Semiconductors/Semi Cap Equipment

3Q Preview: AI/Datacenter Continues to Lead the Semiconductor Cycle Recovery; Non-AI Recovery Slower in 2H, Stronger in CY25; Remain Positive on Stocks

Semiconductors & Semiconductor Capital Equipment / IT Hardware

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Semi, Semicap, and EDA stocks have continued to outperform broader indices YTD (SOX up 25% YTD) in anticipation of 2H24/2025 cyclical recovery trends/ positive earnings revisions and growth dynamics like AI/accelerated computing. Below the top-level view, we do highlight the diverging trends (fundamentals and stock performance) as AI compute/networking/storage beneficiaries continue to benefit from the strong AI infrastructure build-out that has resulted in strong share price outperformance and strong positive earnings revisions trend while the broadly diversified cyclical names (analog, microcontroller, semicap equipment) are slightly under-performing as the slope of the end market recovery has been more gradual and/or as concerns increase around the CY25 macro demand profile and the potential for more restrictions/regulatory actions against China. We expect these dynamics/concerns to persist through 2H of the year. That said, given the level of under-shipment to consumption trends in the more cyclical segments (industrial, automotive, consumer, PCs, smartphones), we do see slight Q/Q improvement through the year even if end demand dynamics have marginally softened. This view was echoed by ADI management at our US All Stars Conference in London in mid September (see note here) where the team continues to see broad-based bookings improvement after under-shipping consumption trends for almost four consecutive quarters. AI and accelerated compute demand dynamics continue to be strong as cloud/hyperscale/enterprises continue to build out their AI infrastructure (compute, networking, memory/storage) through CY25 (XPU shipment outlook up 120% Y/Y in CY24 and up 30-40% Y/Y in CY25). As a result, for the 3Q earnings season, we broadly expect companies to deliver in-line 3Q revenue/EPS results and in-line out-quarter (4Q) guidance on revenues, margins, and EPS. We expect the market to move into a more synchronized cyclical recovery profile across the different end markets in the 1H of next year. China stimulus could potentially fuel a better 2025 recovery profile for the broadly diversified cyclical names. Following the positive Y/Y semiconductor industry revenue inflection in 4Q23, YTD industry data suggests a continued recovery profile that we believe will persist through 2024 and into 2025. From an industry perspective, we expect semi industry revenue to improve 6-8% Y/Y in 2024 and another 10-12% in 2025. In Semicap equipment, near-term fundamentals continue to improve, but the market has already started to discount a more muted WFE spending profile next year amid a slower semi cyclical recovery and potential for more China restrictions – but we remain constructive on the potential for WFE growth next year off of flattish to slighty up trends this year and semicap names to outgrow the industry. Next-gen chip design activities remain strong for our chip design software/IP names (ARM, CDNS , and SNPS) and they are heading into a stronger 2H of the year. Our top semi picks are AVGO, MRVL, MU, ADI, MCHP; top semicap pick is KLAC; top chip design S/W pick is SNPS.

See page 20 for analyst certification and important disclosures.

- **Semiconductor cyclical fundamentals continue to improve through 2HCY24 but with diverging end market demand trends – continued strength in AI/ Datacenter offsetting a slower end market recovery in industrial, auto, enterprise, PC, and consumer.** At the highest level, global GDP is expected to grow 2.6% in 2024 and 2.4% in 2025. We believe that semiconductor shipment trends should continue to improve as we move through the remainder of the year on 2H seasonal tailwinds and more balanced industry supply/demand dynamics. Semiconductor industry revenues turned positive Y/Y in 4Q23 and continue to improve YTD, and we expect to see a recovery profile through 2024 and into 2025. Demand has softened for the cyclical segments (e.g., sub-seasonal 2H PC trends, automotive production outlook cuts, and global PMI contracting for three consecutive months), which we believe could impact the slope of the recovery, though given the level of under-shipment trends, we continue to believe that the bottom is in. We remain constructive on the fundamental setup in the areas of AI and traditional cloud/datacenter and custom ASICs.
- **Overall industry bookings continue to improve Q/Q, with book-to-bill at ~1.** In aggregate, we expect 3Q results (revenues, margins, EPS) to be in line with expectations and 4Q outlook to also be in line with expectations on sustained strong demand in accelerated compute/AI, which should offset slower end-market recovery in the cyclical segments of the market (auto, industrial, IoT). We believe overall industry order trends broadly grew Q/Q in 3Q with book-to-bill ratios at 1.
- **AI/accelerated compute demand continues to strengthen combined with a recovery in traditional cloud and enterprise workloads; look for companies levered to data center trends to outperform across high-performance compute and networking (NVDA, MRVL, AVGO).** Our research colleagues have recently revised their cloud capex (top four US CSPs) outlook (see note here) driven by the strong demand pull from AI, infrastructure upgrades, and new datacenter builds. AI/ accelerated computing build-out continues to drive spending mix shift toward GPU/ accelerators. We expect cloud capex to grow at 57% Y/Y in 2024 and with another 30% Y/Y growth grow in 2025. Overall we believe Nvidia is well positioned to support their next-gen product ramp (GB200, B200, B100) on top of continued strength in its existing H100/H200 products. We expect Blackwell demand to outstrip supply well into CY25. AMD also highlighted it strong competitive AI platform (see note here) with a plethora of new product launches here in the 2H of the year. In custom AI ASICs, we continue to see strong customer adoption/design win pipeline expansion from Broadcom (see note here) and Marvell (see note here). AI compute will also require significant high-speed networking capabilities – areas of strong leadership for Broadcom (switching/routing), Marvell (optical connectivity), and Astera Labs (compute connectivity). Traditional cloud and enterprise demand is also recovering in the 2H and should benefit strong CPU shipments from Intel and AMD.
- **Smartphone fundamentals tracking in line to slightly above seasonal trends.** We expect smartphone-exposed companies' Sep-Q results and Dec-Qtr outlook guidance to be in line with expectations. Smartphone shipments are tracking slightly ahead of 3Q seasonality trends (see note here). IPhone EMS build is on track for the 2H of the year (see note here), and should the AI-enabled iPhone 16 catalyze a strong upgrade cycle, we believe potential revenue upside would be more evident in the Mar-Qtr for our covered companies. For IoT exposed companies, we believe fundamentals are continuing to improve, and companies should be able to drive sequential growth through the Dec-Qtr.

- **WFE trending higher in the 2H of the year and into 2025 – albeit WFE growth outlook for CY25 has come down, we argue that most of our stocks have already discounted this – covered companies set to outperform WFE through share gains, SAM expansion, and services resilience.** Following a 5-10% WFE (ex-litho systems) decline in 2023, near-term fundamentals continue to improve and look set to grow in the 2H of the year (WFE up 10-12% 2H vs 1H) and into 2025. All of our semicap companies are observing rising utilization rates from memory and advanced logic/foundry customers and increasing orders for HBM DRAM equipment, advanced foundry/logic (3nm) equipment spending, and sustained mature node investments in China. Despite all of this, we do acknowledge a slower recovery with the more cyclical segments of the market, continued strong discipline in memory (DRAM and NAND), Intel capex cuts, and potential Samsung foundry cuts, and the potential for more regulatory actions against China. Despite all of this, we continue to see a growth profile in WFE spending next year (up 5-7%) and our large-cap semi equipment names outgrowing WFE by 300-700 basis points through a combination of increasing manufacturing complexity, share gains, SAM expansion, and support from resilient services businesses. We remain OW AMAT, KLAC, and LRCX.
- **Chip design software (EDA)/IP demand remains strong; key enabler in the AI infrastructure build-out.** We continue to see a solid near/intermediate-term demand outlook for chip design software companies driven by increasing chip design complexity/activity and the emergence of the custom chip or ASIC chip design (this is helping drive more chip design activity). After a slower start to CY1H24, 2H fundamentals should drive positive revenue/EPS revisions for both SNPS and CDNS on strong hardware verification/emulation sales, IP programs that are starting to fire, and continued upside on renewals to higher value-added implementation and verification solutions. Overall, we continue to project a 10-15% revenue growth CAGR for the chip design software names (CDNS and SNPS) and with ARM growing at 20%+ revenue growth CAGR over next several years.
- **Long-term sector thesis and multi-year outperformance for the group remains intact, and the sector is outperforming broader indices YTD in anticipation of positive earnings revision trend in CY24/25 as the group moves from the bottom of the cycle into the next up-cycle**. Despite the cyclical characteristics of the semi industry, semi stocks continue to outperform on a multi-year performance profile (1, 3, 5, 10, 15, 20 years), driven by the crucial role semis play in the tech value chain, increasing content tailwind opportunities in all applications, and structural profitability/FCF improvements. Our top semi picks are AVGO, MRVL, MU, ADI, and MCHP, top semicap pick is KLAC, top chip design software/IP – SNPS; we also favor OW NVDA, AMAT, and LRCX.

