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Taiwan Semiconductor Manufacturing Co.

Structural positive on advanced nodes with AI; raise PO to NT$880

Reiterate Rating: BUY | PO: 880.00 TWD | Price: 753.00 TWD

Key enabler of AI with long-lasting leadership

We raise PO to NT$880 (US$155) as we expect the structural advanced node demand to be stronger, supported by AI strength, computing power, power and saving requirement. In addition, Intel's recent confirmation on outsourcing Lunar/Arrow Lake CPU tiles to TSMC should contribute and bode well for TSMC's industry leadership.

AI highlights the strengths of advanced nodes

We see enhanced importance of advanced nodes with the greater computing power requirements brought by AI, echoing the positive view from OpenAI CEO, Sam Altman, and TSMC founder, Dr. Morris Chang. Besides, advanced nodes are essential and effective to reduce ever-surging electricity consumption. We expect industry leading-edge foundry revenue (sub-7nm) to post 22% CAGR in 2023-25E.

Intel outsourcing – contribution to rise to 3%/6% in '24/25

At Intel Foundry event on Feb 21, Intel's CEO confirmed to outsource CPU tiles of Arrow and Lunar Lake to TSMC N3. Thus, contribution from Intel should rise to 3%/6% in 2024/25E. This also signifies the continuous leadership of TSMC in PPAC.

More room for re-rating

TSMC share price has risen 27% YTD, backed by AI strength and industry recovery. The forward P/E tends to move along with SOX since 2020 but underperformed in 2H23-2024YTD. Hence, we believe its valuation should catch up and deserves a re-rating since TSMC is indispensable in the AI era.

Estimates (Dec) (NT$)	2022A	2023A	2024E	2025E	2026E
Net Income (Adjusted - mn)	1,016,530	838,498	1,019,087	1,263,157	1,495,059
EPS	39.2	32.3	39.3	48.7	57.7
EPS Change (YoY)	70.4%	-17.5%	21.5%	23.9%	18.4%
Dividend / Share	11.00	13.00	14.50	16.50	19.25
Free Cash Flow / Share	20.4	11.3	29.6	38.8	48.6
ADR EPS (US$)	6.58	5.19	6.24	7.73	9.15
ADR Dividend / Share (US$)	1.85	2.09	2.30	2.62	3.06
Valuation (Dec)					
P/E	19.2x	23.3x	19.2x	15.5x	13.1x
Dividend Yield	1.5%	1.7%	1.9%	2.2%	2.6%
EV / EBITDA*	12.1x	12.9x	10.3x	8.4x	7.2x
Free Cash Flow Yield*	2.7%	1.5%	3.9%	5.2%	6.5%

* For full definitions of *iQ*method℠ measures, see page 25.

18 March 2024

Equity

Key Changes

(NT$)	Previous	Current
Price Obj.	760.0	880.0
2024E EPS	39.05	39.30
2025E EPS	48.25	48.71
2026E EPS	NA	57.65
2024E EBITDA (m)	1,815,748	1,823,810
2025E EBITDA (m)	2,222,376	2,237,992
2026E EBITDA (m)	NA	2,608,596

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Stock Data

Price (Common / ADR)	753.00 TWD / 136.99 USD
Price Objective	880.00 TWD / 155.00 USD
Date Established	18-Mar-2024 / 18-Mar-2024
Investment Opinion	B-1-7 / B-1-7
52-Week Range	489.00 TWD-796.00 TWD
Market Value (mn)	620,207 USD
Market Value (mn)	19,529,078 TWD
Shares Outstanding (mn)	25,935.0 / 5,187.0
Average Daily Value (mn)	1,245 USD
Free Float	92.0%
BofA Ticker / Exchange	TSMWF / TAI
BofA Ticker / Exchange	TSM / NYS
Bloomberg / Reuters	2330 TT / 2330.TW
ROE (2024E)	27.1%
Net Dbt to Eqty (Dec-2023A)	-21.8%

Exhibit 1: Acronyms

Acronyms and the corresponding full names

Acronym	Full name
AI	Artificial Intelligence
CEO	Chief Executive Officer
CPU	Central Processing Unit
N3	3-nanometer
PPAC	Power, Performance, Area, Cost

Source: BofA Global Research

Refer to important disclosures on page 26 to 29. Analyst Certification on page 23. Price Objective Basis/Risk on page 23.
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Timestamp: 17 March 2024 04:30PM EDT

iQprofile℠ Taiwan Semiconductor Manufacturing Co.

Key Income Statement Data (Dec)	2022A	2023A	2024E	2025E	2026E
(NT$ Millions)					
Sales	2,263,891	2,161,736	2,689,551	3,242,074	3,817,525
Gross Profit	1,348,355	1,175,111	1,426,878	1,774,577	2,098,347
Sell General & Admin Expense	(63,445)	(71,464)	(72,129)	(88,988)	(100,862)
Operating Profit	1,121,279	921,466	1,146,481	1,434,985	1,708,908
Net Interest & Other Income	22,912	57,705	53,649	52,397	52,916
Associates	NA	NA	NA	NA	NA
Pretax Income	1,144,191	979,171	1,200,130	1,487,382	1,761,823
Tax (expense) / Benefit	(127,290)	(141,403)	(181,962)	(225,189)	(267,736)
Net Income (Adjusted)	1,016,530	838,498	1,019,087	1,263,157	1,495,059
Average Fully Diluted Shares Outstanding	25,931	25,932	25,932	25,932	25,932
Key Cash Flow Statement Data					
Net Income	1,016,530	838,498	1,019,087	1,263,157	1,495,059
Depreciation & Amortization	437,254	532,190	677,328	803,007	899,689
Change in Working Capital	(64,994)	(37,713)	(20,685)	(44,453)	(39,417)
Deferred Taxation Charge	NA	NA	NA	NA	NA
Other Adjustments, Net	221,809	(91,009)	34,299	(9,494)	4,486
Cash Flow from Operations	1,610,599	1,241,967	1,710,029	2,012,216	2,359,817
Capital Expenditure	(1,082,672)	(949,817)	(942,004)	(1,004,804)	(1,099,004)
(Acquisition) / Disposal of Investments	(130,522)	(108,194)	(1,313)	(82)	(5)
Other Cash Inflow / (Outflow)	22,266	151,890	(2,051)	316	757
Cash Flow from Investing	(1,190,928)	(906,120)	(945,368)	(1,004,570)	(1,098,252)
Shares Issue / (Repurchase)	0	0	0	0	0
Cost of Dividends Paid	(285,238)	(285,248)	(337,117)	(376,015)	(427,879)
Cash Flow from Financing	(200,244)	(204,894)	(341,980)	(375,746)	(427,665)
Free Cash Flow	527,927	292,150	768,025	1,007,412	1,260,813
Net Debt	(703,075)	(759,439)	(1,192,389)	(1,824,358)	(2,658,065)
Change in Net Debt	(135,238)	(60,981)	(427,545)	(631,631)	(833,686)
Key Balance Sheet Data					
Property, Plant & Equipment	2,693,837	3,064,475	3,430,131	3,633,777	3,781,988
Other Non-Current Assets	218,045	273,863	272,633	272,897	272,966
Trade Receivables	231,340	201,938	210,383	226,162	237,054
Cash & Equivalents	1,561,486	1,687,645	2,115,733	2,747,970	3,581,891
Other Current Assets	260,071	304,450	325,677	375,575	417,350
Total Assets	4,964,779	5,532,371	6,354,556	7,256,382	8,291,249
Long-Term Debt	839,096	918,913	914,824	915,219	915,451
Other Non-Current Liabilities	220,967	216,612	431,449	489,950	552,742
Short-Term Debt	19,314	9,293	8,519	8,393	8,375
Other Current Liabilities	924,913	904,290	921,746	951,525	973,416
Total Liabilities	2,004,290	2,049,108	2,276,539	2,365,088	2,449,984
Total Equity	2,960,489	3,483,263	4,078,017	4,891,295	5,841,265
Total Equity & Liabilities	4,964,779	5,532,371	6,354,556	7,256,382	8,291,249
iQmethod℠ **- Bus Performance***					
Return On Capital Employed	28.5%	19.4%	20.4%	21.6%	22.0%
Return On Equity	39.8%	26.2%	27.1%	28.3%	28.0%
Operating Margin	49.5%	42.6%	42.6%	44.3%	44.8%
EBITDA Margin	68.8%	67.2%	67.8%	69.0%	68.3%
iQmethod℠ **- Quality of Earnings***					
Cash Realization Ratio	1.6x	1.5x	1.7x	1.6x	1.6x
Asset Replacement Ratio	2.5x	1.8x	1.4x	1.3x	1.2x
Tax Rate (Reported)	11.1%	14.4%	15.2%	15.1%	15.2%
Net Debt-to-Equity Ratio	-23.7%	-21.8%	-29.2%	-37.3%	-45.5%
Interest Cover	NM	NM	NM	NM	NM

Key Metrics

* For full definitions of *iQmethod*℠ measures, see page 25.

Company Sector

Semiconductors

Company Description

TSMC was founded in 1987 and is listed in Taiwan (2330TT) and the US (TSM/NYS).TSMC is the largest and global leader in integrated circuit (IC) manufacturing. As a build-to-order foundry, it provides a wide range of value-add activities: IC manufacturing, mask-making, IC design services, turnkey solutions, and process development. We attribute its success to its proven, winning business model, unparalleled scale advantage, optimized execution, and technology scope and depth. 5 shares = 1 ADR.

Investment Rationale

The ongoing semi content growth in mobile, rise of artificial intelligence (AI), and proliferation of Internet of Things (IoT) should result in sustainable upside in aggregate computing power globally. TSMC, as the leading contract manufacturer of semiconductor chips, is in a good position to capitalize. We are structurally positive on TSMC and expect it to sustain over 15% growth with rising FCF and dividends during 2021-25E.

Stock Data

Shares / ADR	5.00
Price to Book Value	4.8x

Key Changes

(US$)	Previous	Current
Price Obj.	130.00	155.00
2024E EPS	6.20	6.24
2025E EPS	7.66	7.73
2026E EPS	NA	9.15

Rising leading-edge demand reaffirmed

Visible rise in leading-edge demand (Open AI)

Strong multi-year AI chip demand implied by OpenAI's US$7tn ambition

According to media reports, OpenAI CEO, Sam Altman, has recently been attempting to raise up to US$7tn to boost semiconductor manufacturing capacity for AI chips and help ease the global chip shortage issues by 1) seeking the US government approval/support; 2) discussing with potential investors including the ones in Middle-East; and 3) discussing with foundry/IDM suppliers such as TSMC, Samsung, and Intel for potential JVs (foundry/IDM to operate the fabs).

In our view, TSMC is unlikely to engage in this big plan given the high risks (ie, building capacities only on AI demand), huge investment amount, and its already fast-expanding global footprints. Taking TSMC's Arizona fab Phase-1/2 as an example, 50k+ monthly capacity for leading-edge nodes in the US requires US$40bn capex investment. In other words, US$7tn investment can translate into 175 two-phase US fabs in total, which will definitely reshape global semis manufacturing industry.

Exhibit 2: TSMC's announced expansion plans in US/Japan/Germany
Kumamoto site to have largest capacity scale among the new overseas fabs

Company	Announcement Date	Confirmed or potential	Time to go on stream	Location	Capex amount (US$bn)	Technology node	Capacity (kwpm)
TSMC	Nov-21 (with Sony), Feb-22 (+ DENSO), Feb-24 (+ Toyota)	Confirmed	First fab late-2024 Second fab late-2027	Kumamoto, Japan	20+	6/7, 12/16, 22/28, 40nm	100+
TSMC	May-20, Dec-22	Confirmed	Phase 1 2024 Phase 2 2026	Arizona, US	40	Phase 1 4nm (5nm family) Phase 2 3nm	50+
TSMC	Aug-23 (with Bosch, Infineon, and NXP)	Confirmed	Late-2027	Dresden, Germany	11	12/16, 22/28nm	40

Source: BofA Global Research, company data

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TSMC founder's recent comments echoing sustained AI capacity shortage

Despite the low likelihood for the US$7tn investment plan, we believe OpenAI's ambitions clearly indicate leading-edge capacity shortage in the coming years, driven mainly by the requirements for AI computing power. TSMC founder, Dr. Morris Chang's recent comments at JASM's opening ceremony also suggest that AI demand will consume likely a significant capacity measured by foundry fabs. In our view, TSMC should continue to benefit from the surging AI demand as the key advanced AI chip enabler with both advanced nodes and advanced packaging offerings, and we see upside to its guidance of high-teens % revenue contribution from cloud AI in 2027.

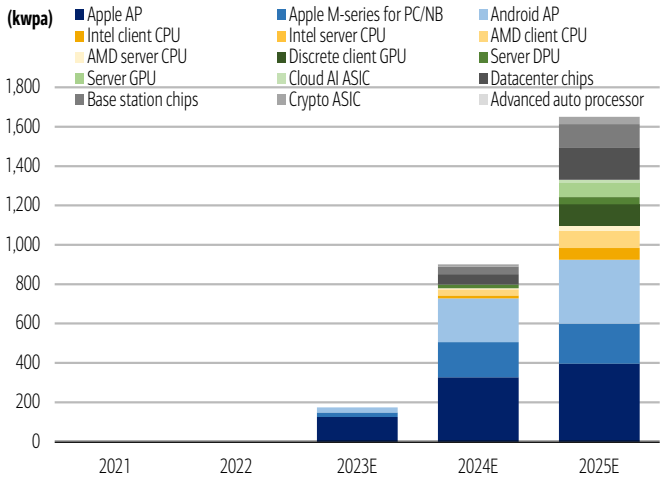
Leading-edge demand forecast with AI

Backed by AI strength, we expect leading-edge node foundry to outperform mature node in 2024, also in view of a better supply/demand landscape (less competition and structural AI/HPC demand) as we discussed in our Foundry S/D monitor. Thanks to the strong AI momentum and demand visibility, we raise our leading-edge foundry (sub-7nm) revenue growth to 22% CAGR over 2023-25E (previously 18%), reaching US$78bn in 2025, led by 3nm and 5nm. TSMC will remain as the go-to supplier across AI and non-AI applications.

