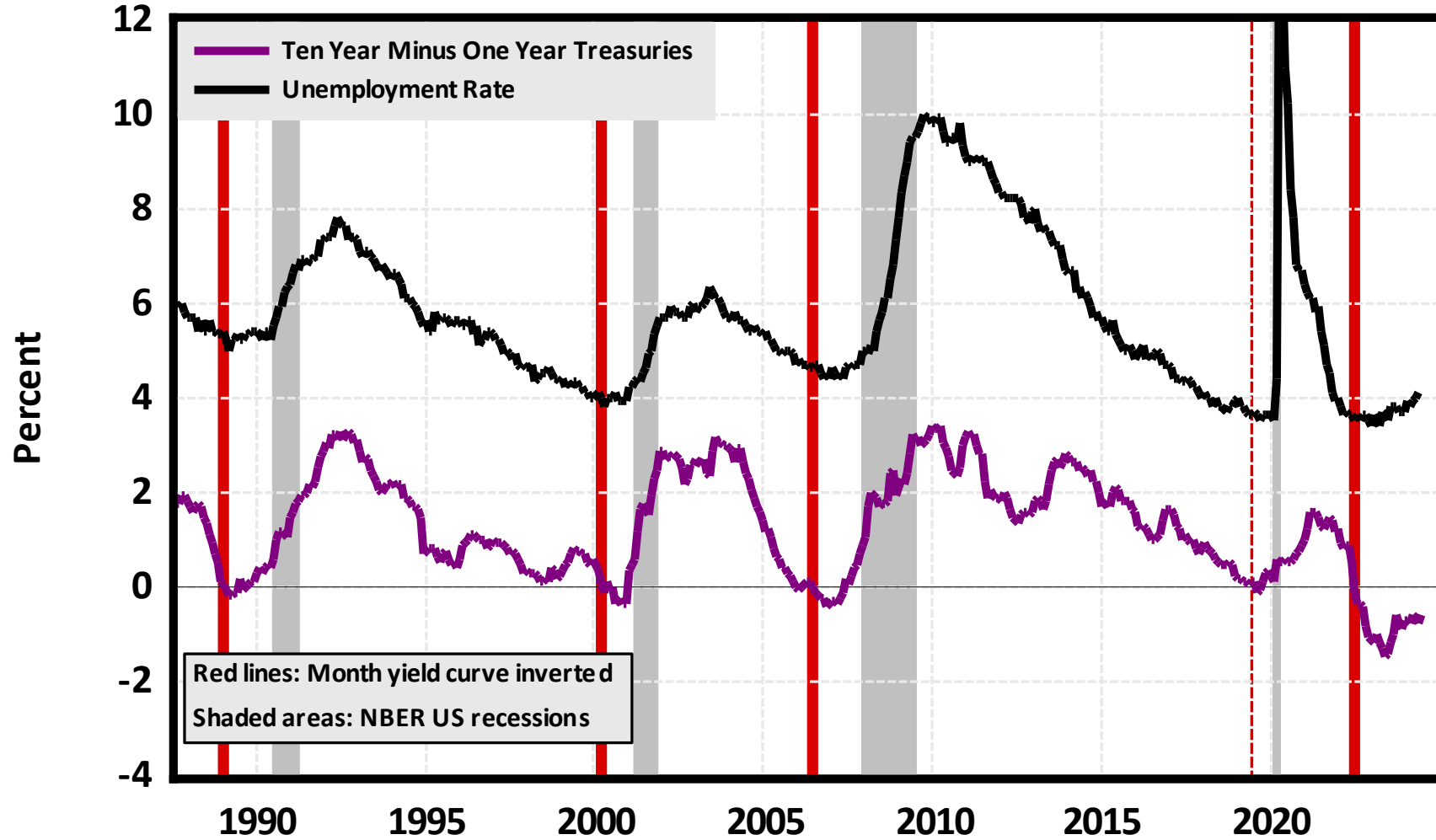
No Recession:

The base case – inflation continues to moderate, interest rates drop (are cut) quickly enough they no longer bind, confidence recovers, jobs hold up enough to keep spending growing. No geopolitical shocks.