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Sustained Strong Cloud/AI Demand with Cyclical Recovery More Gradual in 2H24 – Expect a Semiconductor Recovery Profile through 2024

PC / Datacenter Compute

According to IDC and Gartner, PC shipments in 3Q24 decreased ~2% Y/Y and ~1% Y/Y, respectively. From a Q/Q perspective, 3Q24 shipments were up ~6% Q/Q and up ~2% Q/Q (IDC and Gartner). After several quarters of strong PC shipments led by inventory replenishments, 3Q sales were slightly lower. While 3Q24 PC shipments were up Q/Q in a seasonally stronger period, the growth was well below seasonal trends (vs typical 11% Q/Q). PC volume outlook for 2024 remains muted, and IDC is still looking to see modest growth in 2025. Overall, and as our JPM research colleagues had noted (see note here), 3Q24 shipment and the outlook are underwhelming relative to JPM and consensus expectations for a PC recovery cycle in 2025.

On datacenter compute, our JPM research colleagues have recently revised their cloud datacenter capex (top four hyperscalers) growth to 57% Y/Y (from +39% Y/Y) in 2024 (following+11% Y/Y in 2023), and with strong momentum into 2025 (up 30% Y/Y; unchanged) driven by the AI infrastructure build-out, infrastructure upgrades, and strong datacenter builds (see note here).

Artificial intelligence (AI) and deep learning (DL) continue to be the center of investor focus, and we continue to anticipate AI being one of the fastest-growing silicon opportunities in all of semiconductors. AI/Deep Learning investments should continue growing strongly through the next several years and beyond and proliferate into enterprise and edge. For compute-intensive applications (AI-based and deep learning workloads), this should drive demand for NVIDIA's datacenter GPU business (off-the-shelf) and its Hopper solutions even as Blackwell solutions begin to ramp in the C4Q of this year and into 2025. AMD is emerging as the strong #2 merchant GPU supplier and has recently highlighted its competitive AI platform (see note here). For custom ASIC solutions, this should drive strong demand for Broadcom and Marvell, which have both seen meaningful expansion in their design win pipeline.

Memory and Storage

Memory supply/demand fundamentals remain tight driven by strong memory content (e.g., HBM3e) from AI/accelerated compute server deployments but partially offset by softening demand trends in smartphones and PCs.

We and our global memory team forecast a 94% increase in DRAM revenue for CY24 and a 37% increase for CY25, along with a 98% increase in the NAND market for CY24 and a 9% increase for CY25 (see note here).

On DRAM, we expect continued tight supply/demand fundamentals for both HBM and non-HBM. HBM supply should remain tight into 2025, and we expect AI-related DRAM sales will represent a higher part of the total market in the next two years. On NAND, we see it being a beneficiary of AI server (i.e., QLC SSD penetrating to business near-line storage space) as well as disciplined supply from memory makers ensuring strong ASP growth through 2024.

Spot pricing for DDR5 DRAM DDR has risen 4% Q/Q in 3Q, and pricing for 512Gb TLC flash was down 8% Q/Q in 3Q. On a full-year basis, we pencil in 56%/59%

DRAM/NAND ASP growth in FY24E, which should bode well with earnings growth momentum at memory makers.

At its recent earnings call, MU reported better than expected Aug-Qtr results and provided a stronger rev/EPS outlook for the Nov-Qtr outlook (see note here), reflecting a better shipment profile driven by a recovery in traditional server, enterprise, and cloud demand overlaid with accelerating HBM/AI revenue contribution and continued blended pricing increases. Micron articulated favorable supply/demand/blended pricing dynamics through the remainder of 2024 and into 2025 due to continued strong AI server demand driving growth in HBM/DDR5 and enterprise SSDs amid a tight leading-edge supply environment.

For WDC, the team saw Q/Q strength in cloud/datacenter (both HDD and flash) on strong demand pull from accelerated compute/AI and general cloud datacenter demand recovery, seasonal ramp in mobile/smartphones, partially offset by continued weak consumer/retail and moderation of demand in the client PC segment on pockets of inventory normalization. Overall, we see strong memory demand trends and industry profitability expansion driven by demand recovery in cloud/datacenter, increased usage of gen AI (i.e., ChatGPT), and HBM ramp (HBM3e), which should bode well for MU/WDC.

Communications Infrastructure / Networking

Our JPM research colleagues have recently revised their cloud datacenter capex (top four hyperscalers) growth to 57% Y/Y (from +39% Y/Y) in 2024 (following+11% Y/Y in 2023). Momentum is expected to be sustained into 2025 with a 30% Y/Y cloud capex increase. Importantly, on an absolute dollar basis, cloud datacenter capex is now forecasted to increase by $60 bn+ in 2024, which is well ahead of the average dollar increase of +$10 bn we have seen between 2015-2023 and is surpassing the record expansion seen in 2022.

Datacenter investments from Tier 2 US CSPs are also expected to accelerate in 2024 and expand +31% y/y and are anticipated to increase another 21% Y/Y in 2025.

The strong AI compute demand is also driving strong demand for high-performance networking and should continue to drive strong orders/design activity for Broadcom's networking products (switching/routing, PCIe switching, Optical), Marvell's 800G/1.6T PAM4 DSP chipsets (e.g., strong PAM4 orders from Nvidia/Google), and Astera's Gen5/Gen 6 retimer chipsets.

Marvell has maintained >80%+ market share of PAM4 DSP chipsets for optical transceivers and has enabled Google, Amazon, Meta, and Microsoft to drive their transitions to 200/400G optical connectivity in their datacenters. The team's PAM4 DSP chipset solutions have enabled optical connectivity to scale with Broadcom's aggressive two-year product cadence (switch/routing silicon) of doubling switching data bandwidth. Marvell will be ramping 1.6T (200G electrical/optical channels) pluggable optical transceivers in the 2H of this year to support NVIDIA's Blackwell GPU/QuantumX 800 infiniband switch and Google's TPU V6 /Broadcom's Tomahawk 5 switching chipset. The team introduced its active electrical (copper) cable (AEC) PAM4 based solutions in 2022 and is shipping in production this year to several Tier 1 hyperscalers – both 200G and 800G form factors. In co-packaged optics (CPO), we believe the Marvell team has been working on CPO for many years now, leveraging its

strong foundation in silicon photonics development (COLORZ platform).

For Broadcom, the team is in volume production of its current-gen Tomahawk 5 switching chipset (5nm, 51.2Tbps throughput) since 2023, and we believe the team is set for initial shipments of its next-generation 3nm Tomahawk 6 chipset to support 102.4Tbps switching throughput and with production ramp in CY25/26.

For the AI Custom ASICs, we estimate that Google and Meta combined will drive $9B+ in AI ASIC chip revenues for Broadcom this year (Google ~$8B+ and Meta around $500M-1B), up almost 2.5x over CY23. We believe that Broadcom had won follow-on/next-gen 3nm AI TPU ASIC wins at both customers targeted for tape-out in CY25 with ramp in back-half 25 and into CY26, and this should sustain strong growth in Broadcom's AI ASIC revenues over the next few years. More importantly, as we said back in 2022, we believe that Meta remains on track to become Broadcom's next multi-billion dollar per year AI ASIC customer potentially starting in CY25. Combined with its third AI ASIC customer ramp (we believe Bytedance/TikTok) this year, strong AI-driven demand for the team's Tomahawk 5 and Jericho 3 switching/routing chipsets, and strong demand for its PCIe Gen5/Gen6 switching solutions, we believe Broadcom is set to drive $12B+ in total AI revenues this year (ASICs, networking, PCIe) and $15B+ next year. For Marvell, we believe the team's AI-related programs/products (optical/ASICs) are on track to drive a strong CY24 growth profile (up >3x Y/Y to $1.6B-$1.8B) and visibility for $3B+ in AI revenues in CY25.

Global 5G infrastructure spending trends have bottomed, but spending remains muted as telco and carriers exercise capex discipline amid the macro uncertainty. Within communications infrastructure and networking, companies with exposure are OW-rated AVGO, OW-rated MRVL, UW-rated QRVO, and N-rated MTSI.

Mobile Devices / Consumer

Global smartphone shipments are expected to modestly recover in 2024, following a -3% Y/Y and -10% Y/Y decline in 2023 and 2022, respectively. Our hardware & networking team is forecasting 3% growth for 2024 but with potential shipment upside.

