

Josh Collins

11/21/2023

Ticker TSM	Rating	Buy
Date		11/17/2023
Rec Weight		5%
Bench Weight		0%
Current Price		\$100.0
Price Target		\$152.2
Consensus PT (AVG)		\$110
Key Statistics		
52 Week High		\$110.7
52 Week Low		\$72.84
Market Cap (mn)		519,000.0
Shares Out (mn)		5,190.0
Performance (YTD)		
TSM		29.91%
XLK		48.13%
S&P		17.47%

Taiwan Semiconductor Manufacturing Company

The Babson College Fund is initiating coverage on Taiwan Semiconductor Manufacturing Company (NYSE: TSM) with a price target of \$152 representing ~52% upside. TSMC is a Taiwanese semiconductor manufacturer, and it is the largest manufacturer in the world. TSMC serves the world's largest technology companies, including Apple, NVIDIA, Broadcom, Qualcomm, etc., and in 2022 it produced fully 30% of the non-memory chips in the world.

We believe that their immense economy of scale advantage, effective monopoly on high end chip fabrication, the proliferation of chip production due to the GenAI revolution, and their capital expenditure moat which will benefit from global industry subsidies, will justify the increased value of TSMC. We believe the street underestimates these massive economies of scale and innovation moats that make TSMC a unique, unmatched blue-chip player in the chip manufacturing space set to grow at an unprecedented rate due to AI ballooning the need for the highest end chips.

Stock Selection Process

After discussion with the teams, the tech team indicated that they were considering pitching a silicon company in order to gain exposure to that segment in their portfolio. Given the fairly extensive research and modeling I had done over the summer in this industry, using my industry comparison models I looked for a stock in the semiconductor space that wasn't (as) overextended as the NVIDIAs of the world.

This led to TSMC, as they produce the underlying components that underlie all of NVIDIA's success, and yet trade at a much lower multiple historically. As well, their strong financial position, and pseudo monopoly status, and global secular tailwinds in the technology space confirmed my model's output.

Industry Overview



The semiconductor industry has evolved rapidly over the past few decades. Advances and technological innovations have caused chips to quickly miniaturize, as manufacturers have created better, more efficient ways of making chips. The above chart shows this trend.

Because manufacturing these incredibly intricate chips is difficult, the industry spends massive amounts in capital expenditures in order to update current foundries and build new foundries to expand production capacity and flexibility as the number of models of chips, and thus fabrication capacity, grows. Said differently, the industry grapples with Moore's law, as well as Moore's second law; they state that the number of transistors on a circuit double every ~2 years, and that the cost of chip fabrication facilities doubles every 4 years, respectively

The industry is divided mostly into a few groups notably:

1. Fabless chip design companies (Apple, AMD, NVIDIA)
2. Chip fabricators (TSMC, Samsung, Intel)
3. Lithography/Tool providers (ASML, etc)
4. Design software providers (Cadence, Synopsys, etc.)

The design software and tool providers sell their IP to chip fabricators, with which they produce the designs requested by the fabless chip design companies. An interesting result of this dynamic is that the different partners work closely together, and spend billions in building out their mutual manufacturing ecosystem. It is therefore very hard for new competitors to penetrate the existing paradigm, as this oligopolistic industry is quite insular, and new players need to provide enough volume/a reason to change the status quo, which is massively difficult in this industry.

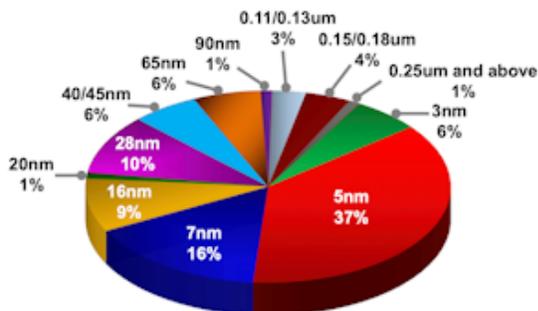
As well, though Intel and Samsung compete as chip fabricators with TSMC, two of the largest clients (Apple and NVIDIA) would never switch to a competitor because both Intel and Samsung compete directly on chip design and smartphones respectively with NVIDIA and Apple, and

therefore NVIDIA and Apple are very interested in staying with the “neutral” manufacturing partner in TSMC, who has no internal use for chip designs and thus has no incentive to steal IP.