Yes Recession:

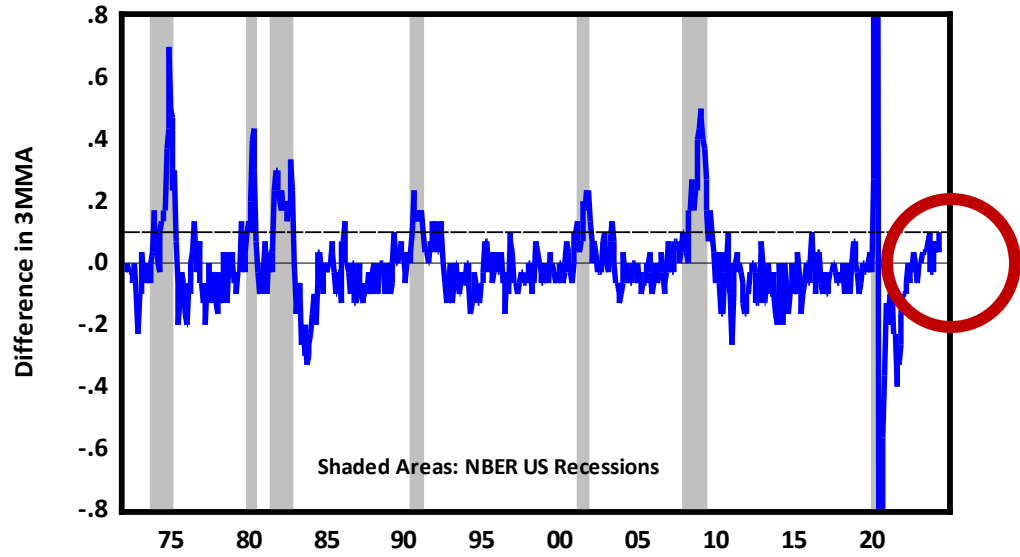
Weakening US labor market, weak confidence, inflation sticky, interest rates still high, deteriorating financial conditions (delinquencies & defaults), investment sags and governments reluctant to stimulate because they're already debt constrained.