For 5G smartphone shipments, the team is forecasting 750M (up 7% Y/Y) units in 2024 and 810M (up 8% Y/Y) units in 2025 led by catch-up from geographies like India. For AI smartphones, our hardware & networking team estimates shipments to track to ~155 mn units for 2024, with 13% penetration for the overall smartphone market shipments, with shipments and penetrations rising to ~350 mn and 28%, respectively, for 2025. QRVO and SWKS benefit from higher RF content growth and stable Android shipment trends.

Beyond mobile, both companies' non-mobile businesses are stabilizing.

Automotive and Industrial

The auto/industrial segment of the market bottomed in the 1H of the year after several quarters of inventory de-stocking, and we expect slightly higher shipment levels in the 2H of the year.

In the auto end market, auto production outlook has continued to soften and is expected to decline 2% Y/Y in 2024 following a 10% Y/Y increase in 2023. The weaker outlook is driven by softening across North America, Europe, and Japan/Korea regions while

China remains stable.

We continue to believe that 1H24 will mark the bottom for most of our covered companies (e.g., ADI, TXN, ON). That said, the pace of recovery has been pushed out on continued macro uncertainty. At our US All Stars Conference in London, ADI management noted it continues to see order improvements across automotive/industrial and overall book-to-bill is trending at or slightly above one. For IoT-exposed companies (e.g., SYNA and SLAB), we believe fundamentals are continuing to recover off the bottom. Long-term demand trends remain intact, in our view driven by the broad proliferation of edge applications in industrial, IoT, and automotive and the rising content to drive a smarter, more connected, more power efficient, and more secure device/application.

Our Economics research team is forecasting global GDP growth of 2.6% in 2024 and 2.4% in 2025. The global manufacturing PMI was 48.8 in September and the third consecutive month below <50, signaling a contraction.

Companies with solid auto/industrial content exposure, including OW-rated TXN, OW-rated MCHP, OW-rated ADI, N-rated ON, N-rated GFS, and N-rated NXPI, should see continued content gains, which should partially offset slower unit growth. We do believe that demand trends have bottomed in the 1H of the year, though we do acknowledge that the pace of recovery has been slower than we had anticipated.

Semiconductor Capital Equipment

Following a 5-10% WFE decline in 2023 (ex-litho systems), near-term fundamentals are improving and set to grow in the 2H of the year (WFE up 10-12% 2H vs 1H) and into 2025. We expect CY25 WFE to continue to increase, albeit at a lower rate (up 5-7%) versus our prior view of low-teens % growth. Advanced logic/foundry should continue to grow driven by continued strong demand in accelerated compute/AI spending, which we believe will also pull in strong compute and storage memory. Advanced technology spend will be offset by a slower semi cyclical recovery (impacting mature/specialty spend) and potential for more China restrictions. We believe our covered stocks (AMAT, KLAC, LRCX) have discounted these dynamics but are not discounting continuing to outpace WFE through a combination of increasing manufacturing complexity, share gains, SAM expansion, and support from resilient services businesses. We remain OW AMAT, KLAC, and LRCX.

JPM C3Q24 and C4Q24 Estimates vs. Consensus

For companies reporting September quarter results over the next several weeks, we provide our revenue and adjusted EPS estimates vs. consensus estimates below.

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Table 1: JPM 3Q24E/4Q24E Revenue Estimates vs Consensus

$ in millions

	3Q24E		4Q24E	
	JPM	Consensus	JPM	Consensus
ALAB	$98	$98	$110	$109
AMD	$6,710	$6,718	$7,715	$7,547
AMKR	$1,835	$1,843	$1,835	$1,835
AVGO	$14,000	$14,099	$14,440	$14,667
GFS	$1,725	$1,725	$1,871	$1,803
INTC	$13,000	$13,012	$13,518	$13,665
MCHP	$1,150	$1,151	$1,173	$1,201
MTSI	$200	$200	$204	$204
NXPI	$3,250	$3,251	$3,400	$3,388
ON	$1,750	$1,750	$1,787	$1,786
QRVO	$1,025	$1,026	$1,052	$1,057
SLAB	$165	$165	$192	$187
SWKS	$1,020	$1,021	$1,091	$1,096
SYNA	$255	$255	$257	$263
TXN	$4,100	$4,123	$4,326	$4,109
WDC	$4,059	$4,117	$4,198	$4,352
AMAT	$6,930	$6,952	$7,265	$7,235
KLAC	$2,752	$2,758	$2,853	$2,857
LRCX	$4,050	$4,054	$4,250	$4,233
ARM	$805	$810	$945	$951
CDNS	$1,180	$1,182	$1,380	$1,376
SNPS	$1,629	$1,628	$1,672	$1,671

Source: J.P. Morgan estimates and Bloomberg Finance L.P.

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Table 2: JPM 3Q24E/4Q24E (Non-GAAP) EPS Estimates vs Consensus

	3Q24E		4Q24E	
	JPM	Consensus	JPM	Consensus
ALAB	$0.17	$0.17	$0.18	$0.18
AMD	$0.91	$0.92	$1.19	$1.16
AMKR	$0.49	$0.50	$0.57	$0.56
AVGO	$1.40	$1.40	$1.46	$1.47
GFS	$0.33	$0.31	$0.40	$0.35
INTC	-$0.03	-$0.03	$0.04	$0.08
MCHP	$0.43	$0.43	$0.43	$0.48
MTSI	$0.73	$0.73	$0.74	$0.75
NXPI	$3.42	$3.41	$3.65	$3.65
ON	$0.97	$0.97	$1.02	$1.01
QRVO	$1.85	$1.85	$2.01	$1.94
SLAB	-$0.20	-$0.21	$0.14	$0.11
SWKS	$1.52	$1.52	$1.71	$1.70
SYNA	$0.75	$0.75	$0.82	$0.84
TXN	$1.45	$1.40	$1.57	$1.35
WDC	$1.70	$1.71	$1.93	$1.98
AMAT	$2.18	$2.19	$2.28	$2.27
KLAC	$7.00	$7.05	$7.47	$7.41
LRCX	$0.80	$0.81	$0.85	$0.85
ARM	$0.25	$0.26	$0.34	$0.34
CDNS	$1.44	$1.44	$1.98	$1.98
SNPS	$3.30	$3.29	$3.40	$3.58

Source: J.P. Morgan estimates and Bloomberg Finance L.P.

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2024 Outlook: Cyclical Recovery and Sustained Cloud/AI Demand Trends

We believe long-term investors should continue to focus on the multi-year (3, 5, 10, 15-year) track record of outperformance (see Table 3) by semis, semicaps, and EDA stocks driven by the crucial role semis play in the tech value chain, increasing content tailwind opportunities in all applications, and structural profitability/FCF improvements, all of which remain intact and set up well for continued outperformance relative to the broader indices in 2024, in our view. 2023 played out largely as we had expected with semiconductor cyclical fundamentals bottoming (albeit auto/industrial trends were weaker than anticipated) and stocks moving higher (SOX up 65% CY23 vs SPX up 24% CY23) as negative earnings revisions improved and in anticipation of better shipment trends nine to 12 months forward. At this point, we believe we are at the cusp of a semiconductor up-cycle (approximately four to six quarters of positive Y/Y growth) with industry revenue growth turning positive Y/Y in 4Q23 and which we believe should persist through 2024 and into 2025. Supporting our view of a semiconductor recovery profile in 2024 is the steep unit decline (semi ex-discretes) in 2023 (semi units trough at down 24% Y/Y in Feb-23, which was worse than the 08/09 semiconductor down-cycle of down 18%), reflective of/discounting the potentially slower macro environment and excess inventory dynamics. We believe the positive earnings revision mix will continue to improve as fundamental dynamics, like excess customer chip inventories across markets, continue to improve and shipments move toward end-market consumption trends in consumer, enterprise, and datacenter markets. That said, demand recovery within the various semiconductor end markets has been uneven with PC, memory, and smartphones emerging out of the down-cycle first, datacenter stabilizing (cloud AI strong), auto/industrial likely to begin recovery in the middle of 2024, while enterprise/telco spending remains weak. From an industry perspective, we expect semi industry revenue to improve 6-8% Y/Y in 2024 with a more back-end recovery profile following an 8-10% decline in CY23. In semiconductors, we continue to favor companies with strong exposure to strategic infrastructure dynamics (i.e., cloud/ hyperscale datacenter spending), especially around custom chips (ASICs – AVGO, MRVL), networking (AVGO, MRVL), and memory (MU). In Semicap equipment, we believe WFE spending trends are at a bottom and are set to increase 3-5% Y/Y in 2024, and stocks will continue to follow the fundamental improvements of customers as memory pricing trends continue to improve and accelerated compute/AI demand for leading edge silicon continues to strengthen. Next-gen chip design activities remain strong for our chip design software/IP names (ARM, CDNS, and SNPS).