3nm – stronger ramps led by AI

On top of Apple, MediaTek, QCOM, we see NVIDIA, Intel, AMD adopting 3nm for their new products from 2H24. NVIDIA's 3nm-based B100 datacenter GPU will fuel growth from 2024. With recent confirmation from Intel, 3nm-based CPU tiles of Arrow/Lunar Lake will be outsourced to TSMC. We now estimate the 3nm foundry S/D ratio will rise to 81%/100% in 2024/25, from 28% in 2023, thanks to HPC and AI megatrend.

Exhibit 3: 3nm foundry demand breakdown, 2021-25E
Steep 3nm ramp in 2024-25E with key customers' migrations



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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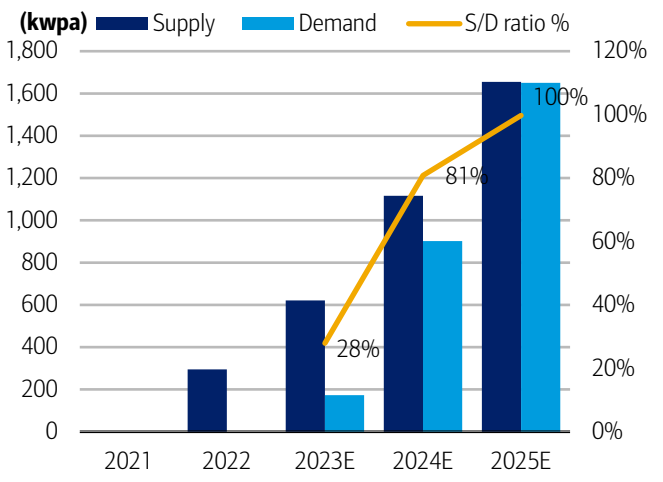
Exhibit 4: 3nm foundry supply-demand situation, 2021-25E
We expect 3nm S/D ratio to start at 28% in 2023 and rise to 100% in 2025



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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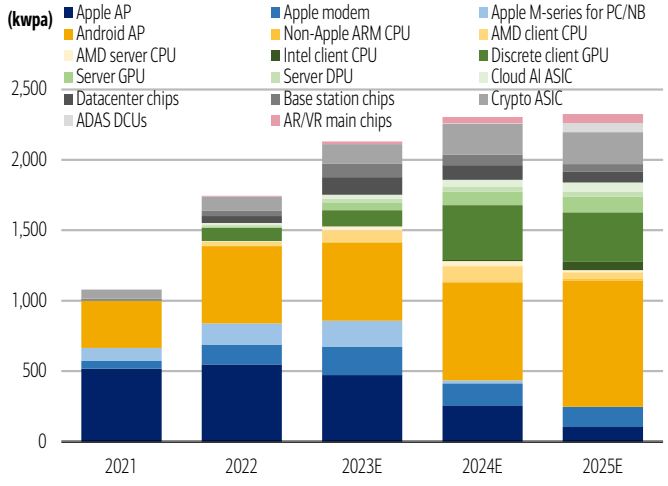
5nm – tighter S/D supported by high-end Android and new adoptions

We believe the 5nm foundry capacity will be tight in 2024/25 and the S/D likely reaches 97%/102% in 2024/25, from the 90% trough in 2023. This should be supported by 1) outperformance in high-end Android smartphone demand; 2) spec upgrade of Android AP and gaming GPU; 3) booming AI GPU demand; and 4) new adoptions by Intel Meteor Lake graphic tile, AI ASIC, and other second-wave chipsets. Besides, partial 5nm foundry tools are converted to accommodate the strong 3nm demand, resulting in a tight supply.

Exhibit 5: 4-5nm foundry demand breakdown, 2021-25E
We expect second-wave applications to support 4-5nm demand in 2024-25



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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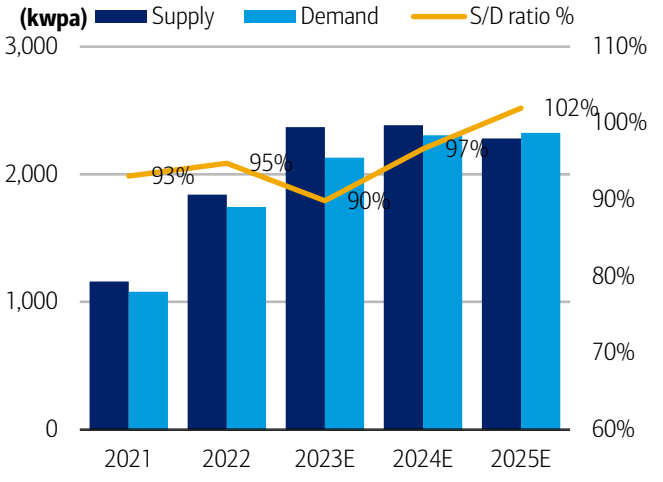
Exhibit 6: 4-5nm foundry supply-demand situation, 2021-25E
We estimate 4-5nm S/D ratios at 97%/102% in 2024/25



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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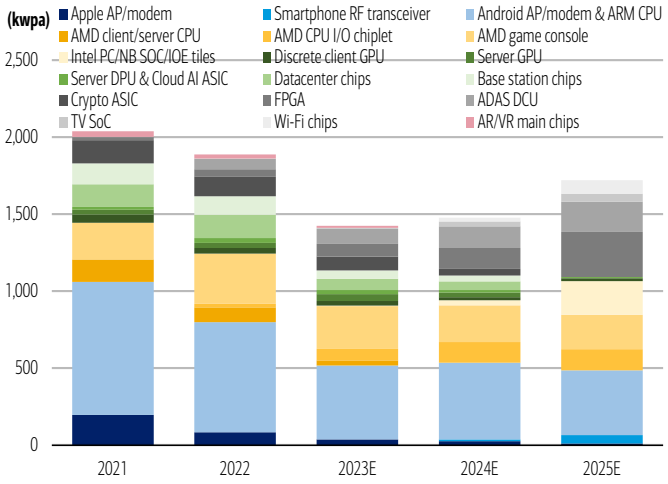
7nm and 8-11nm – relatively muted outlook among advanced nodes

We now expect the 6-7nm foundry S/D to recover to 76%/88% (previously 75%/88%) in 2024/25, thanks to the resilient 7nm-based ASIC demand. With the strong inference demand, tight 3nm/5nm supply, and growing AI demand, we see still many ASICs based on 7nm (Google TPU, Intel/Habana Gaudi, Meta MTIA, etc.). It supports the 7nm UTR until there are more meaningful 7nm drivers (RF mixed-signal, Wi-Fi 7 chipsets, and FPGA) to fuel the demand from 2025.

Exhibit 7: 6/7nm foundry demand breakdown, 2021-25E
We expect a later recovery in 6/7nm demand than 3/5nm families



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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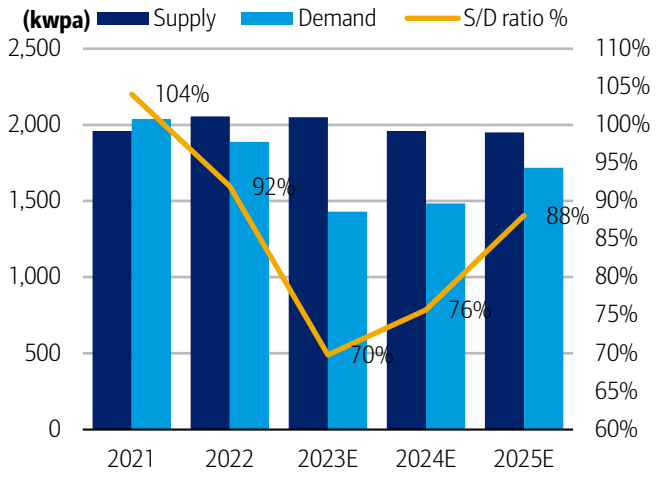
Exhibit 8: 6/7nm foundry supply-demand situation, 2021-25E
We expect 6/7nm S/D ratios to be 76%/88% in 2024/25



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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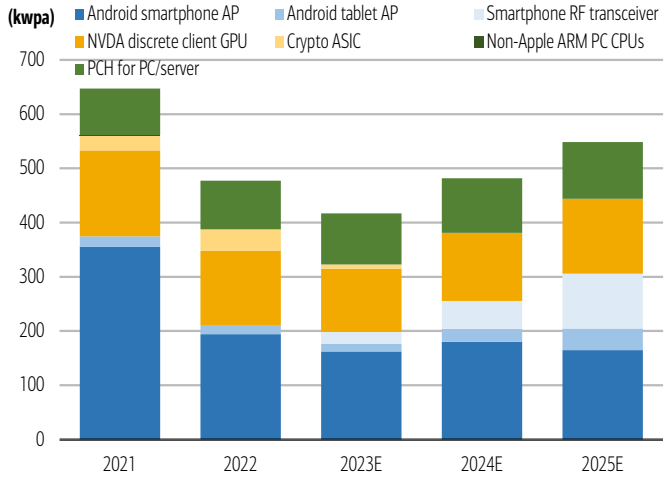
Exhibit 9: 8-11nm foundry demand breakdown, 2021-25E
Key new demand driver in 2024/25 could be smartphone RF transceiver



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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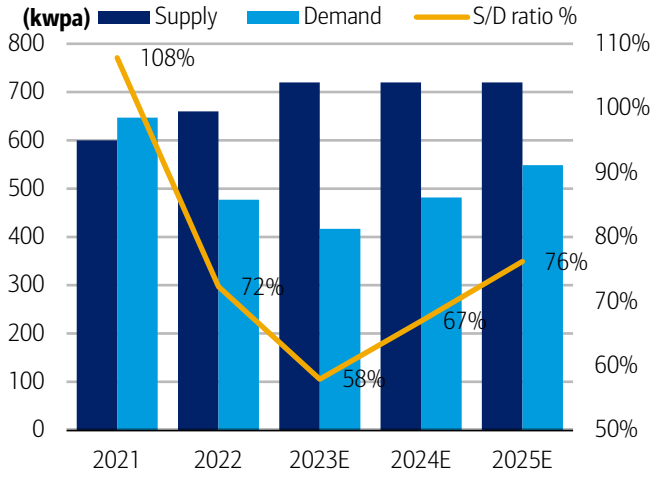
Exhibit 10: 8-11nm foundry supply-demand situation, 2021-25E
We expect 8-11nm S/D ratios to be 67%/76% in 2024/25



Source: BofA Global Research estimates, TechInsights, Gartner, IDC, Trendforce, company data
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Well-positioned in both leading-edge cloud and edge AI

TSMC projected a low-to-mid-20% YoY revenue growth in 2024 on advanced nodes expansion and booming demand for generative AI computing. In view of growing clients' demand forecasts over the past few months, mgmt. raised the guidance of the cloud AI contribution to high-teen (or higher) % of revenue in 2027 (vs. low-teens earlier) with capacity expansions for both front-/back-end (requested by clients) in its January earnings conference. The brighter long-term AI outlook shared by TSMC and the solid capex plan for 2024 both suggest structural demand uptrend for leading-edge nodes, in our view, with which TSMC's industry leadership should further be solidified.

Exhibit 11: Latest AI chips powered by TSMC processes
Key AI chips of major AI vendors are generally based on TSMC 3-7nm nodes

Company	Chip name	Launch year	Chip type	Applications	Node
Amazon	Graviton4	2023	CPU	AWS cloud computing	T 5nm
Amazon	Trainium2	2023	ASIC	AI accelerator (Training)	T 5nm
AMD	Instinct MI300	2023	APU	Cloud computing	T 5nm
Google	TPU v5	2024 (E)	ASIC	Google server	T 5nm (E)
Habana (under Intel)	Gaudi 3	2024 (E)	ASIC	AI accelerator (Training)	T 5nm (E)
NVIDIA	H100	2022	GPU	Cloud computing	T 4nm
NVIDIA	H200	2024 (E)	GPU	Cloud computing	T 4nm
NVIDIA	B100	2024 (E)	GPU	Cloud computing	T 3nm
Meta	MTIA	2025 (E)	ASIC	AI accelerator	T 7nm (E)
Microsoft	Maia 100	2024 (E)	ASIC	AI accelerator	T 5nm
Microsoft	Cobalt 100	2024 (E)	ASIC	Cloud computing	T 5nm

Source: BofA Global Research, company data

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On top of the robust cloud AI computing demand, TSMC is also positive on AI's proliferation into edge devices, which could bring growth for both HPC and leading-edge. As TSMC shared in January earnings conference, it has seen clients adding neural engines into their SoC to enable AI functions in smartphones and PCs. Thus, the chip die size is likely to enlarge. This observation echoes our view that the neural engine size will get bigger over time to offer stronger AI functions. We estimate end-device AI to contribute 2%/4% of TSMC's revenue in 2024/25E, which should further increase in coming years.