Yield Curve Leads Recession

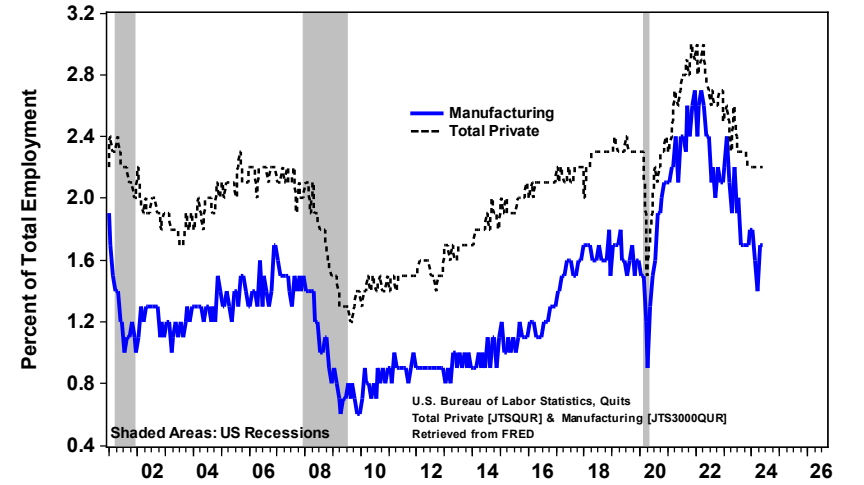


Change in US Unemployment Rate

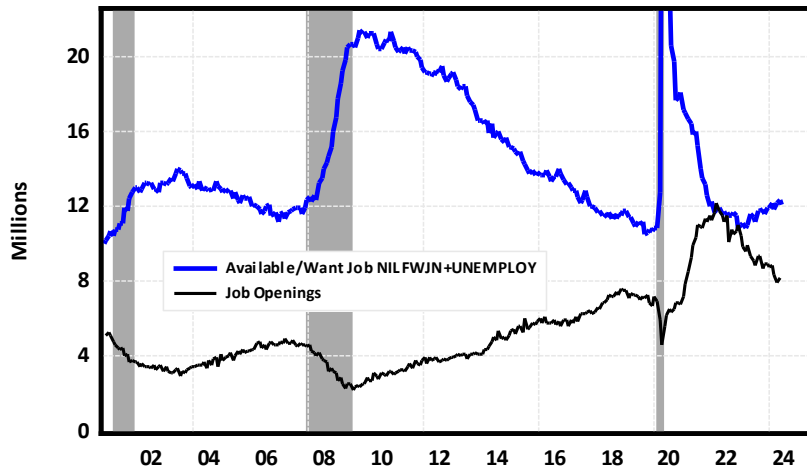
Labor Market Weakness



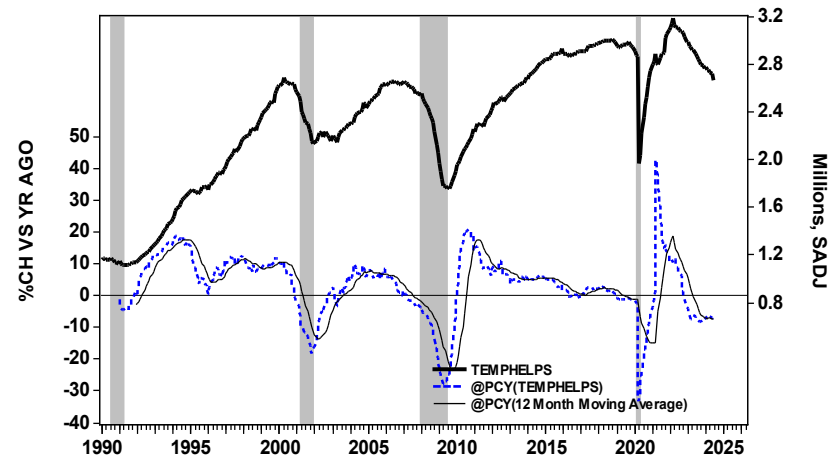
Quit Rate (U.S.)