Table 3: Semiconductor/Semicap/EDA Stocks Have Outperformed the Market over the Past 3, 5, 10, 20 Years – Four Full Semiconductor Cycles over the Past 10 Years

Annual Stock Returns (CAGR%)	3-year	5-year	10-year	15-year	20-year
SOX (Semi) Index	**16%**	**26%**	**25%**	**20%**	**14%**
Semicap Equipment	**21%**	**31%**	**26%**	**21%**	**15%**
Chip Design Software (EDA)	**18%**	**31%**	**30%**	**24%**	**18%**
SP500 Index	9%	14%	12%	12%	9%
NASDAQ Composite Index	7%	18%	16%	15%	12%

Source: Bloomberg Finance L.P. Pricing as of 10/17/2024 market close.

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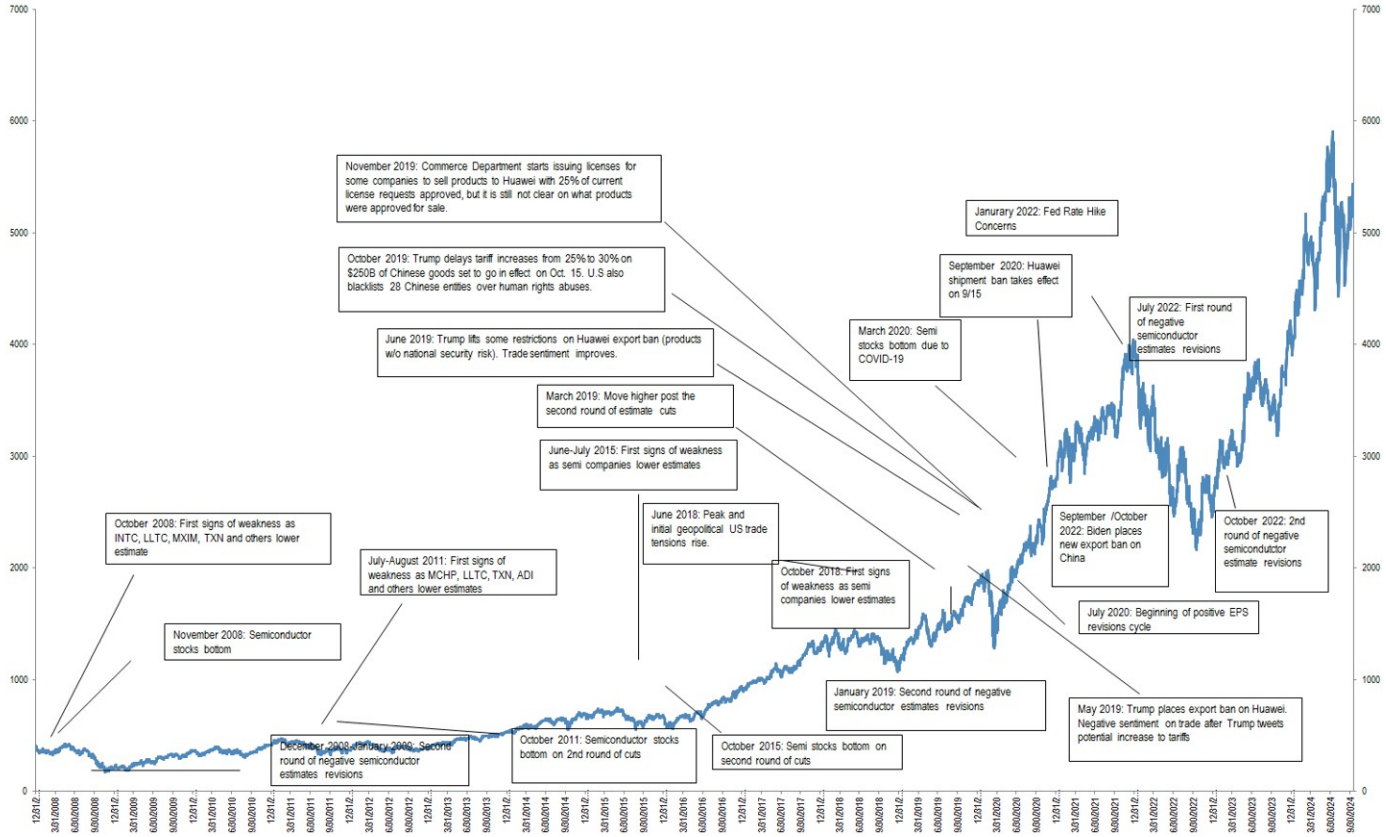
Figure 1: Stocks Should Continue to Move Higher in Anticipation of the Cyclical Recovery



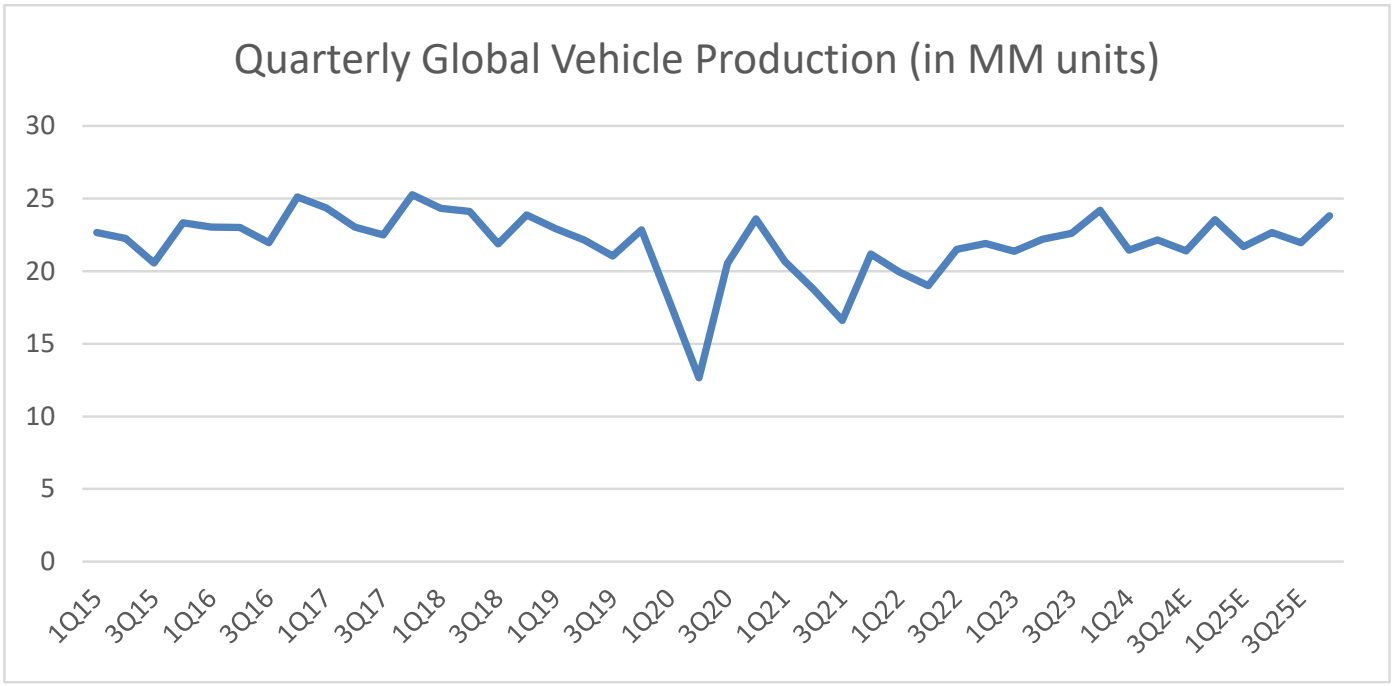
Source: Bloomberg Finance L.P., company data, and J.P. Morgan.