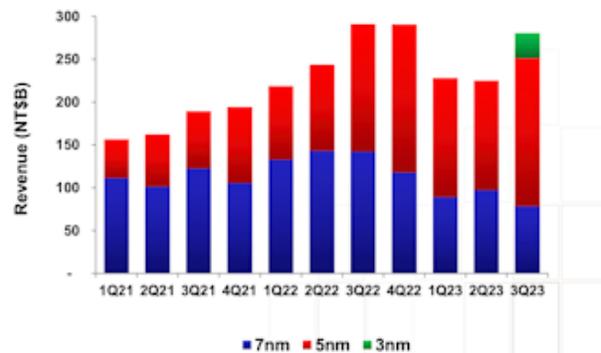
As a result of the above, the industry is remarkably capital intensive, and therefore the leaders in the space have a widening moat. Not only do their competitors have to catch up by building large facilities to manufacture the previous generation chips which are still in demand, they have to plan ahead in building facilities that take years to complete to produce cutting-edge chip models that only a few companies have successfully produced. It is incredibly hard to innovate in the chip space, and companies as large as Samsung have “given up” competing with TSMC given their superior processes for some types of chips.

Company Overview

3Q23 Revenue by Technology



7nm and Below Revenue



Year ended December 31,

Resolution	Year ended December 31,		
	2020	2021	2022
	Percentage of total wafer revenue ⁽¹⁾	Percentage of total wafer revenue ⁽¹⁾	Percentage of total wafer revenue ⁽¹⁾
5-nanometer	8%	19%	26%
7-nanometer	33%	31%	27%
16-nanometer	17%	14%	13%
20-nanometer	1%	—	—
28-nanometer	13%	11%	10%
40/45-nanometer	9%	7%	7%
65-nanometer	5%	5%	5%
90-nanometer	2%	2%	2%
0.11/0.13 micron	3%	3%	3%
0.15/0.18 micron	7%	6%	6%
≥0.25 micron	2%	2%	1%
Total	100%	100%	100%

TSMC is a massive company, with a current market capitalization of ~\$511bil. They had over \$75bil in revenue in 2022, ~90% of which came from silicon wafer (chip) fabrication, 55+% of which was

attributable to high performance/advanced technologies (7nm and smaller). In 2022, TSMC produced more microchips than any other company on earth, which requires many large, expensive fabrication facilities. While the majority of their facilities are located in Taiwan, they have geographic diversity across the world with their 16+ fabs, and are further investing \$40bil in a manufacturing facility in Arizona and ~\$4bil into a German facility due to US and European investment in the space through the bi-partisan CHIPS and Science act and the European chips act, which are set to act as a secular tailwind.

Apple makes up 1/5 of TSM's revenue mostly through their 5nm chip demand for iPhones, and though they are Taiwan based, the US is their largest market (>65% of revenue). As well, TSMC has an effective monopoly on the production of the highest end chips, being the only company globally that can produce the silicon necessary for NVIDIA's cutting edge AI chips at scale due to the complexity of the manufacturing process.

2022 showed TSMC's exceptional performance in a challenging global environment, emphasizing its sustained revenue growth, profitability, and technological leadership. Despite global economic and geopolitical challenges, TSMC achieved a 33.5% YoY increase in revenue and a nearly tripling of earnings per share over three years. As well, TSMC has shown 13 years of record revenues, through a challenging global environment that included COVID and supply chain disruption. In addition to exemplary revenue growth, TSMC's gross profit margin reached ~60%, reflecting the company's efficiency and cost-effectiveness.

The company's commitment to technological innovation is evident in the successful development and production of advanced nodes, with the 3-nanometer technology entering volume production in 2022. TSMC's strategic focus on R&D, including leading on the upcoming 2-nanometer technology, positions it as a leader in the semiconductor industry.

TSMC is responding proactively to macroeconomic uncertainties by expanding its global manufacturing footprint, with fabs in Taiwan, the U.S., Germany, and Japan. This strategic move aligns with customers' preferences for geographic manufacturing flexibility and enhances the company's growth prospects.

Overall, TSMC represents a compelling case for investment, showcasing its immense economies of scale, resilience, innovation, and strategic positioning in the semiconductor industry.