Job Openings VS Available Labor

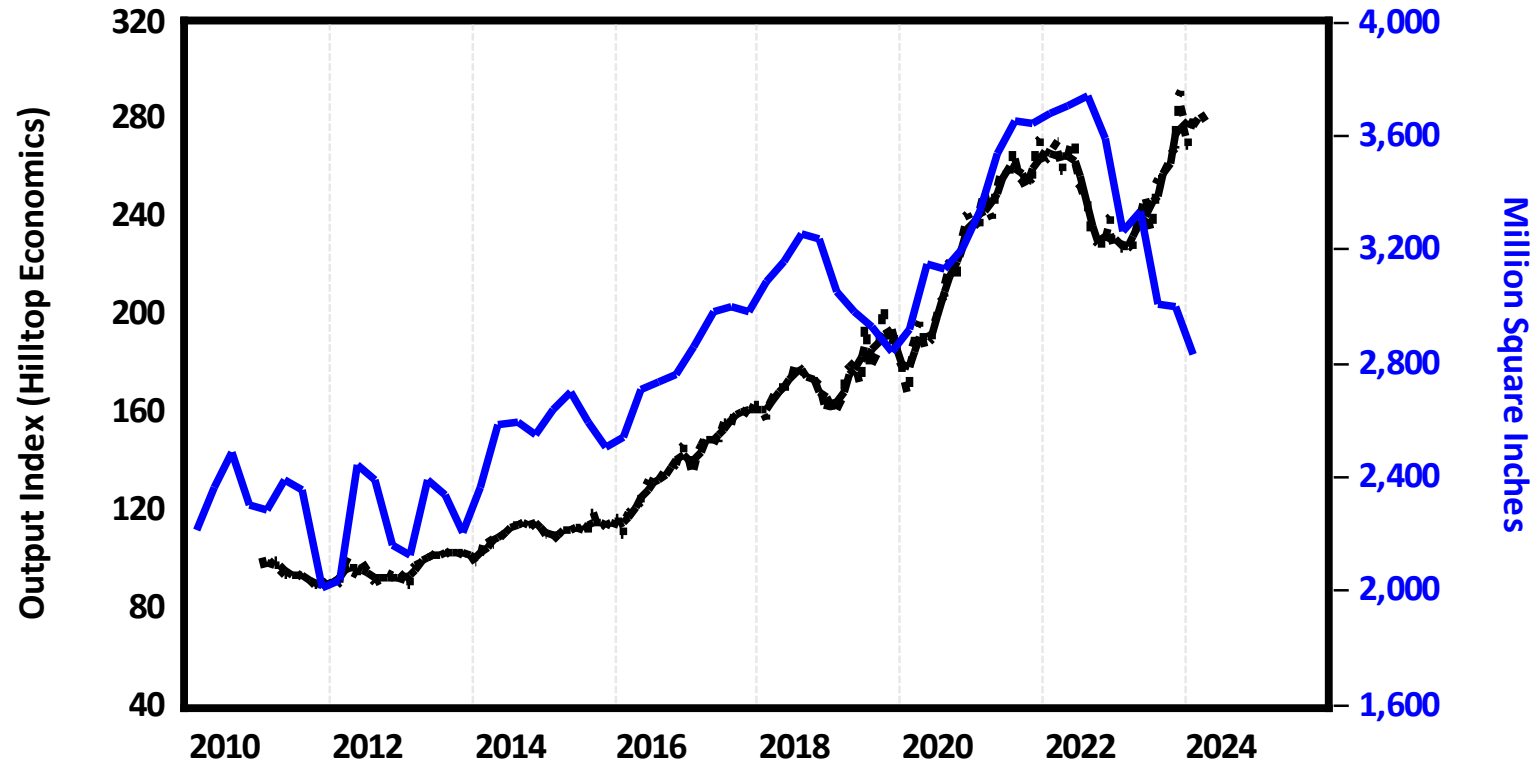


Temporary Workers - U.S.