Exhibit 12: Aggregate end-device AI TAM summary for TSMC
We estimate aggregate end-device AI TAM to be US$1.2/1.9/4.4bn (99/186/487k wafers) for TSMC in 2023/24/25, or 2%/2%/4% revenue contribution

	Unit	2023	2024	2025
Smartphone/tablet Assistive AI TAM for TSMC	US$bn	1.1	1.1	1.1
Smartphone/tablet Generative AI TAM for TSMC	US$bn	0.0	0.4	2.2
AIoT TAM for TSMC	US$bn	0.1	0.2	0.8
Automotive AI TAM for TSMC	US$bn	0.0	0.1	0.3
Total TAM for TSMC	**US$bn**	**1.2**	**1.9**	**4.4**
BofAe TSMC revenue	US$bn	69	86	103
Smartphone/tablet Assistive AI contribution to BofAe TSMC revenue	%	2%	1%	1%
Smartphone/tablet Generative AI contribution to BofAe TSMC revenue	%	0%	1%	2%
AIoT contribution to BofAe TSMC revenue	%	0%	0%	1%
Automotive AI contribution to BofAe TSMC revenue	%	0%	0%	0%
Total potential contribution for TSMC	**%**	**2%**	**2%**	**4%**
Smartphone/tablet Assistive AI wafer consumption for TSMC	k wafers	70	74	76
Smartphone/tablet Generative AI wafer consumption for TSMC	k wafers	1	26	128
AIoT wafer consumption for TSMC	k wafers	24	76	252
Automotive AI wafer consumption for TSMC	k wafers	5	10	32
Total wafer consumption for TSMC	**k wafers**	**99**	**186**	**487**

Source: BofA Global Research estimates

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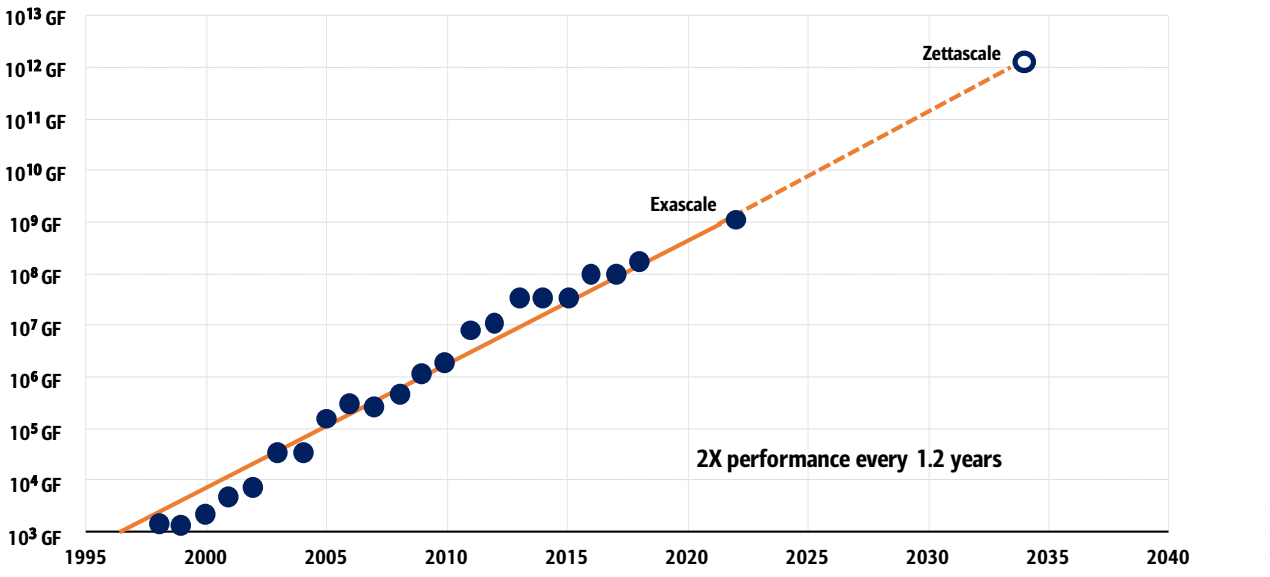
Energy saving through leading edge

We have seen growing concerns about the rapid increase in power consumption with the rising computing power demand. CPU and GPU performance doubles every ~2.4 years, but the power efficiency improvement relatively stalled. At ISSCC 2023, Dr. Lisa Su, the CEO of AMD, urged the HPC industry to be significantly more power efficient, otherwise one supercomputer capable of zettaflop performance may require up to 500 MW of power (vs 1,000 MW capacity of a nuclear reactor), equating to the power consumption of several thousand households. Therefore, we see growing importance and emphasis in compute efficiency, while considering sustainability and environmental protection. In other words, we believe the concerns about slower adoption pace of advanced nodes should reduce with increasing awareness on power-consumption issues.

Exhibit 13: AMD's supercomputing system performance
AMD's supercomputing have doubled in performance per 1.2 years since the late-1990s



Source: BofA Global Research, AMD

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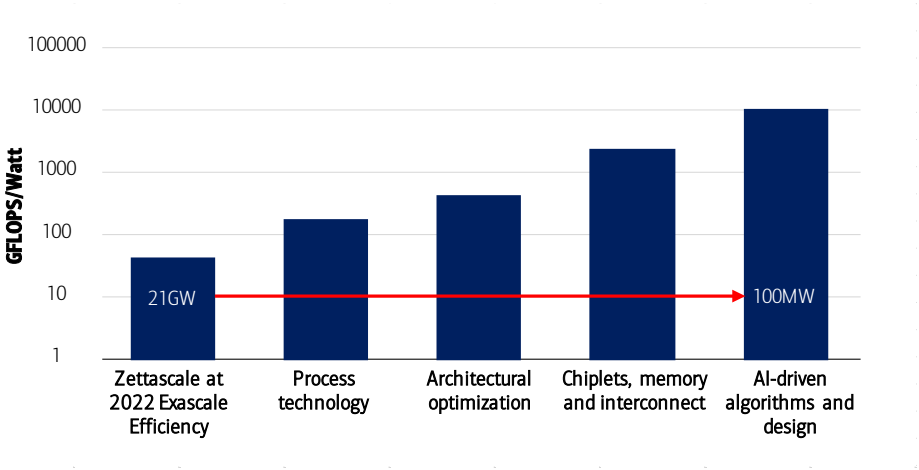
Exhibit 14: AMD - Efficiency roadmap to Zettascale leveraging AI
Zettascale machine efficiency with AI-capability is estimated to be at about 100 megawatts



Source: BofA Global Research, AMD

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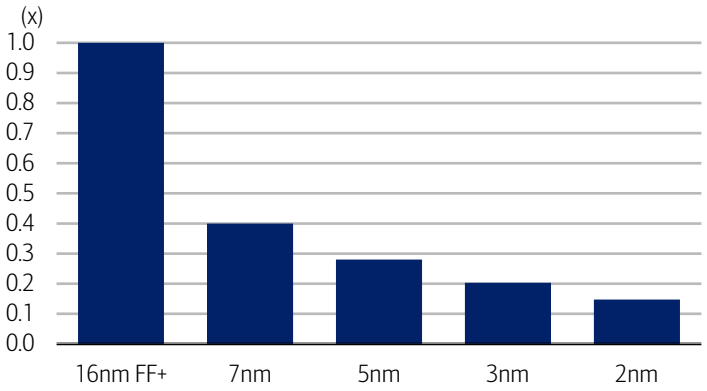
According to industry sources, the key focus areas are: 1) adopting semiconductor with lower power consumption; 2) optimizing the HPC performance by AI and ML; and 3) innovative cooling and heat-recycling methods. While semiconductors consume a substantial portion of power in a supercomputer, we believe the adoption of leading-edge nodes could be an answer. It can save 30% of power when a 7nm chip transitions to 5nm, 25-34% when 5nm upgrades to 3nm, and another 25-30% when migrating from N3E to N2, etc.

Exhibit 15: Power consumption comparison for TSMC 16nm FF+/7nm/5nm/3nm/2nm
In each new node, TSMC achieves lower power consumption



Source: Company data, BofA Global Research
*Note: Using 16nm FF+ as basis (1x) for comparison

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Exhibit 16: TSMC's node comparison
Lower power consumption and higher performance with the adoption of leading-edge nodes

	N5 vs N7	N3 vs N5	N3E vs N5	N2 vs N3E
Power	-30%	-25-30%	-34%	-25-30%
Performance	+15%	+10-15%	+18%	+10-15%
Chip Density	-	-	~1.3X	>1.15X
Volume manufacturing	2Q22	2H22	2Q/3Q23	2H25

Source: BofA Global Research estimates

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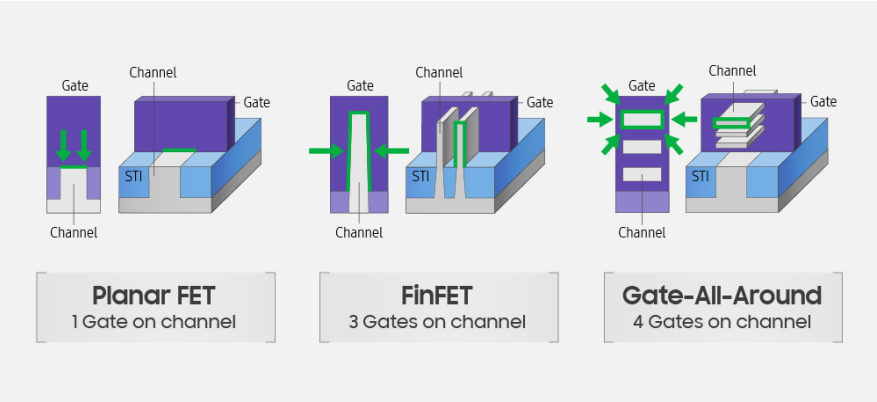
TSMC tackles the power consumption from all angles

TSMC has been the leader in semiconductor process technology, and dedicated to reducing power consumption via low-power design techniques, advanced material, innovative chip architecture (advanced packaging), and collaboration with supply chain partners.

Process technology (5nm, 3nm, 2nm) is critical for power saving. And GAA is the foundry industry's focus and is key to be a winner in the next 5-10 years. It allows node migration beyond current FinFET to improve performance, energy consumption, and form factor of a chip. While GAA has much higher entry barriers than FinFET and provides no leapfrog opportunities to industry followers, we believe TSMC will continue to lead in the GAA era despite aggressive peers' roadmap, thanks to its broad client base, vast experience, optimal cost structure. GAA should help further solidify TSMC's industry position and increase its market share. We expect GAA to account for >10% of TSMC revenue from 2H26.

TSMC will enter GAA-based 2nm production in 2025, and we expect 2nm to contribute more meaningfully in 2026. The node is expected to improve GPM profile in the long term due to the higher value and lower competition. We do not see any leapfrog opportunities when a firm migrates to GAA, which requires solid FinFET capabilities as the foundation, as one must first learn to walk before running. GAA is the go-to solution for wafer fabrication vs. FinFET, if one seeks (1) to compete in leading edge beyond 3nm node and reach a finer geometric scaling for transistor; and (2) to better manage the issues in gate and channel control (leakage). We believe scaling should continue at least for the next 10-20 years, as R&D on A10 (1nm)/A7 (0.7nm) or even A2 (0.2nm) is likely to drive the geometric scaling forward.

Exhibit 17: Comparison of Planar FET, FinFET and GAA structure
The channel under FinFET structure is surrounded by the gate on three fronts, while the gate is all around the channel in GAA structure



Source: Samsung

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Advanced material adoption could improve the chip performance or lower the power consumption. Adopting high-electron mobility transistor (HEMT) materials could enable faster electron movement to enhance performance. Such materials may include but are not limited to Ge (Germanium) and Sn (Stannum). We note the biggest challenge may lie in ensuring (1) the material is in uniform shape; and (2) the structure (of GAA) is complete enough. For even longer term, we note 2D materials like Sb (Stibium) and Ru (Radon) may be needed to achieve better performance. High-K dielectric is a way to optimize the current that passes through the channel, through replacing SiO2 by other high-K Oxide materials (e.g., HfO2) and making dielectric layer thinner.

Lower power design techniques can help minimize power consumption of the silicon by body biasing, multi-voltage domains, transistor sizing, power gating, and clock gating. TSMC's efforts can be reflected by the ULP (ultra-low power) variations across multiple nodes (3nm, 6nm, 12nm, 22nm, 40nm) to improve energy consumption, battery life, and carbon emissions.

Innovative chip structure (or **advanced packaging**) is one of the major ways to enhance overall chip performance and lower power consumption through reduced interconnect length, optimized power delivery, and efficient thermal management, beyond geometric scaling on transistors. TSMC's value proposition in the supply chain (to customers) is increased by extending the supply chain by forward-integrating packaging service in the advanced packaging era. We believe TSMC, with a wider client portfolio, strong execution, leading-edge leadership, and a more comprehensive offerings in advanced packaging, should be well positioned to solve potential yield issues and benefit from the uptrend.

Intel competition and collaboration

Competition: TSMC leadership to continue

Intel established its intel Foundry Services division (IFS) in 2021 and set up "5 nodes in 4 years" goal to compete with TSMC in the foundry business. At the IFS Direct Connect 2024 in Feb, Intel released its extended process roadmap into 2027 and new back-end capabilities for AI era, and Microsoft is alluded to be a potential foundry customer for 18A. Intel indicated the technology development stays on track with Intel 7/4/3/20A/18A to be completed by 2024, and Intel revised its foundry roadmap most recently by moving up Intel 14A to 2026 and introducing Intel 10A (1nm), which is scheduled for trial production in 2027.

Intel is now striving to regain advanced nodes leadership by 2025 through Intel 18A and to become the world's second-largest foundry by 2030. In our view, any additional foundry client/partnership announcement by Intel in the future will not be a surprise with its aggressive business expansion, yet we see execution, scale, and yield rate as the key for foundry competition. We are confident on TSMC's leadership in foundry business with outstanding tech, cost structure, and scalability, without conflicts of interest with clients as a pure-play wafer foundry.