Thesis 1 - TSMC operates with massive economies of scale in a hugely capital/R&D intensive, oligopolistic industry, creating an ever-expanding moat that insulates their strong revenue and margin growth from most competitive pressure

Typically, when an industry shows strong double digit growth along with high (>50%) margins, there is significant competitive pressure. We have seen TSMC generate 13 years of record adjusted revenue, showing incredibly strong top line growth with an average CAGR of ~12% over 23 years

and an ROIC north of 23% over the past decade, one of the best in the industry. TSMC's margins have also *expanded* during this same period, growing from 57% to 62% in the last 5 years.

The charts below show TSMC's long term revenue, net income, and growth of cash balance. As we can see, TSMC has an incredibly stable business, with increasing revenues, earnings, and free cash flow.

Revenue Chart

Annual

Quarterly

Trailing

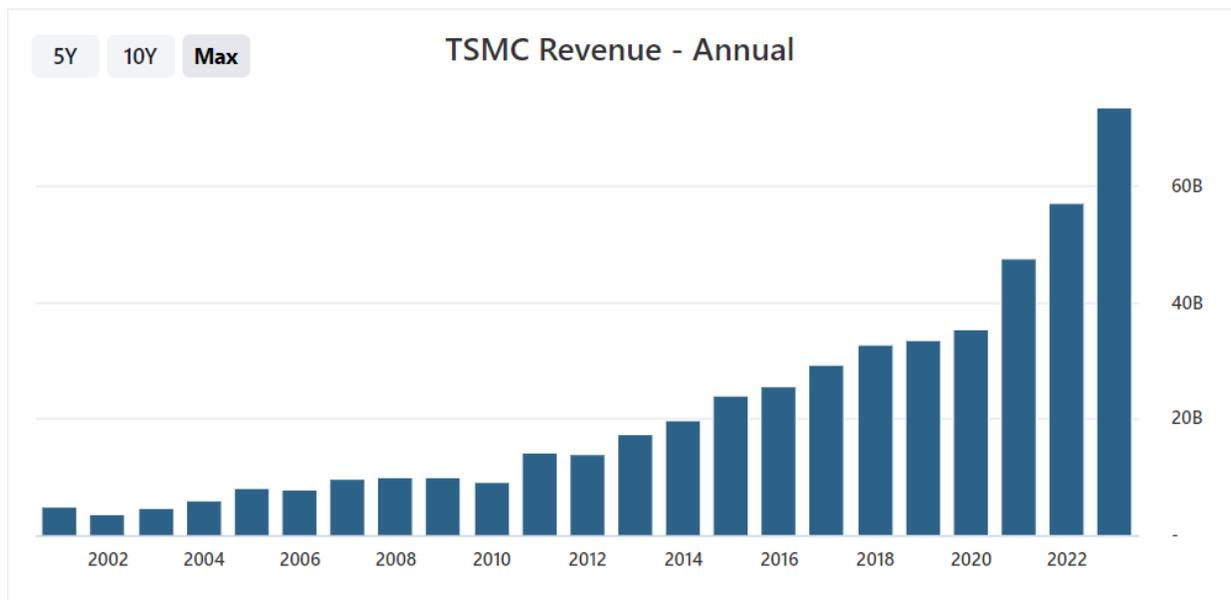


5Y

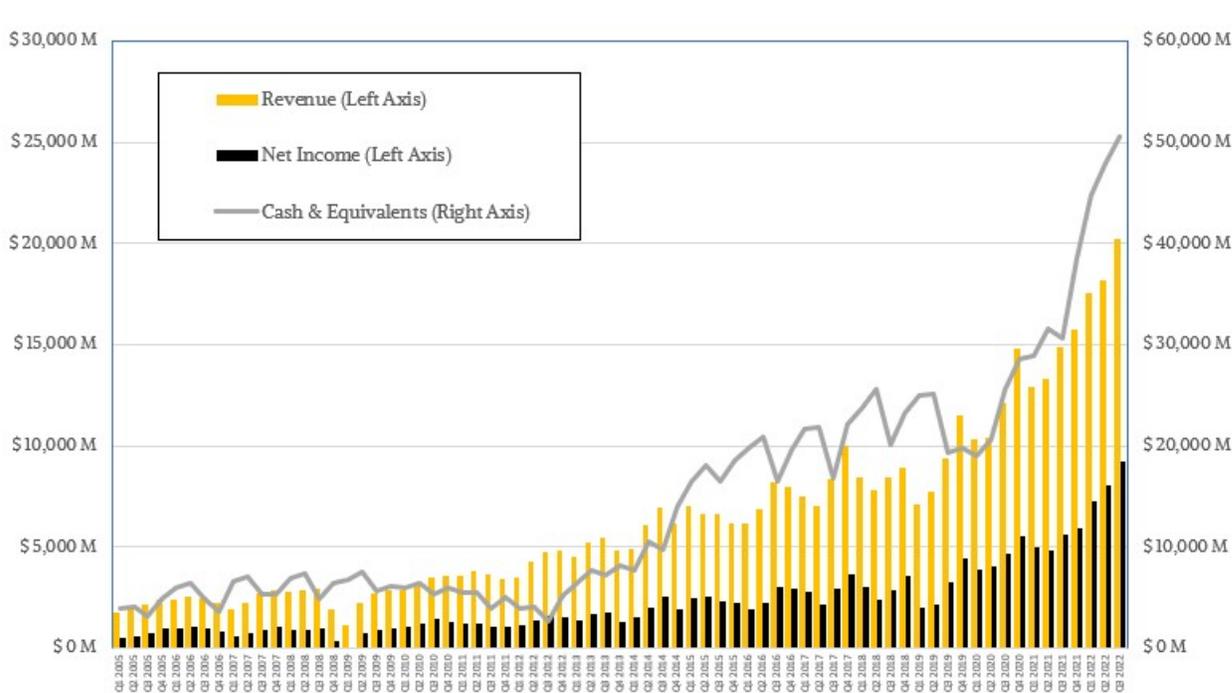
10Y

Max

TSMC Revenue - Annual



* The company reports in TWD currency but revenue data is shown in USD.