Preliminary Semiconductor Output Index

Semiconductor Output VS. MSI Wafers Shipped

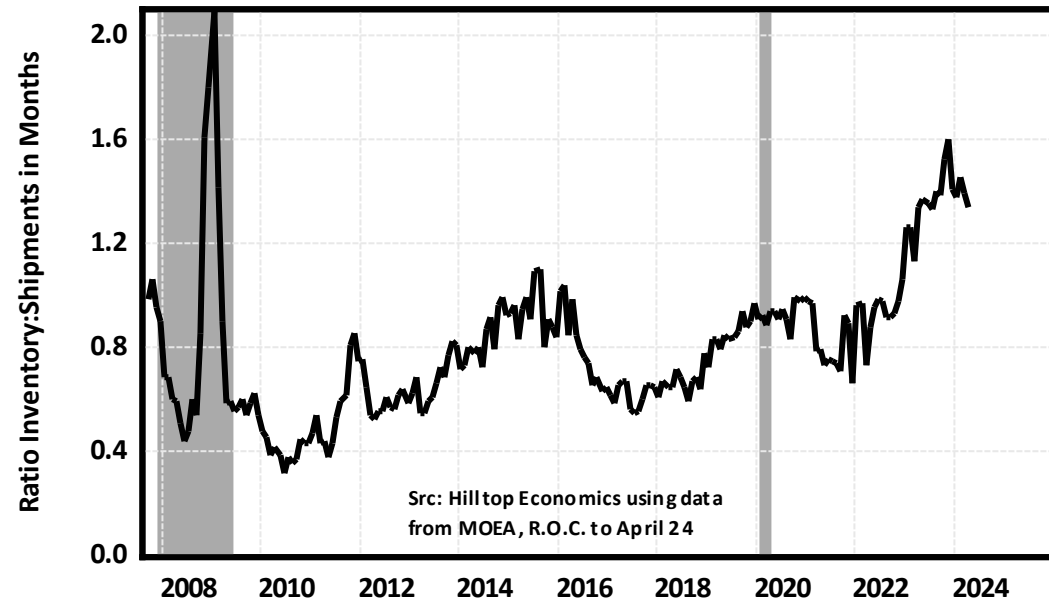


Hilltop Economics index to create “world” output index using output measures from government sources for China, Japan, Singapore, So. Korea, Taiwan and the US.

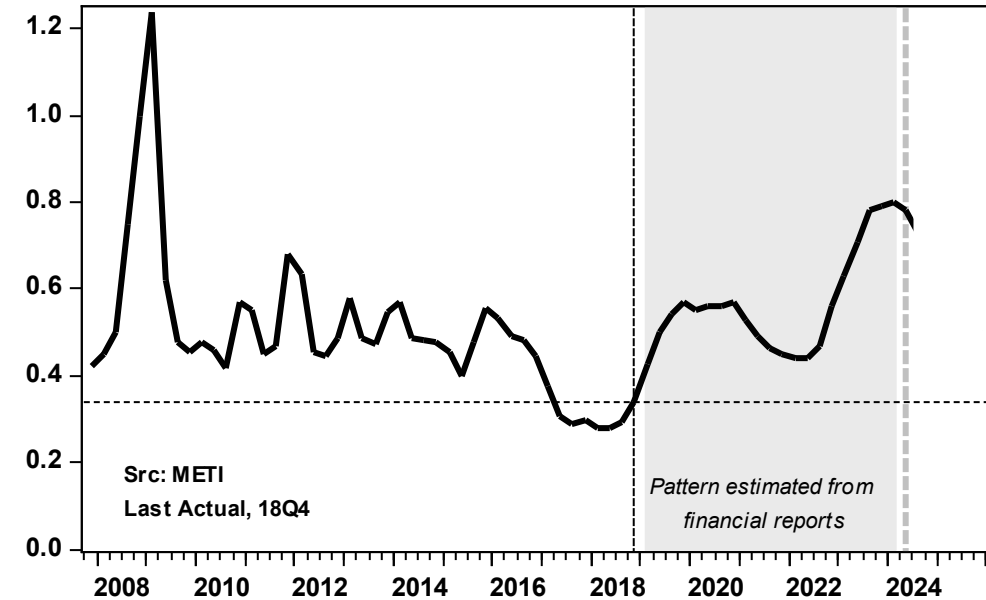
Farther Upstream: More of an Inventory “Whip”