Exhibit 18: Comparison of TSMC, Intel, and Samsung process development roadmaps in leading-edge foundry nodes
The three firms plan to enter 1.4nm (14A) node in 2027

		2023			2024		2025		2026		2027		2028
Process	TSMC	N3 N4P/N4X	N3E N5A			N3P	N3X	N2	N2P/N2X (with BPD) N3A		A14		
	INTC	I-7	I-4	I-3	I-20A (PowerVia, RibbonFET)			I-18A	I-18A-P		I-14A (High NA)		I-14A-E
	Samsung	3GAE			3GAP			SF2	SF2P		SF1.4		
Transistor	TSMC	FinFET			Gate-All-Around								
	INTC												
	Samsung												
Intel products			Meteor Lake (EUV)		Sierra Forest (more EUV), Granite Rapids (Full collection of cell libraries)	Arrow Lake, Lunar Lake		Clearwater Forest, Panther Lake					

Source: BofA Global Research estimates, company data
*Note: the roadmaps are based on BofAe volume production timeline

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Collaboration: core computing tile outsourcing confirmed

On top of the product roadmap updates, Intel's CEO also confirmed the outsourcing of computing tiles for Arrow and Lunar Lake (PC CPU platforms) to TSMC N3 recently at public event. This also signifies the continuous leadership of TSMC in power, performance, area, cost (PPAC), in our view. After factoring in the new computing tiles, we estimate Intel's revenue contribution to be 3%/6% in 2024/25E. Our key assumptions for Intel's PC CPU orders at TSMC include:

1. 5nm graphic/6nm SOC/6nm IOE tiles of Meteor Lake, which was officially launched in Dec 2023

2. 3nm graphic/5nm IOE tiles of Lunar Lake for NB processor, which is expected to be launched in late-2024

3. 3nm computing tiles of Arrow Lake/Lunar Lake for PC/NB processors, which are both expected to be launched in late-2024

Exhibit 19: Intel's potential contribution to TSMC by node/application in 2021-25E
We now estimate Intel's revenue contribution will be 3%/6% in 2024/25

		Wafer volume (k wafers)					Revenue contribution (US$mn)				
Node	**Applications**	**2021**	**2022**	**2023E**	**2024E**	**2025E**	**2021**	**2022**	**2023E**	**2024E**	**2025E**
3nm											
	PC/NB CPU computing tile				14	44				258	839
	PC/NB CPU graphic tile				1	15				25	289
4-5nm											
	PC/NB CPU graphic tile			1	8	52			14	128	890
	PC/NB CPU IOE tile				0	6				7	95
	Datacenter GPU computing tile		1	3	3	4		9	51	59	60
	Crypto ASIC		18	11	0	0		289	178	0	0
	Habana ASIC				5	13				78	221
6-7nm											
	PC/NB CPU SOC/IOE tiles			3	33	217			40	390	2,605
	Client GPU		9	13	13	13		113	152	154	160
	Datacenter GPU I/O tile		0	1	1	1		1	6	8	10
	Mobileye auto DCU	2	47	49	56	79	20	563	586	672	947
	Habana ASIC		1	6	3	0		14	67	41	0
12-20nm											
	PC/NB/tablet Wi-Fi chips	1	2	5	8	10	5	14	31	55	63
	Habana ASIC	1	1				6	9			
22-32nm											
	PC/NB/tablet Wi-Fi chips	16	15	13	10	9	57	62	57	46	41
	Altera FPGA	52	55	58	64	71	183	222	262	290	320
40-45nm											
	PC/NB/tablet Wi-Fi chips	17	10	5	3	0	49	33	16	11	1
Total revenue contribution							**319**	**1,328**	**1,461**	**2,223**	**6,541**
TSMC revenue							56,758	75,881	69,298	85,654	103,250
Contribution % to TSMC							**1%**	**2%**	**2%**	**3%**	**6%**

Source: BofA Global Research estimates, Gartner, IDC, company data

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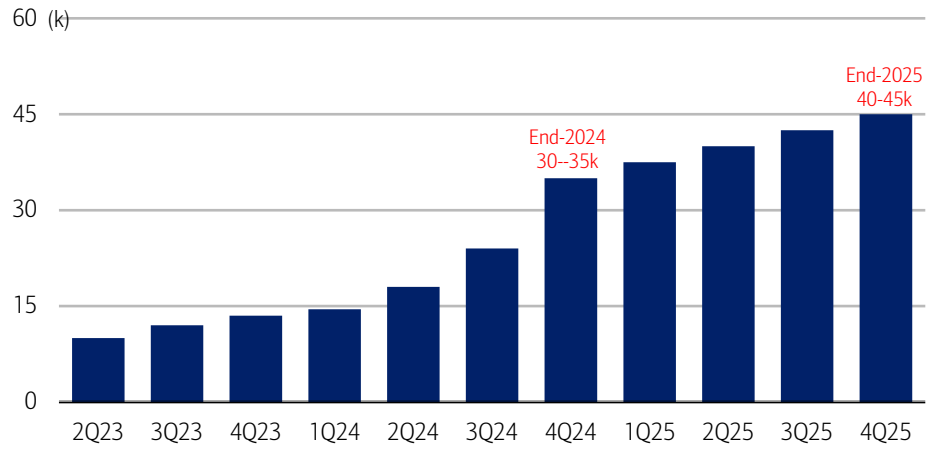
Advanced packaging – CoWoS expansions

The semis industry has been aware of the slowdown of Moore's Law economically and technologically, given increasing challenges and difficulties involved in wafer fabrication with node advancement. Amid this environment, advanced packaging has proven to be one of the major ways to enhance overall chip performance and product quality, beyond geometric scaling on transistors. Among all types of advanced packaging technologies, the surging CoWoS demand has been the most significant highlight in AI era, as it is one of the key technologies supporting the success of Nvidia's AI GPUs and attracted orders from major HPC/network processor vendors and hyperscalers, including Nvidia, AMD, Broadcom, and Amazon.

To accommodate the strong demand for AI computing, TSMC continues to expand advanced packaging capacity amid supply tightness. We expect the CoWoS monthly capacity to reach 30-35k by end-2024, and likely reach 40-45k by end-2025. We believe TSMC will remain the go-to CoWoS supplier globally, despite expansion by other foundry and OSAT peers, thanks to its technology leadership, vast experience, and higher logistics efficiency.

Exhibit 20: CoWoS capacity expansion, 2Q23-4Q25
We expect the CoWoS monthly capacity to reach 30-35k by end-2024, and likely reach 40-45k by end-2025



Source: BofA Global Research, company data

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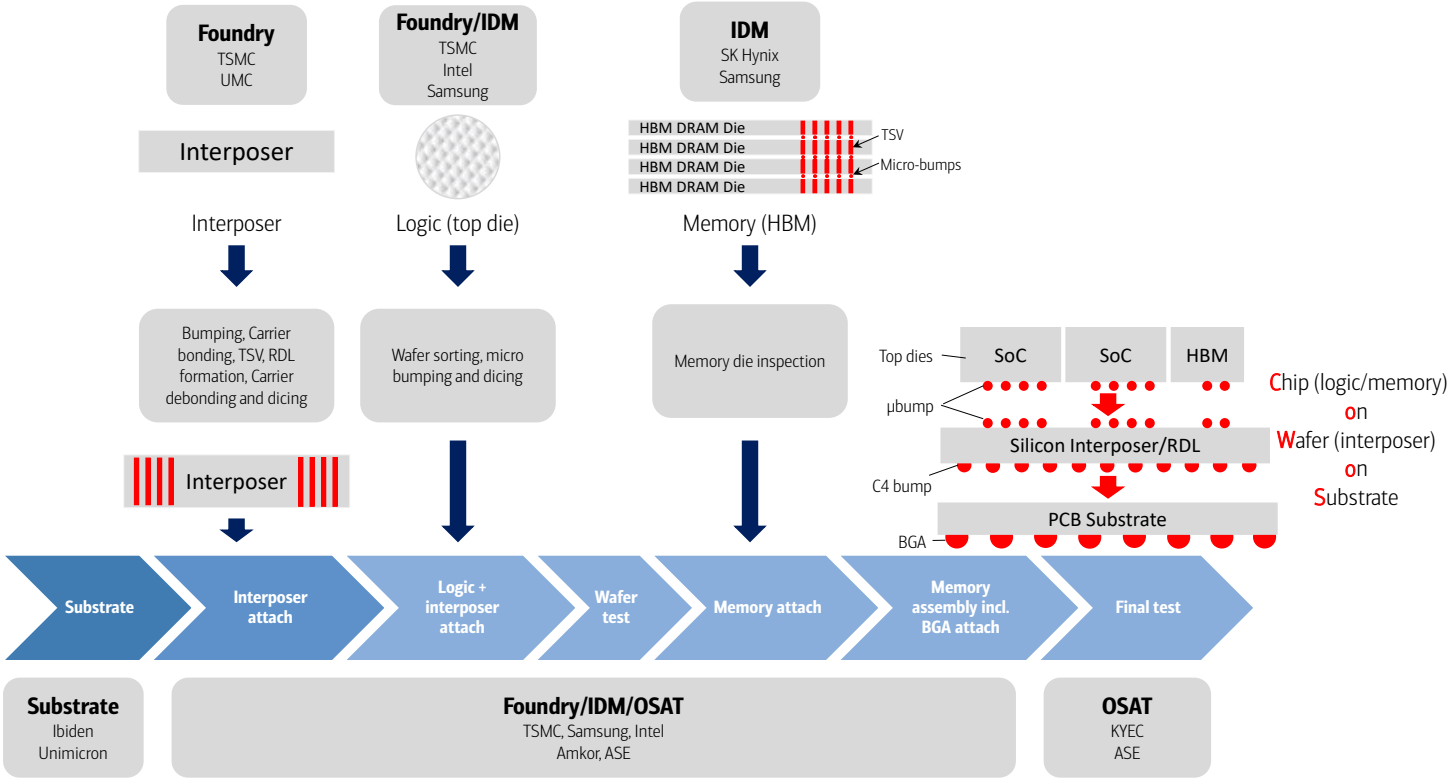
Exhibit 21: Key supply chain players in CoWoS packaging
On top of TSMC, other key CoWoS-related vendors in Taiwan include UMC (interposer), Unimicron (substrate), and OSAT (ASE, KYEC)



Source: BofA Global Research, company data

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Growing global footprints

TSMC's overseas manufacturing footprint is mainly in the US, Germany and Japan in recent years to build globally diversified supply to increase reliability and in response to the government incentives. In our view, the increasing global footprint could enhance TSMC's leadership through solidified partnership with local clients and lower geopolitical risks. And the margin dilution would be minimal, given scale, JV partners, government subsidies and strategic pricing. The reducing geopolitical risks should drive a re-rating for TSMC. We summarize the key overseas expansions as follows:

Kumamoto, Japan – TSMC established a subsidiary, Japan Advanced Semiconductor Manufacturing, Inc. (JASM), in Kumamoto in Nov, 2021 with Sony Semiconductor Solutions (SSS, under Sony) as a minority shareholder (20% equity stake). The initial construction plan of JASM's fab was scheduled to begin in 2022 for production by end-2024 and to have a monthly capacity of 55k 12" wafers. TSMC held the opening ceremony for its first Japan fab in JASM on 24 Feb, 2024. The company has seen customers placing orders proactively in the new fab, which could help fuel UTRs in 4Q24.

With rising customer demand, the 2nd fab of JASM was announced on 6 Feb, 2024, with partners SSS (6%), DENSO (5.5%), and Toyota (2%), for 6/7nm capacity ramp by end-2027. With both fabs, the firm has widened the offerings to 6/7, 12/16, 22/28, 40nm nodes for automotive, industrial, consumer and HPC-related applications. The total investment in JASM will be US$20bn+ (with ¥1.2tn government subsidy, ~US$8bn), and total capacity will be 100k+ 12" wafers per month.

Dresden, Germany – In Aug 2023, TSMC, along with partners Robert Bosch GmbH, Infineon, and NXP, jointly announced to invest in European Semiconductor Manufacturing Company (ESMC) GmbH in Dresden for the new 12" fab, to support the fast-growing auto/industrial demand. The total investment is expected to be EUR10bn+ (TSMC to invest <EUR3.5bn), including EUR5bn under the framework of the European Chip Act. The fab will start construction in 4Q24 with production targeted to begin in end-2027. Total planned capacity from the new Dresden fab will be 40k 12" wafers per month, based on TSMC's 28/22nm planar CMOS and 16/12nm FinFET process technology. TSMC will operate the fab and hold 70% stake in the JV, while Bosch, Infineon, and NXP will hold 10% each.

Arizona, US - TSMC's Arizona fab P1 was completed in Aug, 2022 for 2024 ramp of 4nm node. The company then held its Arizona fab opening ceremony in Dec and announced that the second facility is scheduled to spin up cutting edge 3nm process in 2026. The total investment in the plant (P1+P2) is planned at US$40bn, and TSMC's capacity could expand to 50k+ wafers per month after completion of both phases. Government subsidy amount is not finalized yet when the press speculates ~US$5bn (or 12.5% of total investment). Currently, the pipeline of Arizona fabs will be 1H25 for P1 N4 node's and 2027/28 for P2 N3 node's ramping due to skilled talent and cost issues, while the company believes that the US incentives and support from facility supply chain could fill the gap.

Exhibit 22: TSMC's announced expansion plans in US/Japan/Germany
Kumamoto site to have largest capacity scale among the new overseas fabs

Company	Announcement Date	Confirmed or potential	Time to go on stream	Location	Capex amount (US$bn)	Technology node	Capacity (kwpm)
TSMC	Nov-21 (with Sony), Feb-22 (+ DENSO), Feb-24 (+ Toyota)	Confirmed	First fab late-2024 Second fab late-2027	Kumamoto, Japan	20+	6/7, 12/16, 22/28, 40nm	100+
TSMC	May-20, Dec-22	Confirmed	Phase 1 2024 Phase 2 2026	Arizona, US	40	Phase 1 4nm (5nm family) Phase 2 3nm	50+
TSMC	Aug-23 (with Bosch, Infineon, and NXP)	Confirmed	Late-2027	Dresden, Germany	11	12/16, 22/28nm	40

Source: BofA Global Research, company data

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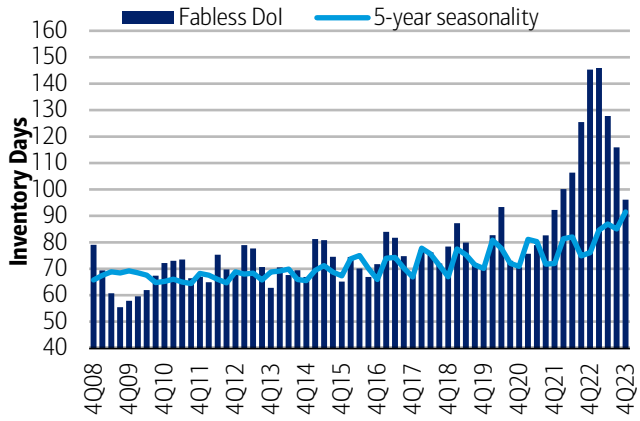
Semi inventory much healthier

Though semiconductor is on a structural growth trend, it is cyclical. Since 1990, each upturn (trough to peak sales) lasts 8-9 quarters, while downturns (peak to trough sales) are roughly 5-7 quarters. The downcycle this time has lasted longer than expected at 7-8 quarters, as the supply chain has been working on excess inventory accumulated during the COVID period amid the macro softness. Since sales can trough in 1Q/2Q, suggesting we are approaching the end of downcycle (if not yet) and entering an upcycle.