Industry SIA Data

WSTS semiconductor industry data was published for the month of August 2024. After an 18% Y/Y increase (up 6% Y/Y ex. memory) in industry sales in the month of July, August industry sales were up 28% Y/Y (up 5.3% Y/Y ex. memory). On a M/M basis, after a 10.8% M/M decrease (down 2.1% M/M ex. memory) in industry sales in the month of July, August industry sales accelerated to 15.4% M/M (up 4.3% M/M ex. memory) in a seasonally stronger period and above seasonal trends. The three-month rolling average for August (up 20.6% Y/Y) continues to improve. Overall units were up slightly (units ex-discretes up 1.8% M/M and 1.7% Y/Y) and complemented by strong pricing power (ASP ex-discretes up 14.2% M/M and up 29% Y/Y). Pricing power remains strong and was broad based (e.g., Analog up 5% M/M, MCU up 3.1% M/M, Flash up 2.6% M/M). On a sub-segment basis, strong QTD (Jul/Aug vs. Apr/May) segments included DRAM (up ~20%), NAND (up ~11%), total logic (up ~11%), power transistors (up ~4%), total Analog (up ~4%), while some segments were muted (general purpose analog down ~2%, MPU down ~3%, and MCU down ~2%) – but in line with guidance from companies post the most recent earnings season. The memory strength was not surprising and was well telegraphed by Micron's recent earnings result as the team had noted strong server DRAM demand and that its HBM capacity is already sold out through CY25 and with pricing locked in. For the cyclical segments like industrial and automotive, while the recovery profile has been pushed out, we continue to believe that the bottom is in. At our US All Stars Conference in London, ADI management noted it continues to see order improvements across automotive/industrial (see note

here), and overall book-to-bill is trending at or slightly above one. Overall, we are encouraged by the sustained positive Y/Y trends and expect semi industry revenue to improve 6-8% Y/Y in 2024 . We remain positive on semiconductor and semiconductor equipment stocks as we believe stocks should continue to move higher in anticipation of better supply/demand in 2H24/25 and stable/rising earnings power trends in CY24/25.

Figure 2: Quarterly Auto SAAR Trends



Source: IHS.

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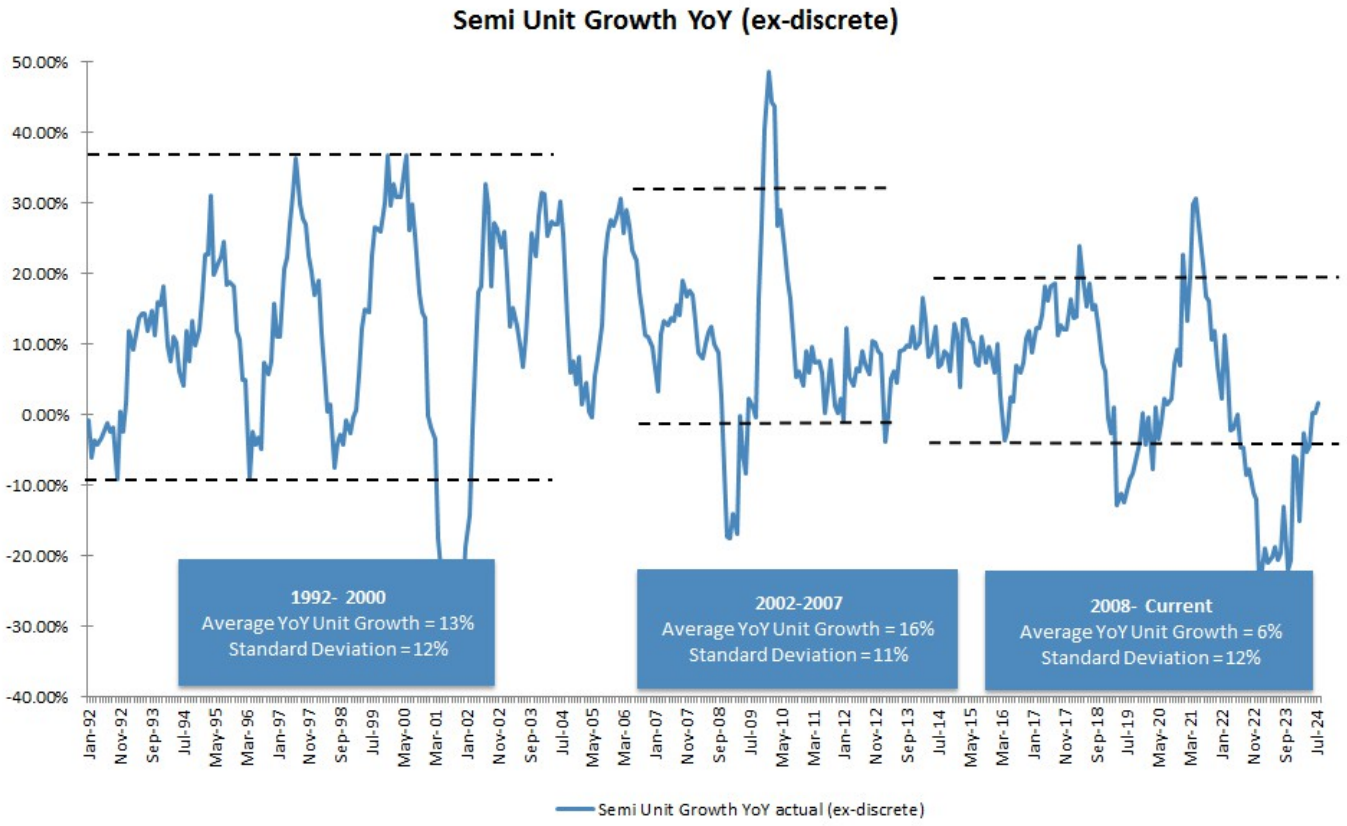
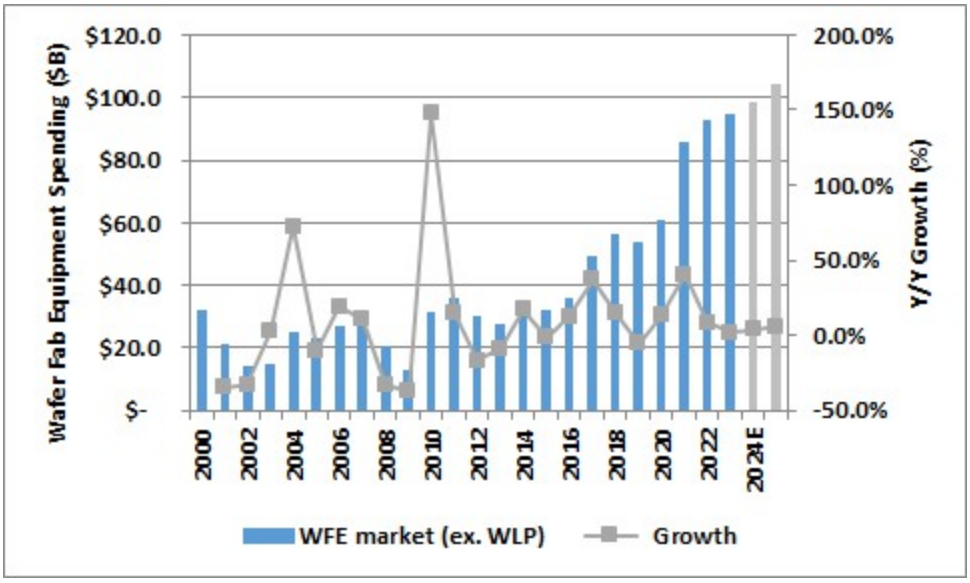
Figure 3: Semiconductor Industry Thesis – Entering More Stable Growth Phase in Semis (Unit Growth Y/Y); Focus on Scale (Market Leadership), Margin/FCF Expansion, and Capital Allocation



Source: WSTS.

Figure 4: Wafer Fab Equipment Spending (2000-2025E)



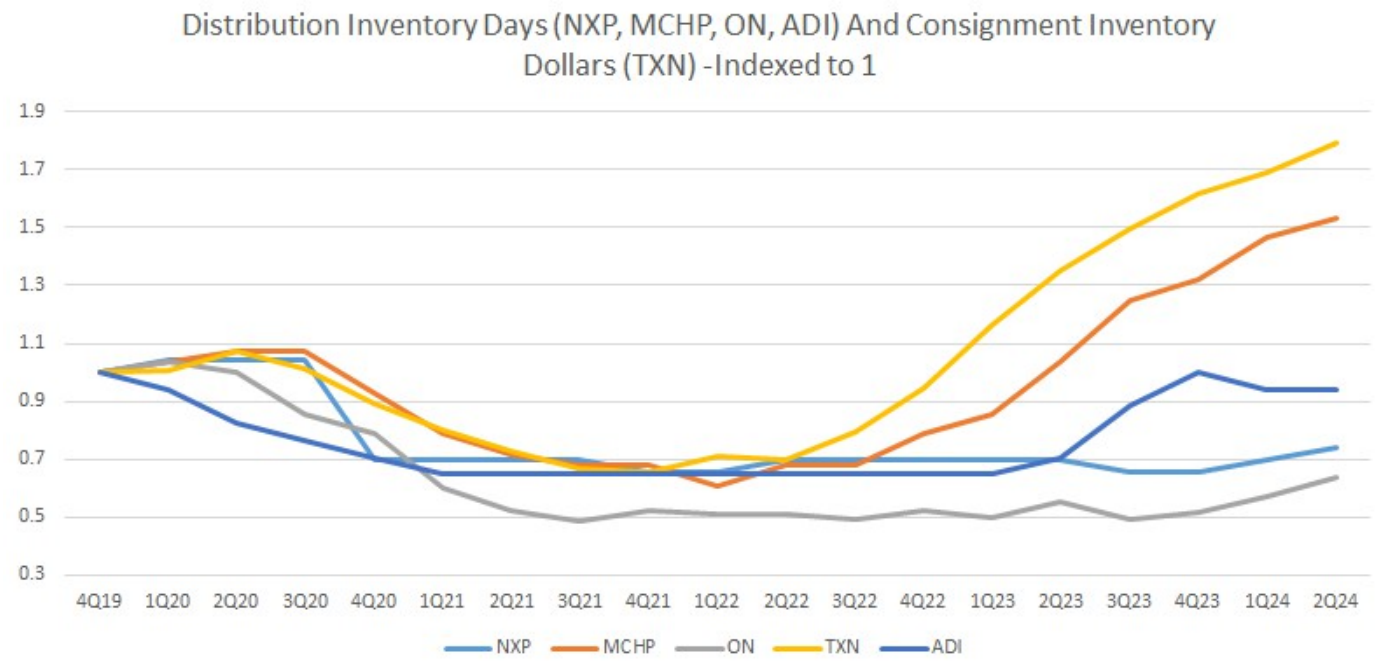
Source: Gartner and J.P. Morgan estimates. Data excludes wafer bonders and other wafer-level packaging equipment.