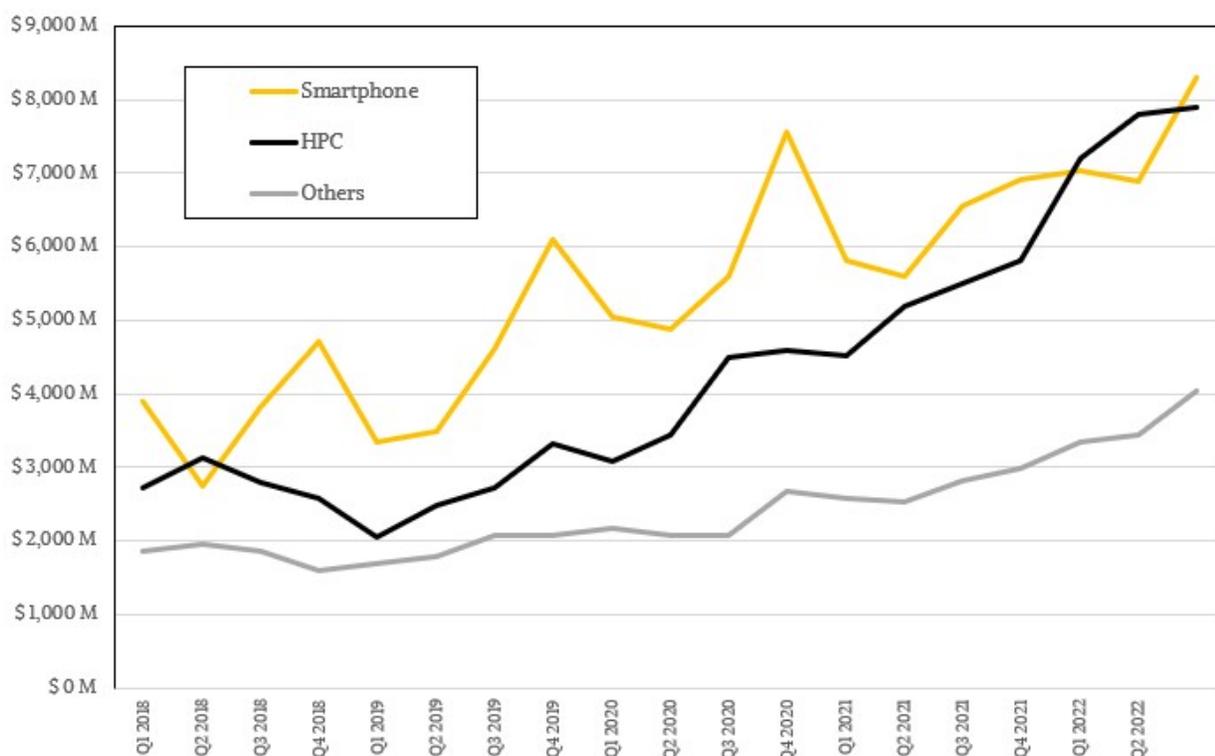


In the silicon fabrication space, TSMC competes with only Intel and Samsung. There have been attempts by both the middle-east and China to develop

their own fabs to enter the space, but they have been largely unsuccessful in replicating TSMC's incredibly high difficulty and quality manufacturing processes. Because the manufacturing processes, especially of the high end chips, is so complex, TSMC has not only a moat in terms of the (increasing) volume of CAPEX required to compete in the industry, but also because the manufacturing process IP is remarkably hard to replicate with any amount of capital.

Further, TSMC's management has stated that they plan to invest in CAPEX with an eye towards the next 10+ years of capacity demand. Given that TSMC is one of the largest companies in the world with a market capitalization above \$500bil, they are one of only a few companies positioned to spend this quantity of capital to satisfy exponential