We are pleased to see the continuously lowering inventory despite seasonal restocking and the macro uncertainties. We note the willingness to restock has slightly increased compared to last quarter, though the inventory digestion remains a business focus. Along with steadily normalizing inventory level through 2024, we expect the procurement strength to gradually enhance. It helps semi supply chain firm up the industry outlook in 2H24. We expect the current set up to be ripe for a solid recovery for the industry.

Exhibit 23: Fabless DoI vs. 5-year seasonality, 4Q08-4Q23
Fabless DoI was only 5 days above the seasonal level in 4Q23



Source: BofA Global Research, company data, Bloomberg
*Note: Global large fabless firms have mostly reported their CY4Q23 results, while Chinese firms and some small Taiwanese ones have not

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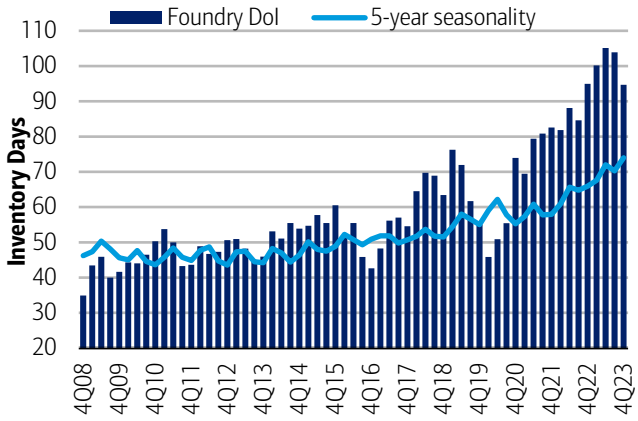
Exhibit 24: Foundry DoI vs. 5-year seasonality, 4Q08-4Q23
Foundry DoI was 21 days above the seasonal level in 4Q23



Source: BofA Global Research, company data, Bloomberg

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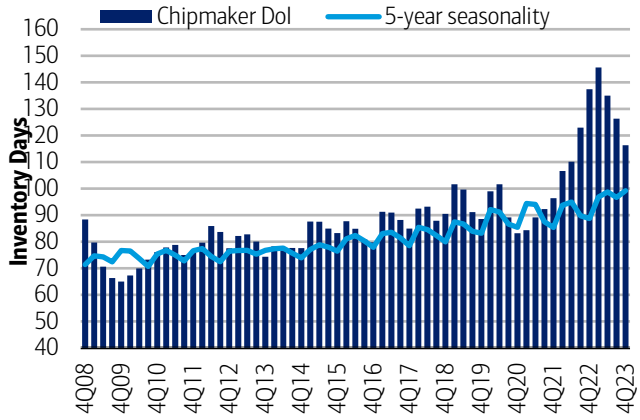
Exhibit 25: Chipmaker DoI vs. 5-year seasonality, 4Q08-4Q23
Chipmakers' DoI was 17 days above the seasonal level in 4Q23



Source: BofA Global Research, company data, Bloomberg
*Note: Global large IDM/fabless firms have mostly reported their CY4Q23 results, while Chinese firms and some small Taiwanese ones have not

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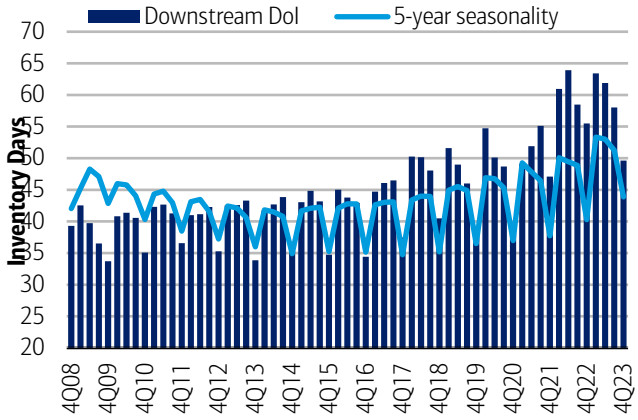
Exhibit 26: Downstream DoI vs. 5-year seasonality, 4Q08-4Q23
Downstream DoI was 6 days above the seasonal level in 4Q23



Source: BofA Global Research, company data, Bloomberg
*Note: Some Asian downstream firms like Xiaomi, Luxshare, etc. have not yet reported their CY4Q23 results, so the industry DoI might be impacted post their announcements

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Financial highlights

Robust multi-year growth in 2024-26 with solid GPM

We expect TSMC to enter a strong multi-year growth cycle from 2024, with 24%/21%/18% YoY revenue growth rates in 2024/25/26E, primarily driven by strong AI growth (mgmt. targets high-teens % cloud AI contribution in 2027), rising leading-edge demand, semi content increases in multiple end devices, as well as its worldwide capacity expansions.

On margin trend, the GPM profile would be impacted by higher depreciation, higher overseas construction costs, and dilution from more 3nm ramp in 2024. We now expect the GPM dip at 52.2% in 2Q24E. Moving forward, in view of TSMC's pricing power and improving UTR, we expect its GPM to improve year over year and model for 53.1%/54.7%/55.0% in 2024/25/26E. Combining our assumptions on stable opex, we estimate TSMC to generate a 21% EPS CAGR over 2024-26E.

Exhibit 27: Earnings estimate changes, 2024-26E
We tweak our 2024/25E EPS estimates slightly on refreshed outlooks, and introduce estimates for 2026E

	2024E			2025E			2026E		
NT$bn	New	Old	Diff	New	Old	Diff	New	Old	Diff
Revenue	2,690	2,664	1.0%	3,242	3,212	0.9%	3,818	n.a.	n.a.
Gross profit	1,427	1,417	0.7%	1,775	1,757	1.0%	2,098	n.a.	n.a.
GPM	53.1%	53.2%	-0.1ppt	54.7%	54.7%	0.0ppt	55.0%	n.a.	n.a.
Opt income	1,146	1,139	0.7%	1,435	1,421	1.0%	1,709	n.a.	n.a.
Opt margin	42.6%	42.8%	-0.1ppt	44.3%	44.2%	0.0ppt	44.8%	n.a.	n.a.
Pretax income	1,200	1,193	0.6%	1,487	1,473	0.9%	1,762	n.a.	n.a.
Pretax margin	44.6%	44.8%	-0.1ppt	45.9%	45.9%	0.0ppt	46.2%	n.a.	n.a.
Net income	1,019	1,013	0.6%	1,263	1,251	0.9%	1,495	n.a.	n.a.
EPS (NT$)	39.30	39.05	0.6%	48.71	48.25	0.9%	57.65	n.a.	n.a.

Source: BofA Global Research estimates

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Exhibit 28: BofAe vs. consensus, 2024-26E
Our 2024-26 EPS estimates are 1-3% ahead of consensus on better revenue assumptions

	2024E			2025E			2026E		
NT$bn	BofA	Consensus	Diff	BofA	Consensus	Diff	BofA	Consensus	Diff
Revenue	2,690	2,677	0.5%	3,242	3,207	1.1%	3,818	3,645	4.7%
Gross profit	1,427	1,421	0.4%	1,775	1,735	2.3%	2,098	2,017	4.0%
Gross margin	53.1%	53.1%	0.0ppt	54.7%	54.1%	0.6ppt	55.0%	55.3%	-0.4ppt
Opt income	1,146	1,128	1.6%	1,435	1,407	2.0%	1,709	1,655	3.3%
Opt margin	42.6%	42.1%	0.5ppt	44.3%	43.9%	0.4ppt	44.8%	45.4%	-0.6ppt
Pretax income	1,200	1,174	2.3%	1,487	1,454	2.3%	1,762	1,718	2.6%
Pretax margin	44.6%	43.8%	0.8ppt	45.9%	45.3%	0.5ppt	46.2%	47.1%	-1.0ppt
Net income	1,019	988	3.2%	1,263	1,231	2.6%	1,495	1,478	1.2%
EPS (NT$)	39.30	38.09	3.2%	48.71	47.49	2.6%	57.65	57.00	1.2%

Source: BofA Global Research estimates, Bloomberg

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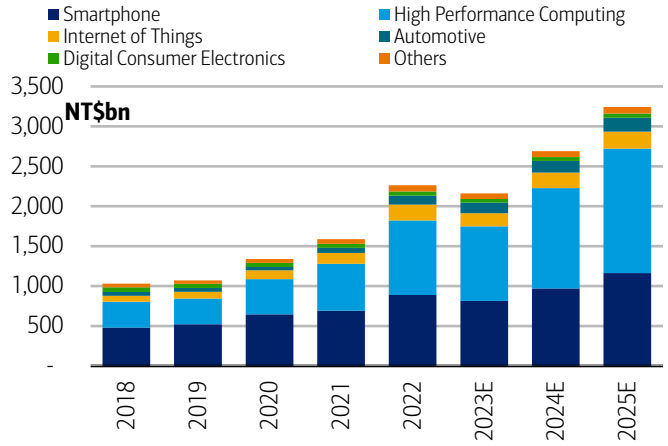
Application mix: HPC to contribute ~50% in 2026

Cloud AI revenue is categorized under HPC platform at TSMC. As we foresee AI business to outgrow in coming years, we expect HPC revenue mix to expand to 47%/48%/50% in 2024/25/26E from 43% in 2023. Supported by continuous node migration and increasing silicon content for end-device AI, we expect smartphone revenue mix to stay at 36% over the same forecasting period.

Exhibit 29: Annual revenue by platform
HPC will likely remain as a key growth contributor in 2024-25



Source: BofA Global Research estimates, company data

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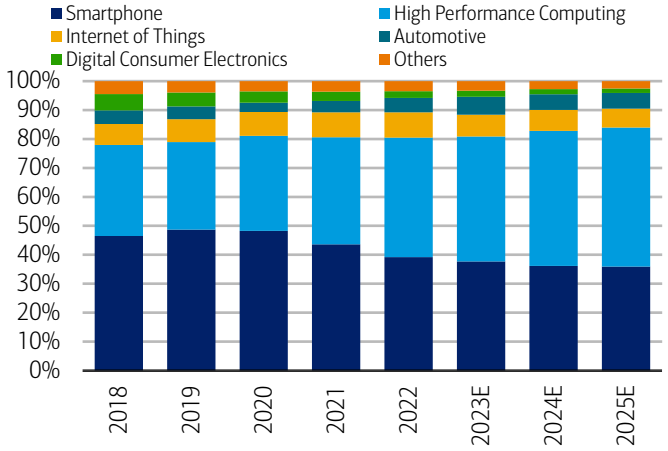
Exhibit 30: Annual revenue % by platform
HPC to be the largest platform in 2024-25E



Source: BofA Global Research estimates, company data

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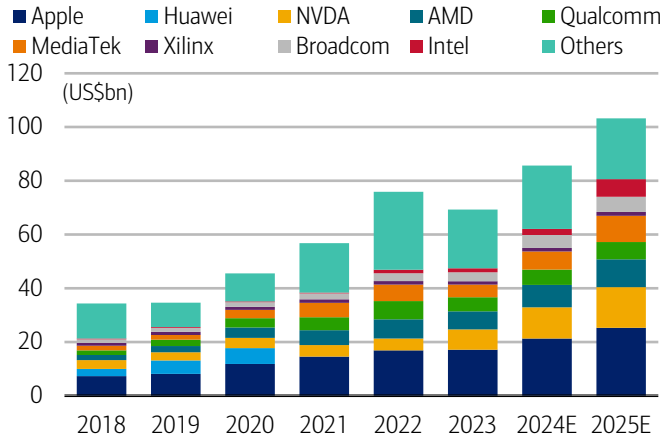
Client mix: NVIDIA to lead the growth

By client, we expect TSMC's revenue mix from NVIDIA to expand to 14%/15% in 2024/25E from 11% in 2023, fueled by upcoming new AI GPU products with node migrations. We expect biggest customer Apple's revenue contribution % to remain stable at 25% in 2024-25E. By factoring in the newly-confirmed 3nm CPU tile outsourcing, we forecast Intel's contribution to increase to 6% in 2025E.