Table 4: Distribution Inventory Remains Lean and Lead Times Are Short

	Distribution inventory days		Lead time	
	Current	Normal	Current	Normal
ADI	8	7-8 weeks	13 weeks or lower	4-8 weeks
MCHP	43	27-47 days	under 8 weeks	4-8 weeks
NXPI	1.7 months	2-3 months	normalized	16 weeks
ON	8.9	11-13 weeks	N/A	8-12 weeks

Source: Company reports from most recently reported quarter.

Figure 5: Distribution Inventory Days and Consignment Inventory Dollars



Source: Company reports and J.P. Morgan.

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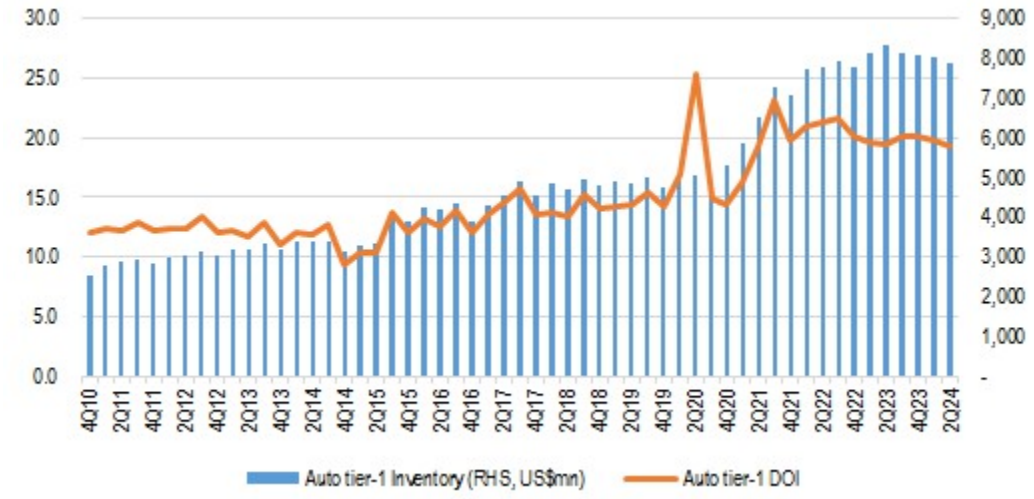
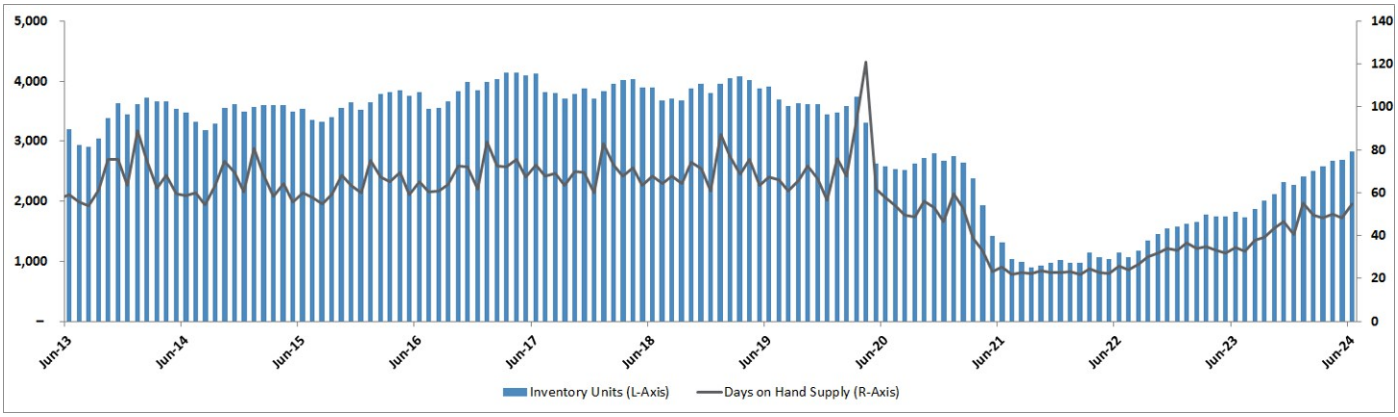
Figure 6: Auto OEM Raw Materials Inventory – Stable/Trending Lower



Source: Company reports. Note: Magna, Hyundai Mobis, Lear, Aptiv, BWA, Autoliv, Adien.

Figure 7: However, New Vehicles in Inventory on US Dealer Lots – ~20% lower Than Pre-COVID-19 Levels

Units (in thousands)



Source: Autodata.

Inventory levels in the channel remain lean as semiconductor companies undershipped demand to flush out excess customer inventories. The weaker demand environment, macro uncertainty, and lower lead times are driving lower bookings and order push-outs /cancellations over the last several quarters. That said, cancellations/push-out activities have stabilized, and we expect a slightly better demand profile in the 2H of the year.

At the end of 2Q, inventories on semiconductor company balance sheets sat at ~126 days, down from the prior quarter but above the five-year historical trendline of 116 days. Semi companies are undershipping demand aggressively to flush out excess customer inventory levels while also slowing down their internal manufacturing utilization to lower inventory levels on their balance sheets. That said, semi/customer inventories remain elevated as end demand has softened, which has delayed the inventory de-stocking cycle.

We acknowledge continued elevated semi/customer inventories in certain end markets like automotive (Figure 6). For example, auto OEM chip/material inventories (raw

materials) are ~1.8x higher vs pre-COVID-19 levels but are past peak levels and are trending lower. Certainly, we have seen that dynamic played out in PC, memory, and smartphone, and it is now working through the auto/industrial segments. Inventory digestion continues to progress well, and we believe industrial/automotive should begin to recover in the 2H of the year.

Table 5: Industry Q/Q Growth above Historical Trends Starting in 2Q23

Quarter	10-year Avg. Q/Q Growth	Actual
1Q17	-2%	0%
2Q17	2%	5%
3Q17	7%	11%
4Q17	-1%	6%
1Q18	-2%	-2%
2Q18	3%	6%
3Q18	7%	6%
4Q18	0%	-8%
1Q19	-6%	-10%
2Q19	-2%	1%
3Q19	13%	9%
4Q19	-1%	1%
1Q20	-3%	-4%
2Q20	3%	-1%
3Q20	6%	10%
4Q20	-1%	5%
1Q21	-4%	4%
2Q21	3%	9%
3Q21	7%	8%
4Q21	0%	5%
1Q22	-4%	-1%
2Q22	4%	-1%
3Q22	7%	-6%
4Q22	1%	-7%
1Q23	-3%	-9%
2Q23	3%	6%
3Q23	6%	6%
4Q23	0%	8%
1Q24	-4%	-6%
2Q24	4%	9%

Source: WSTS.

We believe the positive earnings revision mix (Figure 8) will continue to move higher as fundamental dynamics, like excess customer chip inventories across markets, continue to improve and shipments move toward end-market consumption trends in consumer, enterprise, and datacenter markets. For example, back in the most recent earnings season, those companies posting positive EPS earnings revisions represented 40% of the mix versus only 20-30% in 2022. In aggregate, we expect 3Q results/4Q outlook to be in line with expectations.