Now: Wafer Inventory at Manufacturers Hints at a Turn

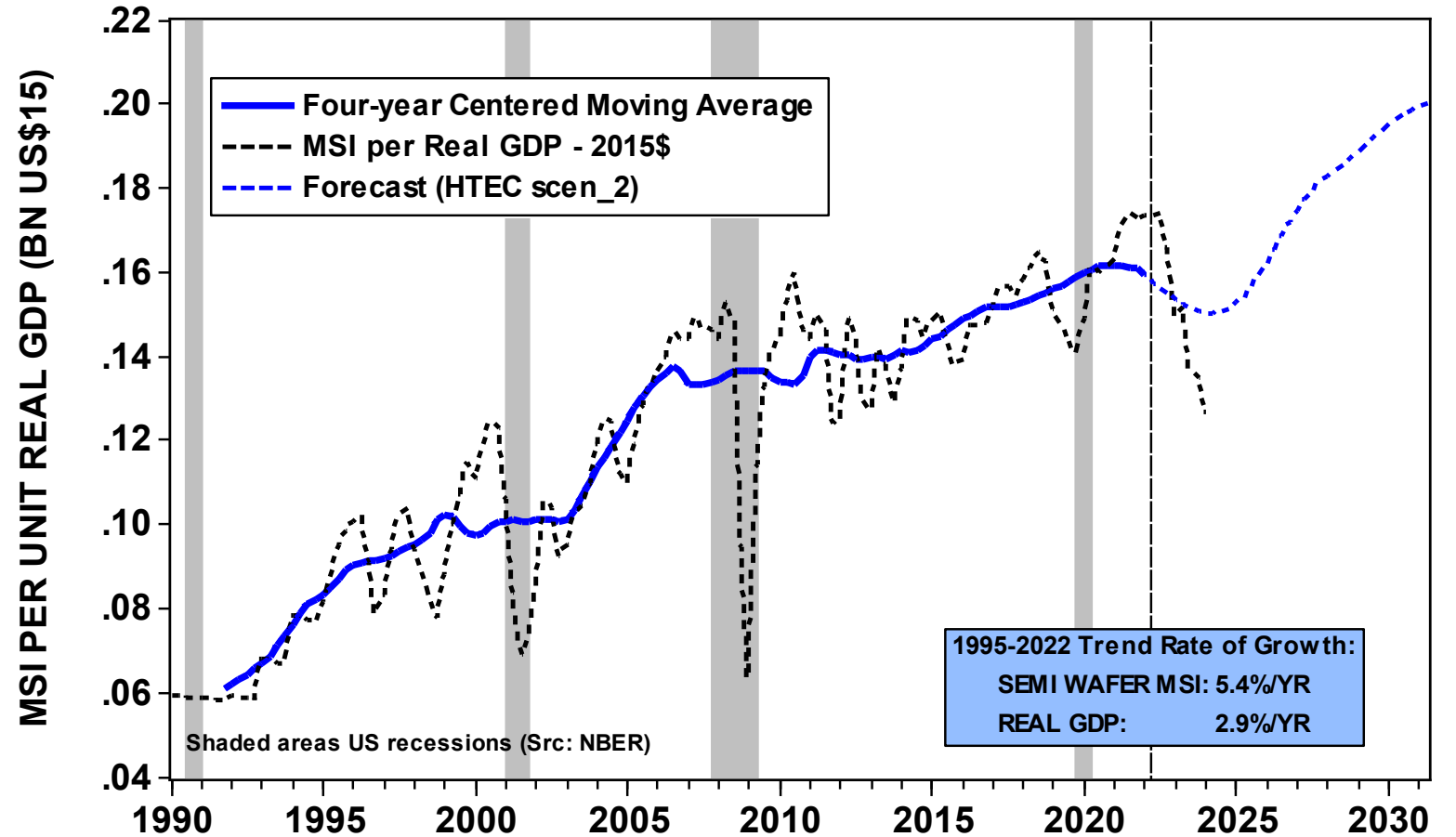
Taiwan Wafer Manufacturers I-S Ratio



Japan Semi Wafer I-S Ratio



Global Real GDP Output Continues to Need More Semiconductors (MSI)



Before 2007, semiconductor applications and products showed sequential, individual “S” curves as MSI penetrated the economy, e.g., PCs into business; the internet boom; the beginning of the mobile phone penetration.