Exhibit 31: Revenue mix by customer
TSMC's 2024 sales to be mainly supported by major customers' growth



Source: BofA Global Research estimates, company data

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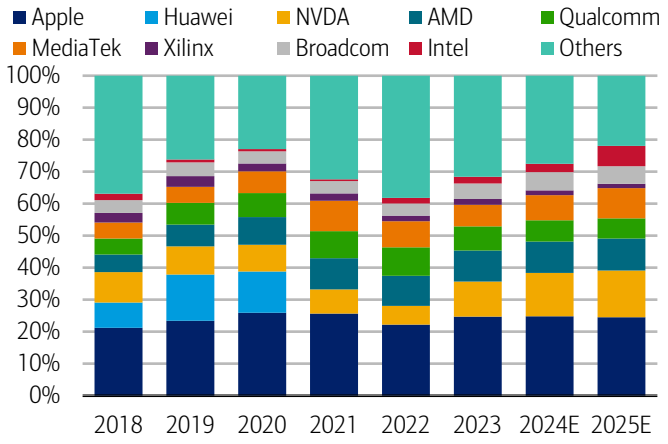
Exhibit 32: Revenue mix % by customer
Major customers contribute ~70% of total revenue for TSMC



Source: BofA Global Research estimates, company data

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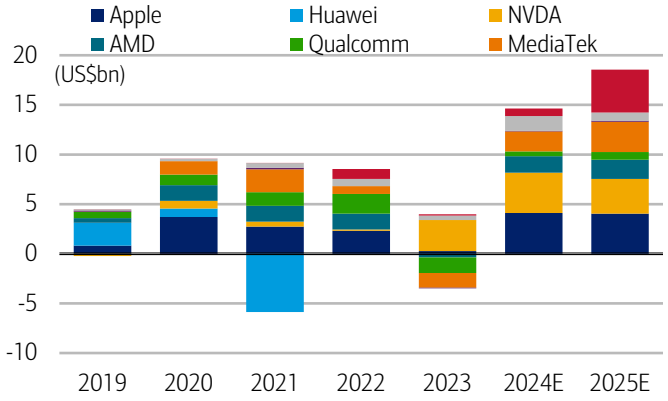
Exhibit 33: Incremental revenue from key customers
We expect incremental revenue across all key customers in 2024



Source: BofA Global Research estimates, company data

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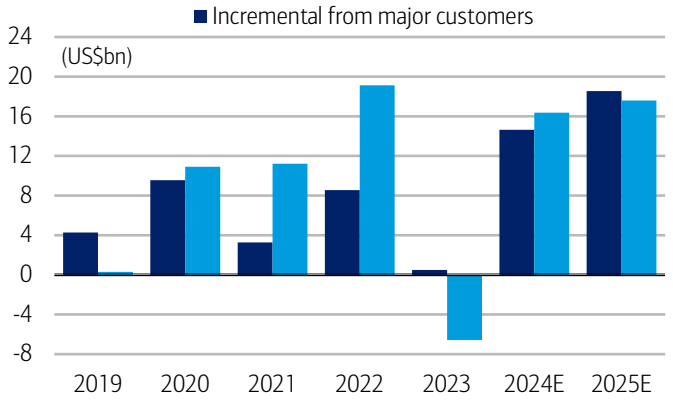
Exhibit 34: Incremental revenue - from key customers vs overall
Key clients' incremental revenue to be supportive to TSMC '24 sales rebound



Source: BofA Global Research estimates, company data

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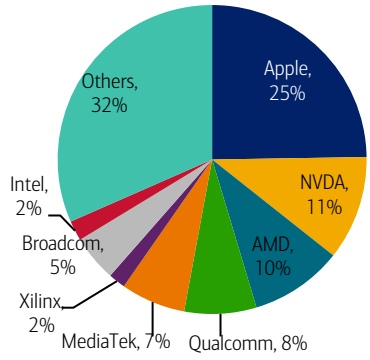
Exhibit 35: 2023 customer revenue mix
We estimate NVDA/AMD and QCOM/MTK contributed 10-11% and 7-8% revenue in 2023



Source: BofA Global Research estimates, company data

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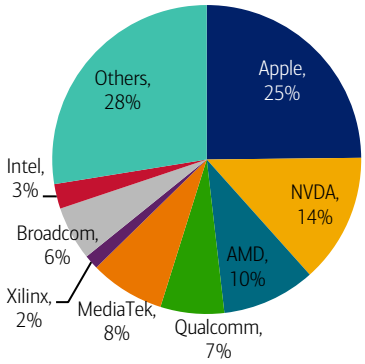
Exhibit 36: 2024E customer revenue mix
We expect NVDA's revenue contribution to expand to 14% in 2024



Source: BofA Global Research estimates, company data

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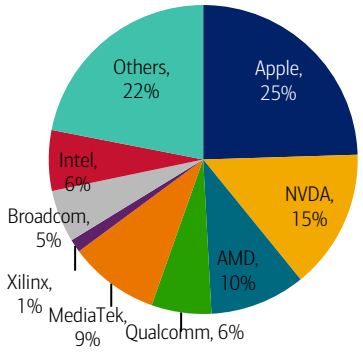
Exhibit 37: 2025E customer revenue mix
We expect Intel's revenue contribution to expand to 6% in 2025



Source: BofA Global Research estimates, company data

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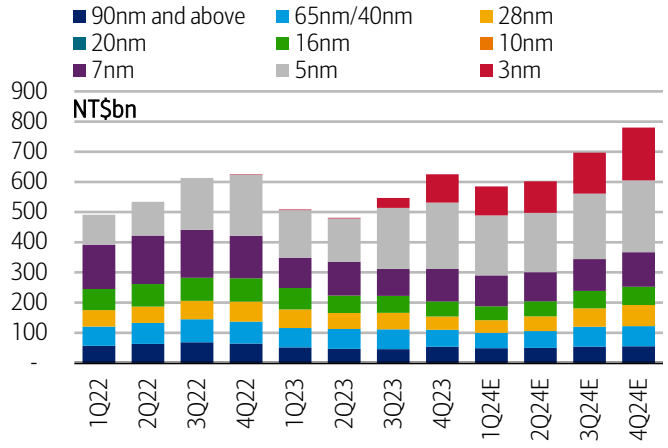
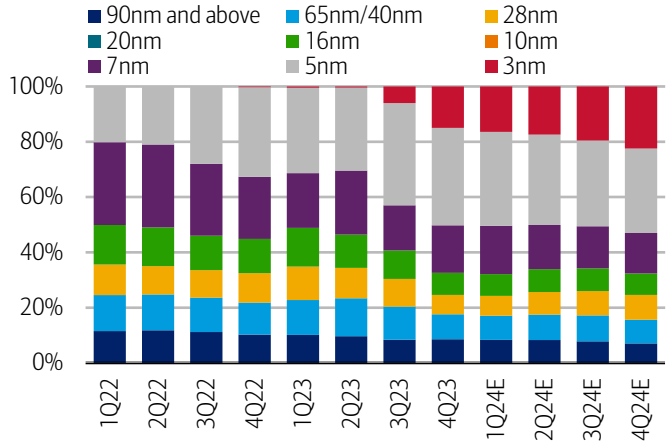
Exhibit 38: Revenue by technology node
3nm to be a key driver throughout 2024



Source: BofA Global Research estimates, company data

BofA GLOBAL RESEARCH

Exhibit 39: Revenue % by technology node
We expect expanding 3nm mix into 2024



Source: BofA Global Research estimates, company data

BofA GLOBAL RESEARCH

Exhibit 40: Earnings model, 2023-26E
We now model 24%/21% YoY revenue increase in 2024/25 in NT$ terms, and introduce 2026E earnings estimates

(NT$bn, %)	1Q24E	2Q24E	3Q24E	4Q24E	1Q25E	2Q25E	3Q25E	4Q25E	2023	2024E	2025E	2026E
Revenues	591	608	714	777	711	754	877	900	2,162	2,690	3,242	3,818
Cost of Sales	-278	-291	-336	-358	-331	-343	-399	-395	-987	-1,263	-1,467	-1,719
Gross Profit	313	317	378	419	380	411	478	505	1,175	1,427	1,775	2,098
Operating Expenses	-69	-64	-71	-76	-77	-78	-90	-94	-254	-280	-340	-389
Operating Income	244	253	306	343	304	333	388	411	921	1,146	1,435	1,709
Non-operating Income (Exp)	13	13	14	14	13	13	13	13	58	54	52	53
Pretax Income	257	266	320	357	316	346	401	424	979	1,200	1,487	1,762
Net tax	-39	-41	-49	-53	-48	-53	-61	-63	-141	-182	-225	-268
Net Income	218	226	272	304	268	292	341	361	838	1,019	1,263	1,495
Fully Diluted EPS - Local (NT$)	8.4	8.7	10.5	11.7	10.3	11.3	13.1	13.9	32.3	39.3	48.7	57.7
% of Revenue												
Gross Profit	53.0	52.2	52.9	53.9	53.5	54.5	54.5	56.1	54.4	53.1	54.7	55.0
Operating Expenses	-11.7	-10.6	-10.0	-9.8	-10.8	-10.4	-10.3	-10.5	-11.7	-10.4	-10.5	-10.2
Operating Income	41.3	41.7	42.9	44.2	42.7	44.1	44.2	45.7	42.6	42.6	44.3	44.8
Pretax Income	43.4	43.8	44.8	45.9	44.5	45.8	45.7	47.2	45.3	44.6	45.9	46.2
Net Income	36.8	37.1	38.1	39.1	37.7	38.8	38.8	40.1	38.8	37.9	39.0	39.2
QoQ Growth %												
Revenues	-5.6	2.9	17.5	8.8	-8.5	6.1	16.3	2.5				
Gross Profit	-5.6	1.3	19.1	10.9	-9.2	8.1	16.3	5.6				
Operating Income	-6.2	3.8	21.0	12.0	-11.5	9.6	16.6	6.0				
Net Income	-8.8	3.8	20.4	11.8	-11.8	9.1	16.4	6.0				
YoY Growth %												
Revenues	16.1	26.4	30.6	24.2	20.3	24.1	22.9	15.8	-4.5	24.4	20.5	17.7
Gross Profit	9.3	21.9	27.4	26.2	21.5	29.5	26.6	20.6	-12.8	21.4	24.4	18.2
Operating Income	5.5	25.3	34.3	31.8	24.4	31.4	26.6	19.8	-17.8	24.4	25.2	19.1
Net Income	5.1	24.2	28.8	27.3	23.2	29.6	25.3	18.8	-17.5	21.5	23.9	18.4

Source: BofA Global Research estimates, company data

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Exhibit 41: Operation model, 2023-26E
TSMC mgmt. expects to see improvement in utilization rates in coming years

	1Q24E	2Q24E	3Q24E	4Q24E	1Q25E	2Q25E	3Q25E	4Q25E	2023	2024E	2025E	2026E
Utilization	71%	74%	85%	89%	79%	81%	90%	87%	76%	80%	84%	93%
Shipments (12-inch equivalent, '000s)	2,829	2,987	3,428	3,625	3,374	3,489	3,951	3,896	12,002	12,869	14,710	16,192
Total revenue (NT$bn)	591	608	714	777	711	754	877	900	2,162	2,690	3,242	3,818
ASP ($)	6,649	6,480	6,635	6,825	6,710	6,883	7,072	7,355	5,782	6,656	7,019	7,509
Sequential growth (%)												
Shipments	-4%	6%	15%	6%	-7%	3%	13%	-1%	-21%	7%	14%	10%
ASP ($)	0%	-3%	2%	3%	-2%	3%	3%	4%	16%	15%	5%	7%
Revenue share by process technology												

Exhibit 40: Earnings model, 2023-26E

We now model 24%/21% YoY revenue increase in 2024/25 in NT$ terms, and introduce 2026E earnings estimates

(NT$bn, %)	1Q24E	2Q24E	3Q24E	4Q24E	1Q25E	2Q25E	3Q25E	4Q25E	2023	2024E		2025E	2026E
0.11 micron and more matured nodes	7%	7%	7%	6%	7%	6%	6%	6%		8%	7%	6%	5%
90nm	1%	1%	1%	1%	1%	1%	1%	1%		1%	1%	1%	1%
65nm	5%	5%	5%	4%	4%	5%	4%	4%		6%	5%	4%	4%
40nm	4%	4%	4%	5%	4%	4%	4%	4%		6%	4%	4%	3%
28nm	7%	8%	9%	9%	9%	9%	8%	7%		10%	8%	8%	7%
16-20nm	8%	8%	8%	8%	8%	8%	7%	7%		11%	8%	8%	7%
2-10nm	68%	66%	66%	67%	67%	67%	69%	72%		58%	67%	69%	73%
Total	100%	100%	100%	100%	100%	100%	100%	100%		100%	100%	100%	100%
Revenue percentage by platform													
Smartphone	38%	35%	37%	36%	38%	34%	37%	35%		38%	36%	36%	36%
High Performance Computing	48%	47%	46%	46%	49%	49%	47%	48%		43%	47%	48%	50%
Internet of Things	5%	7%	9%	7%	5%	7%	8%	7%		8%	7%	7%	6%
Automotive	5%	6%	6%	6%	5%	6%	5%	6%		6%	5%	5%	5%
Digital Consumer Electronics	2%	2%	2%	2%	1%	2%	2%	2%		2%	2%	2%	1%
Others	3%	4%	2%	3%	2%	3%	2%	3%		3%	3%	3%	2%
Total	100%	100%	100%	100%	100%	100%	100%	100%		100%	100%	100%	100%
Revenue percentage by region													
North America	65%	67%	70%	73%	66%	68%	71%	73%		68%	69%	70%	70%
Asia Pacific	9%	9%	9%	9%	9%	9%	9%	9%		8%	9%	9%	8%
China	13%	12%	12%	11%	13%	12%	12%	11%		12%	12%	12%	11%
Europe	7%	7%	5%	4%	7%	6%	4%	3%		6%	5%	5%	5%
Japan	7%	5%	5%	4%	6%	5%	5%	5%		6%	5%	5%	6%
Total	100%	100%	100%	100%	100%	100%	100%	100%		100%	100%	100%	100%

Source: BofA Global Research estimates, company data

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Exhibit 42: Balance sheet, 2023-26E

Despite heavy capital investment, we expect TSMC's balance sheet to remain pretty solid