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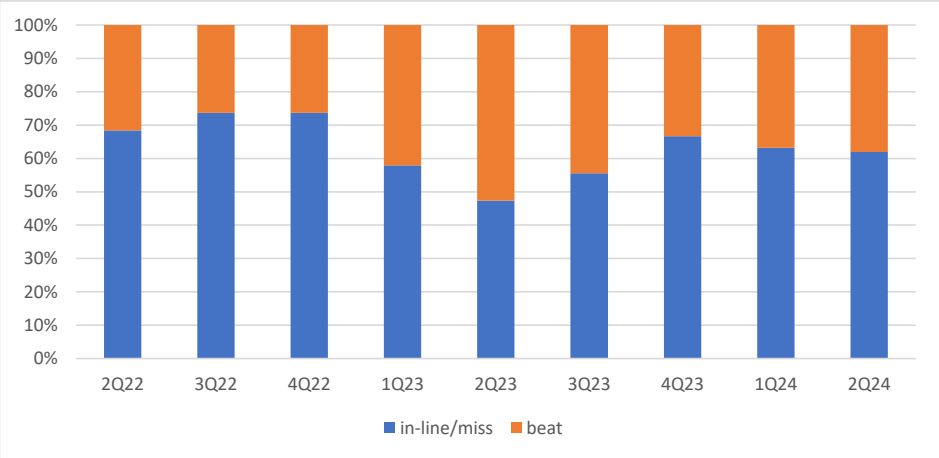
Figure 8: Semiconductor Coverage Earnings Revision Trend



Source: Company reports

Many Companies Have Attractive Dividend Yields and Strong Share Buyback Programs in Place

As the semiconductor industry matures, we expect companies to focus on shareholder returns and anticipate continued dividend growth and increased share repurchases. We expect continued strong shareholder returns in 2024 through repurchasing activities and dividend increases. Higher dividend yields and share repurchases should help limit downside. Table 6 illustrates dividend yields for select semi companies.

Table 6: Dividend Table

Company	Yield
SWKS	2.9%
TXN	2.7%
MCHP	2.4%
NXPI	1.7%
ADI	1.6%
LRCX	1.3%
AVGO	1.2%
AMKR	1.0%
Average	**1.8%**
S&P Average	**1.3%**

Source: Bloomberg Finance L.P. as of market close on 10/17/2024.

Consolidation in the Semi Industry Likely to Continue and Provide Valuation Support

Based on Bloomberg and company reports, YTD 2024 semi and semicap deal volume stands at ~$17B versus ~$25B in 2023, ~$18B in 2022, ~$41B in 2021, ~$88B in 2020, $31B in 2019, ~ $48B in 2018, ~$140B in 2017, and ~$141B in 2016. We continue to see strong M&A activity, with the smaller/medium-sized companies as tuck-in acquisitions from larger companies or consolidation to drive scale to compete with much bigger competitors. We believe deal activity will be a key component of capital allocation and supportive of valuations in 2023 and beyond. Table 7 illustrates announced M&A since the middle of 2015.

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Table 7: We Expect More M&A in the Long Term as Industry Consolidation Should Continue to Support Valuations

Date	Buyer	Target	Deal Value ($M)	Status
8/19/2024	AMD	ZT Systems	4,900	Pending
2/15/2024	Renesas Electronics	Altium	5,900	Completed
1/11/2024	Renesas Electronics	Transphorm	339	Completed
8/22/2023	Macom	Wolfspeed's RF division	125	Completed
8/7/2023	Renesas Electronics	Sequans	230	Terminated
3/3/2023	Infineon Technologies	Gan Systems	880	Completed
8/15/2022	Navitas Semioncductor	GeneSic Semiconductor	227	Completed
5/26/2022	Broadcom	Vmware	61,000	Completed
5/5/2022	MaxLinear	Silicon Motion	3551	Terminated
4/4/2022	AMD	Pensando	1900	Completed
3/14/2022	Alphawave IP	OpenFive (SiFive)	210	Completed
2/15/2022	Intel	Tower Semiconductor	5400	Terminated
2/14/2022	Murata	Resonant	296	Completed
12/15/2021	Entegris Inc.	CMC Materials	6500	Completed
9/20/2021	Thomas Lee Partners	Brooks Automation (Semiconductor Solutions)	3000	Completed
8/30/2021	Synaptics	DSP Group	421	Completed
8/25/2021	ON Semiconductor	GT Advanced Technologies	N/A	Completed
8/3/2021	Marvell Technology Group Ltd	Innovium	1100	Completed
6/30/2021	Texas Instruments	Micron Lehi Fab	900	Completed
5/10/2021	MKS Instruments	Photon Control	387	Completed
4/21/2021	Skyworks	Silicon Labs' Infrastructure and Automotive Business	2750	Completed
2/8/2021	Renesas	Dialog Semiconductor	5900	Completed
1/13/2021	Qualcomm	NUVIA	1,400	Completed
10/28/2020	Marvell Technology Group Ltd	Inphi	8,200	Completed
10/27/2020	Advanced Micro Devices	Xilinx	35,000	Completed
10/19/2020	SK-Hynix	Intel (NAND)	9,000	Completed
9/13/2020	NVIDIA Corp.	ARM Ltd.	40,000	Terminated
7/13/2020	Analog Devices	Maxim Integrated	21,300	Completed
7/7/2020	Synaptics Inc.	Broadcom's Wireless IoT Connectivity Business	250	Completed
4/6/2020	MaxLinear	Intel's Connected Home Business	150	Completed
2/20/2020	Dialog Semiconductor	Adesto Technologies	358	Completed
12/16/2019	Intel	Habana Labs	2,000	Completed
8/8/2019	Broadcom	Symantec's Enterprise Security Business	10,700	Completed
7/9/2019	Cisco Systems	Acacia Communications Inc.	2,600	Completed
7/1/2019	Applied Materials	Kokusai Electric	2,200	Terminated
6/24/2019	Nanometrics Inc	Rudolph Technologies	N/A	Completed
6/10/2019	Intel	Barefoot Networks	N/A	Completed
6/3/2019	Infineon Technologies	Cypress	10,000	Completed
5/29/2019	NXP Semiconductors	Marvell's Connectivity Business	1,760	Completed
5/20/2019	Marvell Technology Group Ltd	Avera Semiconductor LLC	650	Completed
5/6/2019	Marvell Technology Group Ltd	Aquantia Corp	452	Completed
4/10/2019	Qorvo Inc.	Active-Semi International	325	Completed
3/27/2019	ON Semiconductor Corp.	Quantenna Communications Inc.	1,070	Completed
3/15/2019	Ideal Industries	Cree Huizhou Solid State Lighting Co Ltd	310	Completed
3/11/2019	NVIDIA Corp.	Mellanox Ltd.	6,900	Completed
12/18/2018	Cisco Systems	Luxtera	660	Completed
10/30/2018	MKS Instruments	Electro Scientific Industries	1,000	Completed
9/11/2018	Renesas	Integrated Device Technology	6,700	Completed
7/11/2018	Broadcom Inc.	CA Technologies	18,900	Completed
5/8/2018	Cohu	Xcerra Corp	796	Completed
3/19/2018	KLA-Tencor Corp.	Orbotech Ltd.	3,200	Completed
3/6/2018	Cree	Infineon RF Power	428	Completed
3/1/2018	Microchip Technology	Microsemi Corp	10,150	Completed
11/20/2017	Marvell Technology Group Ltd	Cavium Inc	6,018	Completed
10/5/2017	Dialog Semiconductor	Silego technology	276	Completed
9/22/2017	Canyon Bridge Capital	Imagination Technologies	743	Completed
6/12/2017	Synaptics Inc	Conexant Systems	341	Completed
3/29/2017	MaxLinear Inc.	Exar Corp	446	Completed
3/13/2017	Intel	Mobileye	15,300	Completed
2/13/2017	IDT	Gigpeak	250	Completed
2/2/2017	Veeco	Ultratech	815	Completed
12/21/2016	TDK	Invensense	1,300	Completed
11/21/2016	MACOM	Applied Micro	770	Completed
11/2/2016	Broadcom	Brocade	5,900	Completed
10/31/2016	Inphi	ClariPhy	275	Completed
9/23/2016	Shanhai Capital	Analogix Semiconductor	500	Completed
9/13/2016	Renesas	Intersil	3,200	Completed
8/25/2016	Littelfuse Inc.	ON Semi's Ignition IGBT business	100	Completed
7/26/2016	Analog Devices	Linear Technology	14,800	Completed
7/17/2016	Softbank	ARM Holdings	32,000	Completed
6/15/2016	Cavium	QLogic	1,360	Completed
6/14/2016	JAC Capital	NXP's Standard Products Business	2,750	Completed
5/18/2016	ARM Holdings PLC	Apical Ltd	350	Completed
5/13/2016	NavInfo Co. Ltd	Autochips Heifei Inc.	598	Completed
4/28/2016	Cypress	Broadcom's IoT	550	Completed
3/3/2016	Cisco Systems	Leaba Semiconductor Ltd	320	Completed
2/23/2016	MKS Instruments	Newport Corporation	980	Completed
2/4/2016	FormFactor Inc	Cascade Microtech	296	Completed
1/13/2016	Microchip	Atmel	3,420	Completed
12/14/2015	Micron Techonology	Inotera Memories	3,200	Completed
11/18/2015	ON Semiconductor	Fairchild Semiconductor	2,400	Completed
10/26/2015	Integrated Device Technology	ZMDI	310	Completed
10/21/2015	Western Digital	Sandisk	19,000	Completed
10/20/2015	MicroSemi	PMC-Sierra	2,400	Completed
9/30/2015	Mellanox	Ezchip	811	Completed
9/7/2015	Mediatek	Richtek	879	Completed
6/1/2015	Intel	Altera	16,700	Completed

Source: Bloomberg Finance L.P. and company data.