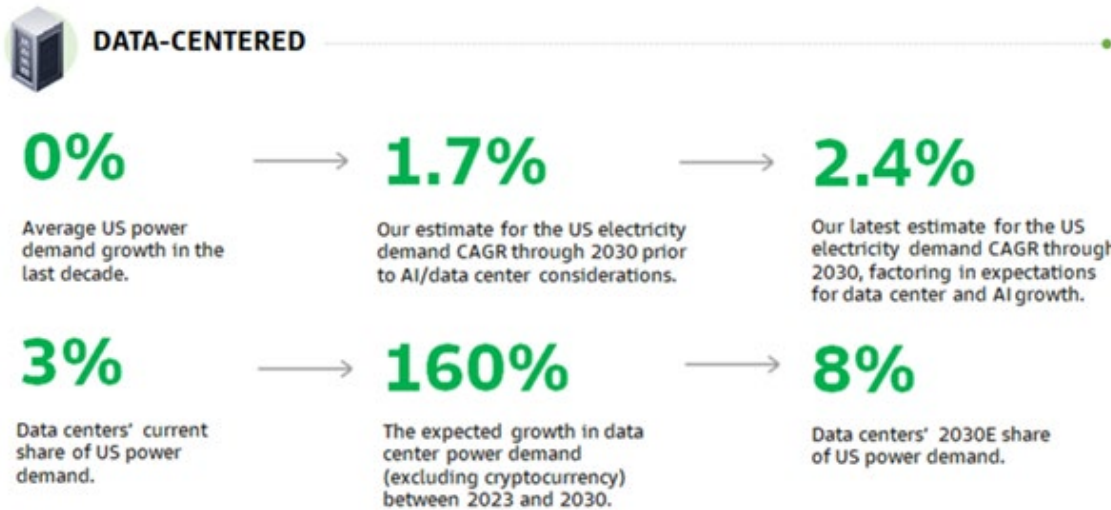
By 2010, semiconductors became pervasive enough that new applications containing chips no longer produced a large surge in the MSI:Real GDP ratio.

In the endemic-Covid world beginning in 2022, Real GDP becomes increasingly dependent on goods and activities that embed semiconductor technology and AI develops meaningful applications.

2021-2032 Quarterly Trend Rates of Growth: Real GDP 2.6%/yr ESF SEMI MSI 5.5%/yr Multiple rounds to 2.1 X in forecast period