(NT$bn)	1Q24E	2Q24E	3Q24E	4Q24E	1Q25E	2Q25E	3Q25E	4Q25E	2023	2024E	2025E	2026E
Cash	1,539	1,609	1,718	1,888	1,944	2,059	2,246	2,520	1,465	1,888	2,520	3,354
Short Term Investment	231	227	229	228	228	228	228	228	222	228	228	228
Accounts receivable	206	218	231	210	244	250	266	226	202	210	226	237
Inventory	246	264	276	278	310	334	335	328	251	278	328	370
Other current assets	45	46	47	48	48	47	47	47	53	48	47	47
Current Assets	2,267	2,364	2,501	2,652	2,774	2,918	3,122	3,350	2,194	2,652	3,350	4,236
Long Term Investments	123	126	125	125	125	125	125	125	129	125	125	125
Fixed Assets	3,229	3,303	3,371	3,430	3,484	3,542	3,592	3,634	3,064	3,430	3,634	3,782
Other Assets	148	148	148	147	148	148	148	148	144	147	148	148
Long-term Assets	3,500	3,578	3,644	3,703	3,757	3,816	3,865	3,907	3,338	3,703	3,907	4,055
Total Assets	**5,767**	**5,942**	**6,145**	**6,355**	**6,531**	**6,733**	**6,988**	**7,256**	**5,532**	**6,355**	**7,256**	**8,291**
Short term loans	-	-	-	-	-	-	-	-	-	-	-	-
Notes & Accounts Payable	66	70	73	66	86	90	92	88	57	66	88	101
Current portion of long term debt	8	8	8	9	8	8	8	8	9	9	8	8
Other current Liabilities	855	855	855	855	864	864	864	864	847	855	864	873
Current Liabilities	930	933	937	930	958	963	964	960	914	930	960	982
Long term debt	904	917	919	915	914	916	916	915	919	915	915	915
Other non-current liabilities	247	321	360	431	340	363	373	490	217	431	490	553
Long-term Liabilities	1,151	1,238	1,279	1,346	1,254	1,279	1,289	1,405	1,136	1,346	1,405	1,468
Total Liabilities	**2,081**	**2,171**	**2,216**	**2,277**	**2,212**	**2,242**	**2,254**	**2,365**	**2,049**	**2,277**	**2,365**	**2,450**
Total parent shareholders' equity	3,666	3,749	3,907	4,056	4,297	4,469	4,712	4,869	3,459	4,056	4,869	5,819
Minority Interest	20	21	23	22	22	22	22	22	24	22	22	22
Total Liabilities and Equity	**5,767**	**5,942**	**6,145**	**6,355**	**6,531**	**6,733**	**6,988**	**7,256**	**5,532**	**6,355**	**7,256**	**8,291**

Source: BofA Global Research estimates, company data

BofA GLOBAL RESEARCH

Exhibit 43: Cash flow, 2023-26E

TSMC has committed to deliver a steady dividend payout policy

(NT$bn)	1Q24E	2Q24E	3Q24E	4Q24E	1Q25E	2Q25E	3Q25E	4Q25E	2023	2024E	2025E	2026E
Net Profit	218	226	272	304	268	293	341	361	838	1,019	1,263	1,495
Depreciation & Amortization	156	163	176	183	185	193	209	217	532	677	803	900

Exhibit 43: Cash flow, 2023-26E
TSMC has committed to deliver a steady dividend payout policy

(NT$bn)	1Q24E	2Q24E	3Q24E	4Q24E	1Q25E	2Q25E	3Q25E	4Q25E	2023	2024E	2025E	2026E
Change in Working Capital	18	(27)	(22)	11	(47)	(24)	(16)	42	(38)	(21)	(44)	(39)
Other adjustment	17	9	8	1	(7)	(7)	2	3	(91)	34	(9)	4
Operating Cash Flow	**408**	**370**	**433**	**499**	**399**	**455**	**535**	**623**	**1,242**	**1,710**	**2,012**	**2,360**
Capital Expenditure	(236)	(236)	(236)	(236)	(251)	(251)	(251)	(251)	(950)	(942)	(1,005)	(1,099)
Proceeds from sale of non-current assets	0	0	0	0	0	0	0	0	1	1	1	1
Acquisitions/Disposals of investments	(2)	1	(1)	0	(0)	0	(0)	0	(108)	(1)	(0)	(0)
Other investment items	(4)	(0)	(0)	1	(1)	(0)	0	0	151	(3)	(1)	(0)
Investing Cash Flow	**(241)**	**(235)**	**(236)**	**(234)**	**(252)**	**(251)**	**(251)**	**(251)**	**(906)**	**(945)**	**(1,005)**	**(1,098)**
Net Share issue/repurchase	-	-	-	-	-	-	-	-	0	-	-	-
Dividends paid	(78)	(78)	(91)	(91)	(91)	(91)	(97)	(97)	(292)	(337)	(376)	(428)
Change in debt	(16)	13	3	(4)	(1)	2	(0)	(1)	70	(5)	0	0
Other financing cash flow	-	-	-	-	(0)	-	(0)	(0)	17	-	(0)	0
Financing Cash Flow	**(94)**	**(65)**	**(88)**	**(95)**	**(92)**	**(88)**	**(97)**	**(98)**	**(205)**	**(342)**	**(376)**	**(428)**
Net Change in Cash	74	70	109	170	55	116	186	274	131	423	632	834
Exchange effect	-	-	-	-	-	-	-	-	(8)	-	-	-
Cash, Beginning of Year	1,465	1,539	1,609	1,718	1,888	1,944	2,059	2,246	1,343	1,465	1,888	2,520
Cash, End of Year	1,539	1,609	1,718	1,888	1,944	2,059	2,246	2,520	1,465	1,888	2,520	3,354

Source: BofA Global Research estimates, company data

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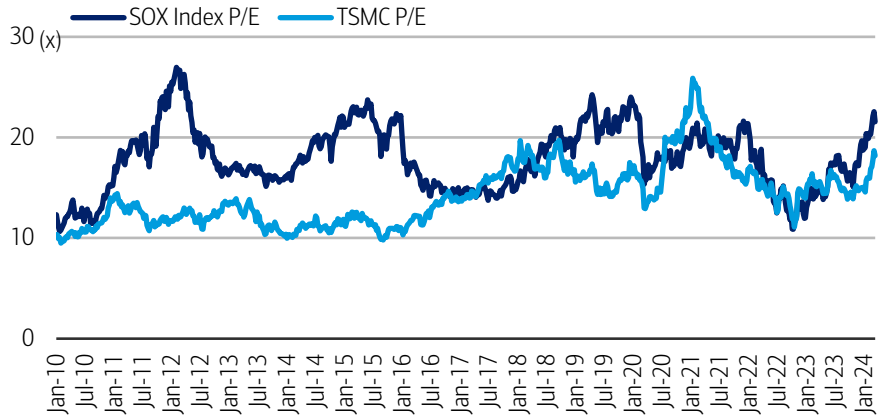
Valuation discussion

PO of NT$880 based on 18x 4Q24-3Q25E P/E

Our NT$880 PO is based on 18x 4Q24-3Q25E P/E (previously 2H24-1H25), which is in line with its 5-year average. In our view, P/E valuation is appropriate for TSMC given its strong earnings growth and outstanding FCF. TSMC has been on a continuous re-rating trend since 2015, driven by technology leadership and structural positive trends, including market-share gains, IDM outsourcing, fabless share gains, and semis content increase. TSMC's leading position is reinforced by its outstanding capability in leading edge and advanced packaging, which becomes more significant in the AI era. This is likely to place TSMC further ahead of competitors and drive its earnings growth and lead to a re-rating.

We note that TSMC's forward P/E has tended to move along with SOX since 2020. SOX trades at upcycle valuation currently, while TSMC's valuation has not picked up as fast as SOX's YTD. In this case, we believe the risk to the stock's valuation is skewed to the upside and see room for further re-rating even post the 27% share rally YTD, in view of the estimated 21% revenue/earnings CAGR over 2024-26E riding on AI megatrend. TSMC currently trades at 19x/15.5x 2024/25E P/E vs. historical range at 10-26x, which we deem attractive given its critical role in all types of AI chips and rising leading-edge demand.

Exhibit 44: TSMC's 12-month forward P/E vs SOX's
Since 2020, TSMC's P/E often moved in the same direction with SOX's; we see upside for TSMC's P/E to catch up with SOX's



Source: BofA Global Research estimates, company data, Bloomberg

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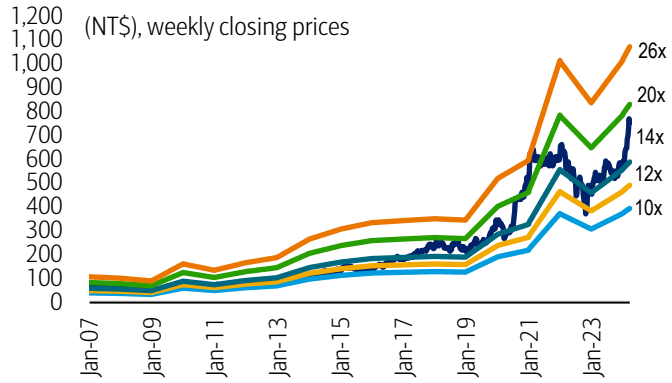
Exhibit 45: 12-month forward P/E
The stock now trades at 19x 2024E P/E



Source: BofA Global Research estimates, Bloomberg

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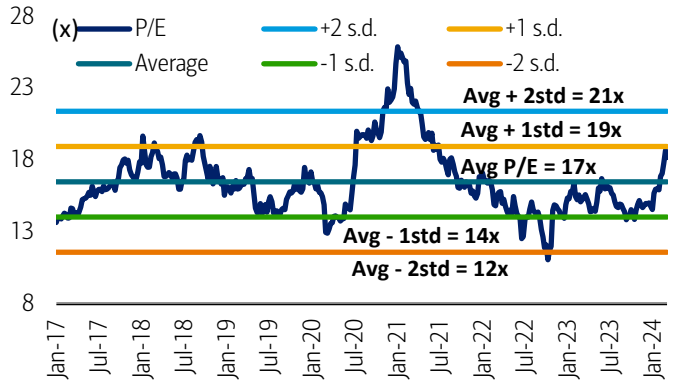
Exhibit 46: 12-month forward P/E with +2 to -2 standard deviation
Current P/E (19x) is trading at 1SD above average level since 2017



Source: BofA Global Research estimates, Bloomberg

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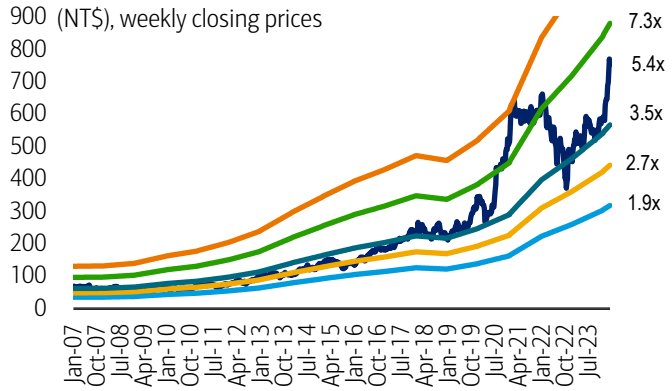
Exhibit 47: 12-month forward P/B
The stock now trades at 4.8x 2024E P/B



Source: BofA Global Research estimates, Bloomberg

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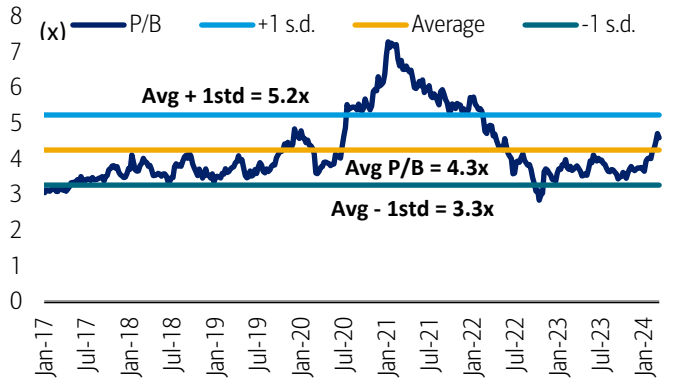
Exhibit 48: 12-month forward P/B with +1 to -1 standard deviation
Current P/B (4.8x) is ~0.5SD above the average level since 2017



Source: BofA Global Research estimates, Bloomberg

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Exhibit 49: Valuation comparisons
TSMC currently trades at lower P/E level vs. foundry/IDM/fabless/equipment maker companies' average levels