global demand for semiconductors. As a reference, TSMC spent over \$30bil on CAPEX in 2022 alone, and over \$100bil in the last three years, with little indication of slowing down much in the next ~5 years.

Thesis 2 - The global silicon demand pressure presented by GenAI will cause large industry growth in cutting edge chips for which TSMC owns most manufacturing ability



Revenue contribution by segment over time

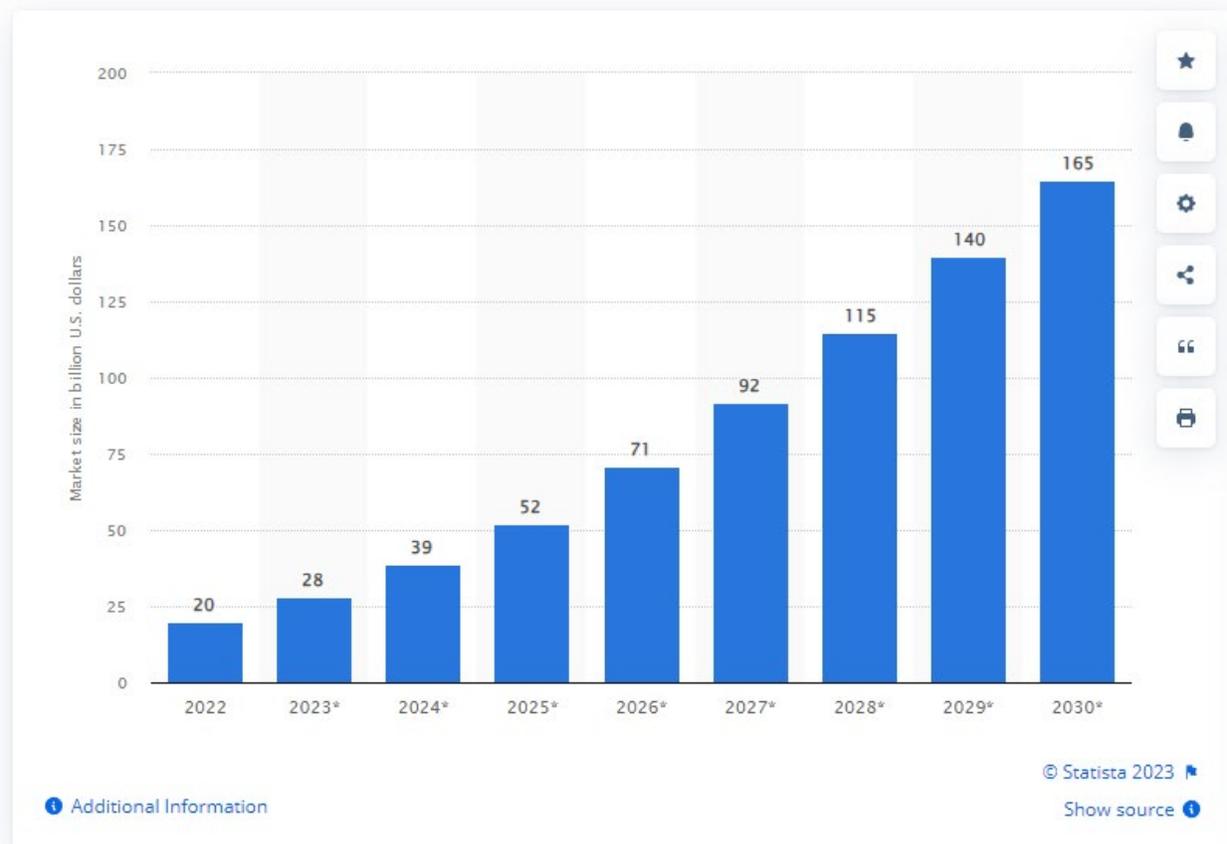
Platform	Year ended December 31,					
	2020		2021		2022	
	Net Revenue	Percentage	Net Revenue	Percentage	Net Revenue	Percentage
	(NTS in millions, except percentages)					
High Performance Computing	439,810	33%	587,780	37%	932,384	41%
Smartphone	645,304	48%	695,091	44%	888,879	39%
Internet of Things	110,355	8%	133,006	8%	196,115	9%
Automotive	44,367	3%	67,077	4%	116,381	5%
Digital Consumer Electronics	54,556	4%	55,577	4%	56,159	3%
Others	44,863	4%	48,884	3%	73,973	3%
Total	1,339,255	100%	1,587,415	100%	2,263,891	100%