Goldman Sachs' View Fairly Typical

THE US POWER DEMAND SURGE in numbers



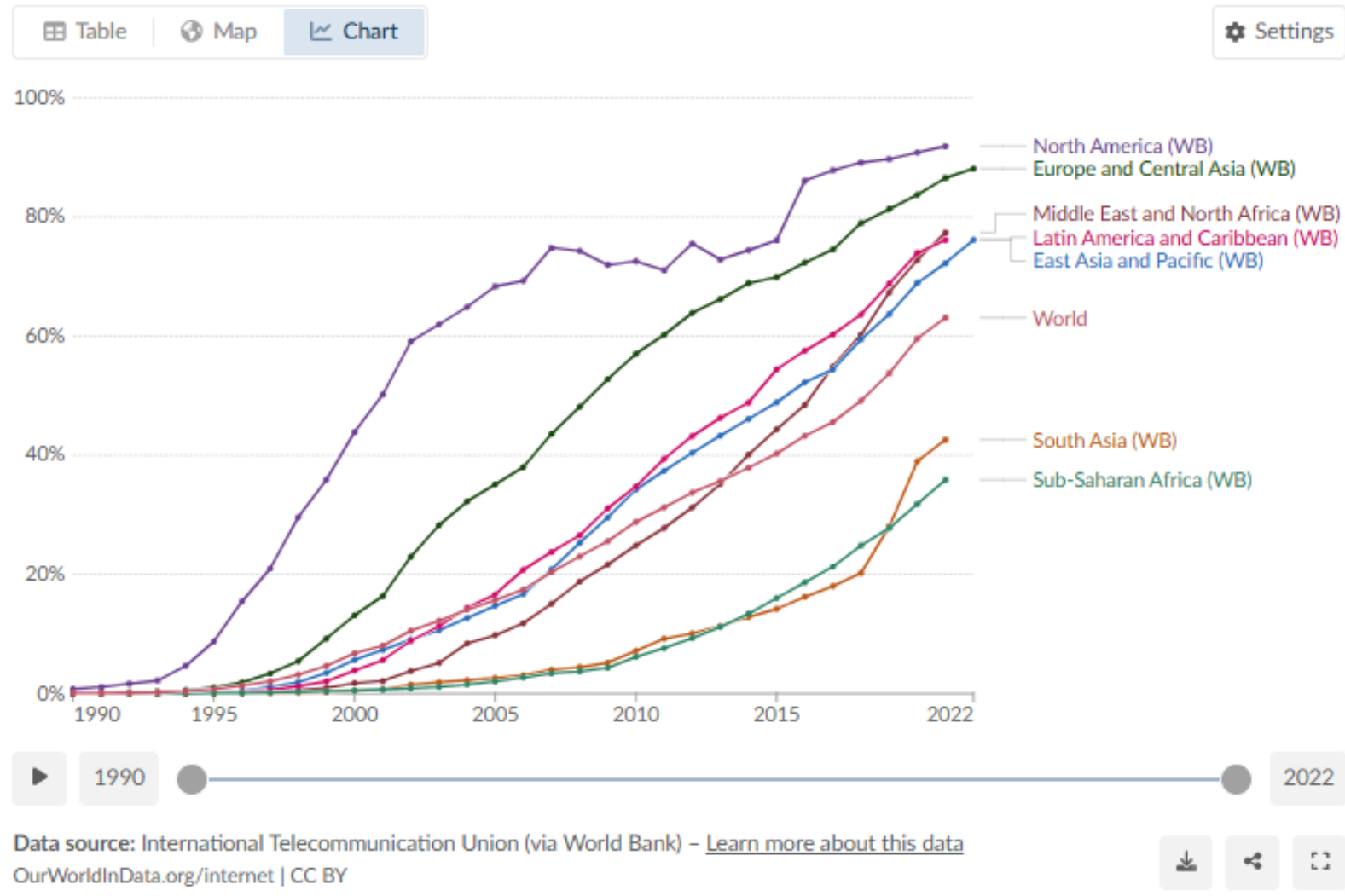
[report.pdf \(goldmansachs.com\)](https://goldmansachs.com/report.pdf)

Generational growth AI, data centers and the coming US power demand surge

Driven by AI, broader demand and a deceleration in the pace of energy efficiency gains, global data center power demand is poised to more than double by 2030 after being flattish in 2015-20. This growth is the primary catalyst alongside increasing manufacturing/industrial production and broader electrification trends, to an acceleration in US electricity demand CAGR to 2.4% through the end of the decade from 0% in the last decade. We believe supporting data center driven load growth will require investment by Utilities of \$50 bn in new power generation capacity. We assume a 60/40 split between gas and renewables, which we expect to drive ~3.3 bcf/d incremental natural gas demand by 2030. While investor interest in the AI revolution theme is not new, we believe downstream investment opportunities in utilities, renewable generation and industrials whose investment and products will be needed to support this growth are underappreciated.

Share of the population using the Internet

Share of the population who used the Internet in the last three months.



SEMI's View

- Future Horizon 4.9 Gartner 17.4 23.1 tech insights 16 wsts 16.4 Omdia
- 23-30 CAGR 10% 24-30f: 18-15-2-5-15-9-6
- Fabs 2X in Japan & SEA; 1.5X in Americas; 0.7X slowdown in China – geopolitics, “chips acts: and supply chain resiliency contribute to investment shifts (semi)
- Kdot 24-27: 6,7,7,6% Foundry double Memory. China 4.4 mm wpm; industry up 8.7
- China equipment spend highlighted (fear-driven not economic)
- WFE forecast 24: +3%; 25: +16.5% does NOT include Wafer Mfg Equipment
- Smart Mfg in Silicon Wafer fab;
- GlobalWafers using AI