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Table 8: Semiconductor Group and Comp Valuation

$ in millions, except for EPS

	JPM Rating	Market Cap	10/17/24 Price	Non-GAAP EPS C24E	Non-GAAP EPS C25E	P/E C24E	P/E C25E	Revenues C24E	Revenues C25E	P/S C24E	P/S C25E	Consensus Non-GAAP EPS C24E	Consensus Non-GAAP EPS C25E	Consensus Sales C24E	Consensus Sales C25E	Consensus P/E C24E	Consensus P/E C25E	Consensus P/S C24E	Consensus P/S C25E
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phone: 415-315-6700, email: harlan.sur@jpmchase.com																			
PC Semiconductors																			
INTC	UW	$95,751	$22.44	$0.29	$0.84	76.4	26.7	$52,075	$54,599	1.8	1.8	$0.25	$1.05	$52,274	$56,270	90.9	21.4	1.8	1.7
NVDA	OW	$3,402,437	$136.93	$2.81	$4.02	48.7	34.1	$125,219	$182,609	27.2	18.6	$2.74	$3.89	$120,984	$175,572	49.9	35.2	28.1	19.4
AMD	N	$255,781	$156.25	$3.41	$5.30	45.8	29.5	$25,732	$32,562	9.9	7.9	$3.40	$5.44	$25,604	$32,854	46.0	28.7	10.0	7.8
Memory																			
MU	OW	$126,056	$112.05	$3.95	$11.23	28.3	10.0	$29,085	$42,593	4.3	3.0	$4.50	$10.83	$30,164	$41,960	24.9	10.4	4.2	3.0
WDC	NR	$23,505	$67.35	$5.70	$7.64	11.8	8.8	$15,478	$16,783	1.5	1.4	$5.72	$8.90	$15,670	$18,298	11.8	7.6	1.5	1.3
Enterprise/Networking/Datacenter Semiconductors																			
MRVL	OW	$69,178	$79.91	$1.46	$2.42	54.6	33.1	$5,538	$7,466	12.5	9.3	$1.45	$2.53	$5,470	$7,338	55.2	31.6	12.6	9.4
AVGO	OW	$846,474	$181.53	$5.18	$6.53	35.0	27.8	$54,366	$63,196	15.6	13.4	$5.08	$6.41	$53,443	$62,198	35.7	28.3	15.8	13.6
ALAB	OW	$10,268	$65.99	$0.57	$0.80	115.1	82.4	$350	$504	29.4	20.4	$0.57	$0.79	$349	$498	116.2	83.4	29.4	20.6
Mobile Devices																			
SWKS	N	$15,827	$98.06	$5.99	$6.78	16.4	14.5	$4,063	$4,444	3.9	3.6	$5.98	$6.68	$4,068	$4,332	16.4	14.7	3.9	3.7
QRVO	UW	$10,064	$104.28	$6.13	$7.64	17.0	13.6	$3,905	$4,157	2.6	2.4	$6.05	$7.63	$3,910	$4,182	17.2	13.7	2.6	2.4
IoT																			
SLAB	OW	$3,730	$116.10	N/A	$2.03	N/A	57.1	$609	$908	6.1	4.1	($1.59)	$2.48	$604	$898	(73.1)	46.8	6.2	4.2
SYNA	OW	$2,901	$72.70	$2.75	$4.41	26.4	16.5	$997	$1,132	2.9	2.6	$2.76	$4.65	$1,003	$1,159	26.4	15.6	2.9	2.5
Analog/Microcontrollers																			
TXN	OW	$182,238	$198.30	$5.26	$1.45	37.7	136.8	$15,909	$18,856	11.5	9.7	$5.19	$6.35	$15,729	$17,861	38.2	31.2	11.6	10.2
ADI	OW	$113,396	$227.34	$6.11	$7.84	37.2	29.0	$9,178	$10,609	12.4	10.7	$6.26	$7.95	$9,290	$10,673	36.3	28.6	12.2	10.6
NXPI	N	$60,098	$232.28	$13.52	$14.74	17.2	15.8	$12,903	$13,790	4.7	4.4	$13.54	$15.31	$12,905	$13,955	17.2	15.2	4.7	4.3
MCHP	OW	$41,568	$76.58	$1.96	$2.47	39.0	31.0	$4,890	$5,383	8.5	7.7	$2.01	$2.96	$4,911	$5,747	38.1	25.9	8.5	7.2
Diversified/Consumer/Standard Components/Other																			
ON	N	$29,995	$69.24	$4.02	$4.65	17.2	14.9	$7,135	$7,719	4.2	3.9	$4.02	$4.75	$7,133	$7,717	17.2	14.6	4.2	3.9
MTSI	N	$8,362	$112.67	$2.72	$3.44	41.5	32.8	$775	$888	10.8	9.4	$2.74	$3.57	$776	$903	41.2	31.6	10.8	9.3
Foundries																			
GFS	N	$22,503	$40.40	$1.42	$1.90	28.4	21.3	$6,777	$7,677	3.3	2.9	$1.28	$1.79	$6,712	$7,623	31.5	22.6	3.4	3.0
OSAT																			
AMKR	OW	$7,671	$30.95	$1.56	$2.06	19.8	15.0	$6,496	$4,807	1.2	34.1	$1.57	$2.30	$6,508	$7,191	19.7	13.5	1.2	1.1
Semiconductor Capital Equipment																			
AMAT	OW	$152,639	$183.24	$8.67	$10.54	21.1	17.4	$27,619	$31,925	5.5	4.8	$8.63	$9.87	$27,444	$30,520	21.2	18.6	5.6	5.0
LRCX	OW	$95,895	$73.14	$3.25	$4.00	22.5	18.3	$15,965	$18,700	6.0	5.1	$3.25	$4.02	$15,945	$18,738	22.5	18.2	6.0	5.1
KLAC	OW	$90,713	$670.25	$26.32	$31.86	25.5	21.0	$10,534	$12,100	8.6	7.5	$26.34	$31.67	$10,544	$12,031	25.5	21.2	8.6	7.5
Chip Design Automation Software																			
ARM	OW	$163,876	$154.60	$1.34	$2.06	115.6	75.0	$3,617	$4,807	45.3	34.1	$1.36	$2.05	$3,629	$4,841	114.0	75.3	45.2	33.8
CDNS	N	$71,944	$263.03	$5.87	$6.92	44.8	38.0	$4,630	$5,290	15.5	13.6	$5.89	$6.92	$4,626	$5,264	44.7	38.0	15.6	13.7
SNPS	OW	$78,798	$504.69	$13.13	$15.91	38.4	31.7	$6,282	$2,023	12.5	39.0	$13.33	$15.40	$6,271	$7,062	37.9	32.8	12.6	11.2
Large Cap Semi Average						**40.8**	**37.8**			**10.7**	**8.7**					**42.4**	**26.1**	**10.8**	**8.8**
Small-Mid Cap Semi Average						**25.2**	**29.6**			**5.9**	**5.0**					**25.2**	**19.9**	**5.9**	**5.2**
Semi Group Average (ex-outliers)						**34.8**	**33.1**			**7.6**	**6.6**					**36.3**	**23.3**	**7.7**	**6.6**
SOX Index			**5,205**	**143**	**229**	**36.5**	**22.8**			**7.1**	**6.0**					**36.5**	**22.8**	**7.1**	**6.0**
S&P500			**5,841**	**237**	**273**	**24.7**	**21.4**			**3.1**	**2.9**					**24.7**	**21.4**	**3.1**	**2.9**

Source: Company reports, Bloomberg Finance L.P., and J.P. Morgan estimates. Pricing as of market close 10/17/2024.

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