Historically, we've seen TSMC generate most revenue from three major segments, the Smartphone High Performance Computing (HPC), and Other. These segments are representative of two of the largest TSMC clients, NVIDIA (HPC) and Apple (Smartphones), as well as the breadth of their other 500+ clients across the globe (Other). The other component is all the smaller segments/end markets, such as cloud computing, automotive, normal compute, specialty custom chips, etc.

As we can see, the HPC segment has increased 59% between 2021 and 2022 (though has declined in the beginning of 2023), and the Smartphone segment increased ~28% yoy (though again, 2023 was a rougher year).

The actual and further expectation of growth in the HPC market can largely be attributed to high end chips used in GenAI, which is dominated by NVIDIA. In June of 2023, NVIDIA's CEO stated that TSMC is a "world class company with immense capacity and incredible agility", while also committing to source both the current and next generation from various TSMC foundries, including the planned Arizona facility. He continued: "The process of diversifying in different geographies is

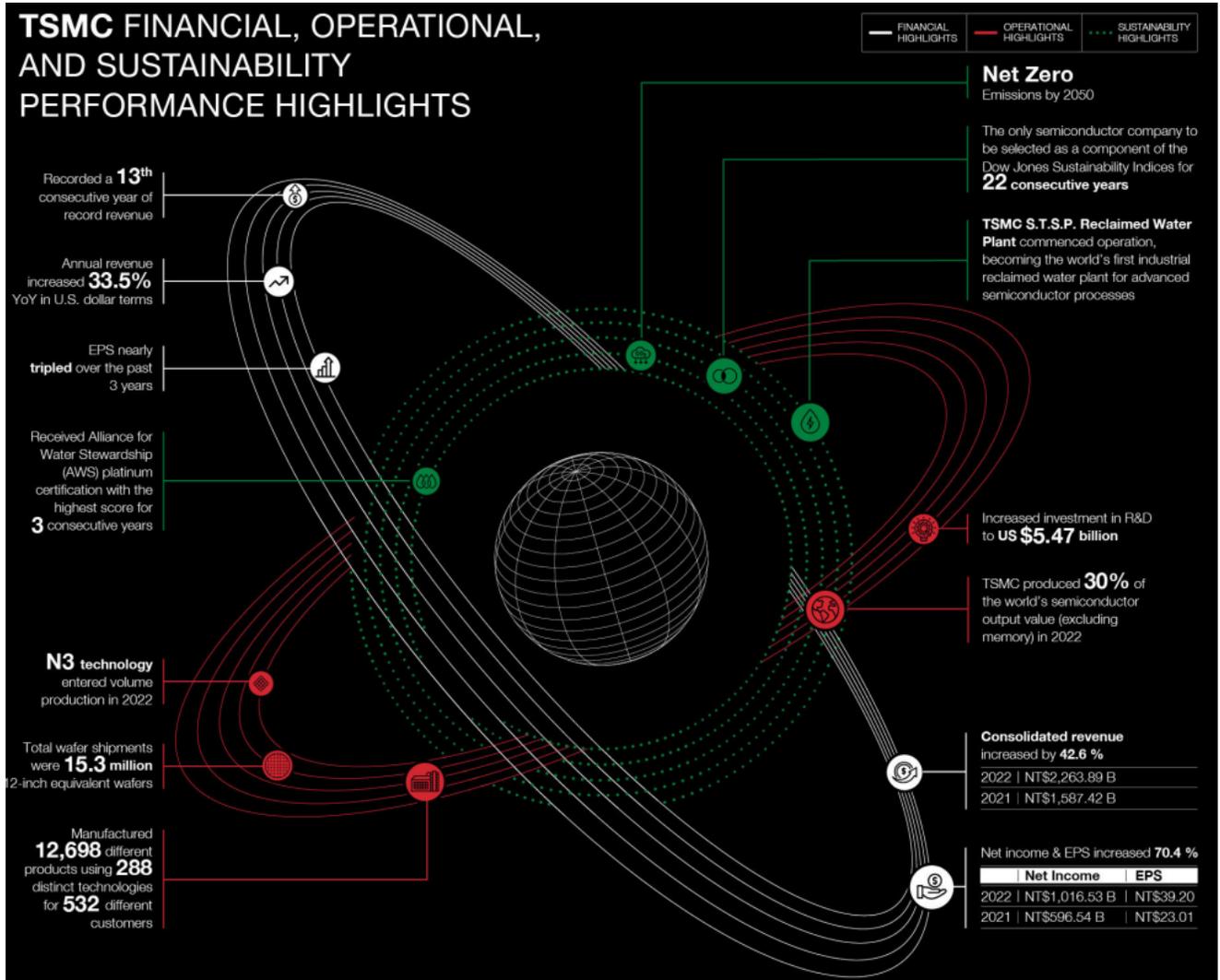
an excellent strategy by TSMC and so TSMC is now part of Nvidia's diversity and redundancy strategy.” It is important to note that this year, Nvidia announced a revenue target more than 50% above Wall Street estimates with plans to boost supply to meet surging demand for its AI chips. Because TSMC remains by far their largest manufacturing partner, they will benefit as NVIDIA grows without the downside exposure from NVIDIA’s high volatility. This market is expected to grow at a 30% CAGR through 2030, per the chart below, and barring significant, rapid advancement by competitors, TSMC remains the only company capable of manufacturing such chips:



AI Chip Revenue Growth Projections (Statista)

While less explosive, we also expect growth in the smartphone and “other” segments as well. In the smartphone segment, experts predict anywhere from a 2% to 8% market CAGR through 2029, largely driven by non-US markets, as the US smartphone market is fairly saturated and growth appears to be slowing down. As smartphones advance, we expect them to transition from 3nm chips to the future 2nm chips, and TSMC is the market leader and holds an effective monopoly on this new innovative design, and we expect them to continue as the market leader as designs continue to further miniaturize every ~2 years or so. Therefore, our model reflects increasing market share in this segment as part of the revenue projections.

Thesis 3 - TSMC has an immensely strong financial position and track record. These give it a unique position to gain free CAPEX leverage from global silicon manufacturing subsidies, including the CHIPS and Science act in the US, and maintain their world leading position