Ticker	Company	Share price (LC)	Rating	Mkt cap (US$mn)	EPS (LC) 2024E	EPS (LC) 2025E	PER (X) 2024E	PER (X) 2025E	PBR (X) 2024E	PBR (X) 2025E	Div. yield (%) 2024E	Div. yield (%) 2025E	ROE (%) 2024E	ROE (%) 2025E	EV/EBITDA 2024E	EV/EBITDA 2025E
Foundry																
2330 TT	TSMC	753.0	BUY	617,423	39.30	48.71	19.2	15.5	4.8	4.0	1.9	2.2	27.1	28.3	10.3	8.4
GFS US	GlobalFoundries	52.6	Neutral	29,076	1.30	1.79	40.4	29.4	2.7	2.5	0.0	0.0	6.6	8.9	13.6	11.4
981 HK	SMIC	16.9	NC	25,674	0.06	0.10	36.5	21.1	0.8	0.8	0.0	0.0	2.3	3.7	12.6	10.4
2303 TT	UMC	51.9	BUY	20,558	4.43	5.15	11.7	10.1	1.8	1.7	6.1	7.1	15.4	17.3	6.0	4.9
5347 TT	Vanguard	83.9	Neutral	4,347	3.65	5.21	23.0	16.1	3.5	3.5	5.4	5.4	14.6	21.8	9.8	8.9
1347 HK	Hua Hong	17.0	U/P	4,753	0.03	0.10	70.4	22.1	0.5	0.5	0.0	0.0	0.8	2.5	1.9	1.5
6770 TT	PSMC	26.3	U/P	3,400	-0.99	-0.60	n.m.	n.m.	1.2	1.2	0.0	0.0	-4.4	-2.7	13.7	8.5
3105 TT	Win Semi	145.5	U/P	1,950	5.19	8.25	28.0	17.6	1.6	1.6	2.0	3.2	6.3	9.4	11.5	9.4
Foundry average							**32.8**	**18.8**	**2.1**	**2.0**	**1.9**	**2.2**	**8.6**	**11.1**	**9.9**	**7.9**
IDM																
005930 KS	Samsung	72,300.0	BUY	324,208	3982.03	7063.76	18.2	10.2	1.3	1.2	2.0	2.0	7.5	12.3	5.9	4.3
INTC US	Intel	42.8	Neutral	180,747	1.18	1.91	36.2	22.4	1.3	1.2	1.2	1.2	4.0	5.6	10.3	7.9
TXN US	Texas Instruments	171.1	Neutral	155,615	4.89	5.54	35.0	30.9	9.5	10.1	3.1	3.3	26.9	32.0	22.4	16.9
IFX GY	Infineon	32.7	BUY	46,531	2.08	2.65	15.7	12.3	2.3	2.0	1.1	1.2	15.3	17.4	9.4	7.1
IDM average							**26.3**	**19.0**	**3.6**	**3.6**	**1.8**	**1.9**	**13.4**	**16.8**	**12.0**	**9.0**
Fabless																
NVDA US	NVIDIA	879.4	BUY	2,198,600	12.96	23.11	67.9	38.1	50.5	24.2	0.0	0.0	99.3	86.6	56.5	31.2
AVGO US	Broadcom	1,262.3	BUY	584,963	46.70	57.82	27.0	21.8	7.5	6.5	1.7	1.8	44.7	33.4	21.1	17.5
QCOM US	Qualcomm	168.5	BUY	187,990	9.84	10.76	17.1	15.7	7.1	5.7	1.9	1.9	45.8	40.2	16.9	15.8
AMD US	AMD	187.1	BUY	302,249	3.62	5.07	51.7	36.9	5.0	4.5	0.0	0.0	10.1	12.9	31.8	24.9
Fabless average							**40.9**	**28.1**	**17.5**	**10.2**	**0.9**	**0.9**	**50.0**	**43.3**	**31.6**	**22.3**
Semi equipment makers																
ASML NA	ASML	880.6	BUY	382,988	19.01	30.31	46.3	29.1	26.2	22.1	0.8	0.9	55.8	81.6	36.7	24.1
AMAT US	Applied Material	200.8	BUY	166,803	8.02	9.04	25.0	22.2	8.4	6.9	0.7	0.9	36.8	34.1	21.8	19.5
LRCX US	Lam Research	925.7	BUY	121,359	28.71	33.53	32.2	27.6	14.2	12.3	0.9	1.0	45.1	46.6	26.1	22.9
8035 JP	Tokyo Electron	35,410.0	BUY	112,287	739.83	1015.31	47.9	34.9	9.8	8.4	1.0	1.4	21.0	25.9	32.2	23.4
KLAC US	KLA Corp	692.3	BUY	93,626	23.12	26.82	29.9	25.8	26.8	21.3	0.8	1.0	98.0	91.1	22.6	20.2
Semi equipment average							**36.3**	**27.9**	**17.1**	**14.2**	**0.9**	**1.0**	**51.3**	**55.9**	**27.9**	**22.0**

Source: BofA Global Research estimates, company data, Bloomberg; "NC" = not covered

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Price objective basis & risk

Taiwan Semiconductor Manufacturing Co. (TSMWF / TSM)
We value TSMC at NT$880 per share (US$155 per ADR), based on 18x 4Q24-3Q25E P/E, or slightly above its five-year average P/E and SOX index's ten-year average P/E, given the structural long-term opportunities. We expect the valuation to be underpinned by its stronger industry position especially in leading edge technology, improved earnings quality, and subsequently FCF/dividend upside.

Downside risks are (1) greater-than-expected slowdown in global smartphone/consumer electronics demand, (2) Intel's potential insourcing strategy and ambitions in foundry service, and (3) execution risks on advanced nodes.

Analyst Certification

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APR - Semiconductor Coverage Cluster

Investment rating	Company	BofA Ticker	Bloomberg symbol	Analyst
BUY				
	Alchip	ALCPF	3661 TT	Mike Yang
	ASE Technology Holding	XSRIF	3711 TT	Brad Lin
	ASE Technology Holding -ADR	ASX	ASX US	Brad Lin
	ASMPT	ASMVF	522 HK	Simon Woo, CFA
	Aspeed	XLKMF	5274 TT	Mike Yang
	Crystal Clear	XPPTF	300655 CH	Dai Shen
	eMemory	XYLWF	3529 TT	Mike Yang
	Faraday	FDYTF	3035 TT	Mike Yang
	Global Unichip Corp.	GBUHF	3443 TT	Mike Yang
	GlobalWafers	XWLFF	6488 TT	Brad Lin
	Hwatsing Technology	XSNIF	688120 CH	Dai Shen

APR - Semiconductor Coverage Cluster

Investment rating	Company	BofA Ticker	Bloomberg symbol	Analyst
	JCET Group Co Ltd	XJIEF	600584 CH	Mike Yang
	King Yuan Electronics Corp.	KYUFF	2449 TT	Angela Huang
	Kingsemi	XKSQF	688037 CH	Dai Shen
	LX Semicon	XLXSF	108320 KS	Simon Woo, CFA
	Maxscend	XMXSF	300782 CH	Daley Li, CFA
	MediaTek	MDTKF	2454 TT	Brad Lin
	Montage Technology	XRDFF	688008 CH	Daley Li, CFA
	Nanya Technology	NNYAF	2408 TT	Simon Woo, CFA
	Novatek	NVKMF	3034 TT	Brad Lin
	Parade	PRDWF	4966 TT	Mike Yang
	Realtek	RLTKF	2379 TT	Brad Lin
	Samsung Elec -G	SSNHZ	SMSN LI	Simon Woo, CFA
	Samsung Electronics	SSNLF	005930 KS	Simon Woo, CFA
	Samsung Electronics Preferred	SSNNF	005935 KS	Simon Woo, CFA
	Silicon Motion	SIMO	SIMO US	Simon Woo, CFA
	SK Hynix	HXSCF	000660 KS	Simon Woo, CFA
	Taiwan Semiconductor Manufacturing Co.	TSM	TSM US	Brad Lin
	Taiwan Semiconductor Manufacturing Co.	TSMWF	2330 TT	Brad Lin
	United Microelectronics Corp.	XUMIF	2303 TT	Brad Lin
	United Microelectronics Corp.	UMC	UMC US	Brad Lin
	Will Semiconductor	XXHQF	603501 CH	Dai Shen
	Winbond Electronics	WBEKF	2344 TT	Dai Shen
	Wonik IPS	XRHQF	240810 KS	Simon Woo, CFA
NEUTRAL				
	ASMedia Technology Inc.	XZSFF	5269 TT	Mike Yang
	Macronix International	MXICF	2337 TT	Dai Shen
	Powertech Technology	XPPZF	6239 TT	Simon Woo, CFA
	Soulbrain	XSBOF	357780 KS	Simon Woo, CFA
	Vanguard International Semiconductor Co	VGILF	5347 TT	Mike Yang
UNDERPERFORM				
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	Hangzhou Silan Microelectronics	XDFRF	600460 CH	Mike Yang
	Hua Hong Semi	HHUSF	1347 HK	Mike Yang
	Ingenic	XISCF	300223 CH	Dai Shen
	Lion Electronics	XDHFF	605358 CH	Dai Shen
	Phison Electronics	PISNF	8299 TT	Simon Woo, CFA
	Powerchip Semiconductor Manufacturing Co	XCHPF	6770 TT	Mike Yang
	Shenzhen Goodix	XQPLF	603160 CH	Mike Yang
	Silergy Corp.	SLEGF	6415 TT	Brad Lin
	VeriSilicon	XMLZF	688521 CH	Mike Yang
	Win Semiconductors	XWIIF	3105 TT	Brad Lin

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Business Performance	Numerator	Denominator
Return On Capital Employed	NOPAT = (EBIT + Interest Income) × (1 – Tax Rate) + Goodwill Amortization	Total Assets – Current Liabilities + ST Debt + Accumulated Goodwill Amortization
Return On Equity	Net Income	Shareholders' Equity
Operating Margin	Operating Profit	Sales
Earnings Growth	Expected 5 Year CAGR From Latest Actual	N/A
Free Cash Flow	Cash Flow From Operations – Total Capex	N/A

Quality of Earnings	Numerator	Denominator
Cash Realization Ratio	Cash Flow From Operations	Net Income
Asset Replacement Ratio	Capex	Depreciation
Tax Rate	Tax Charge	Pre-Tax Income
Net Debt-To-Equity Ratio	Net Debt = Total Debt – Cash & Equivalents	Total Equity
Interest Cover	EBIT	Interest Expense

Valuation Toolkit	Numerator	Denominator
Price / Earnings Ratio	Current Share Price	Diluted Earnings Per Share (Basis As Specified)
Price / Book Value	Current Share Price	Shareholders' Equity / Current Basic Shares
Dividend Yield	Annualised Declared Cash Dividend	Current Share Price
Free Cash Flow Yield	Cash Flow From Operations – Total Capex	Market Cap = Current Share Price × Current Basic Shares
Enterprise Value / Sales	EV = Current Share Price × Current Shares + Minority Equity + Net Debt + Other LT Liabilities	Sales
EV / EBITDA	Enterprise Value	Basic EBIT + Depreciation + Amortization

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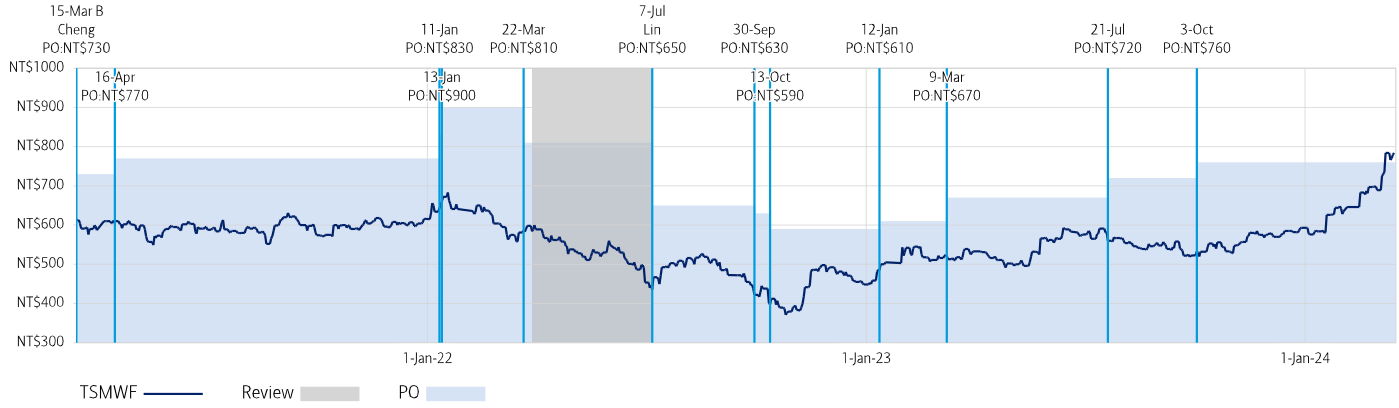
Disclosures

Important Disclosures

Taiwan Semi Mfg Co (TSMWF) Price Chart



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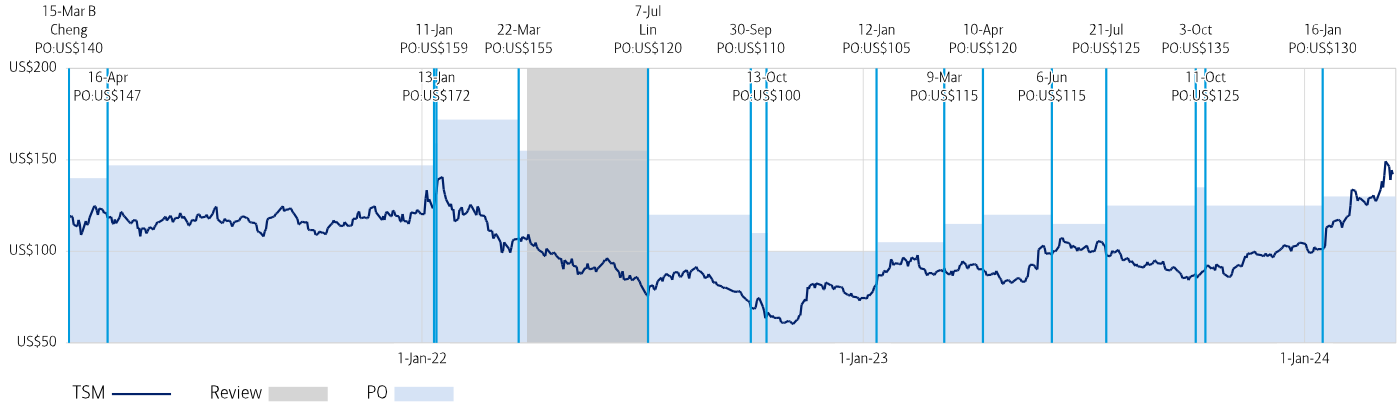
Taiwan Semi Mfg Co (TSM) Price Chart



B: Buy, N: Neutral, U: Underperform, PO: Price Objective, NA: No longer valid, NR: No Rating

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Equity Investment Rating Distribution: Technology Group (as of 31 Dec 2023)

Coverage Universe	Count	Percent	Inv. Banking Relationships [R1]	Count	Percent
Buy	215	53.09%	Buy	111	51.63%
Hold	97	23.95%	Hold	45	46.39%
Sell	93	22.96%	Sell	24	25.81%

Equity Investment Rating Distribution: Global Group (as of 31 Dec 2023)

Coverage Universe	Count	Percent	Inv. Banking Relationships [R1]	Count	Percent
Buy	1895	53.62%	Buy	1083	57.15%
Hold	832	23.54%	Hold	454	54.57%
Sell	807	22.84%	Sell	383	47.46%

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