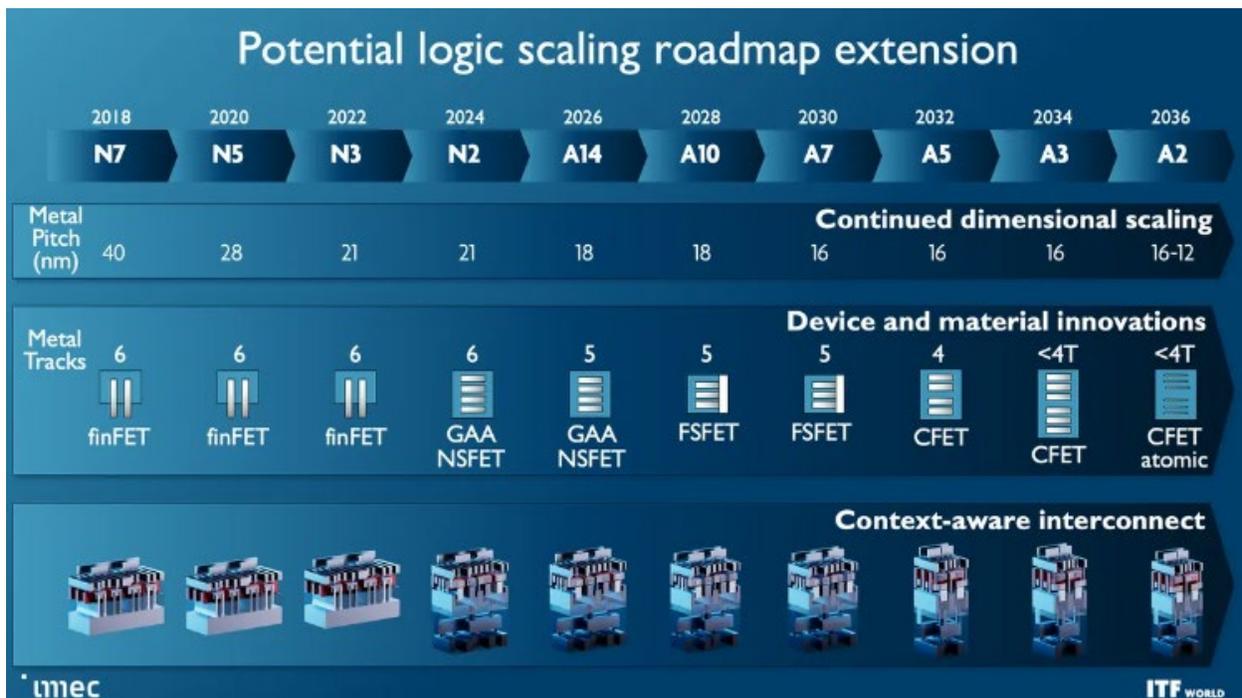


Despite the capital intensive nature of their industry and challenging global conditions over the past 3 years, TSMC has a strong cash position, had recorded 13 straight years of revenue growth, and has tripled EPS in the last 3 years. The above graphic from their 2022 annual report shows more accomplishments of the company in recent years. TSMC also has relatively little debt relative to size, with only ~\$30bil in debt. It maintains a cash reserve of over \$49bil, and therefore TSMC operates with *negative* net debt, despite the incredible capital requirements in the industry. They are able to do

this because of their immense financial growth and free cash flow, both with regard to top line and earnings, over the past decade.

Partially due to the CHIPS and Science act, TSMC is investing ~\$40bil into a new US fabrication facility in Arizona, and ~\$4bil towards a joint facility in Germany, and expects to receive a combined ~\$20bil in government subsidies from both the US and Europe. This is indicative of the desire for large world players to increase their silicon production ability. Because TSMC has such massive cash reserves (~\$45bil) and therefore can expand CAPEX to take advantage of global subsidies, TSMC will benefit from programs all over the world aimed at this goal, thus reducing their costs and accelerating the payback period for massive expenditures. This also further increases their competitive moat, as subsidy distribution is inherently a zero sum proposition. Since TSMC stands to receive a large share of the subsidies to build their own fabs, their competitors will receive less as a result. TSMC expects to receive about \$15bil in combined tax credits and subsidies from the CHIPS act, and \$5bil from the European chips act. As well, these subsidies reduce the overall cost of these large facilities, and contributes to ensuring that chips produced in global fabs can remain cost competitive with those produced in Taiwan.

The reason that this CAPEX is important is the competitiveness of the industry. The below graphic from a leading silicon research firm projects the innovation trend in the industry over the next decade:



In order to stay on the cutting edge, we can see that major new manufacturing innovations occur roughly every 2 years. It requires a large amount of both forward planning and capital expenditures to upgrade or build new manufacturing facilities in order to produce the new technologies. Currently, TSMC and Samsung lead on the production of the cutting edge 3nm chips, but TSMC is

well ahead in terms of their production ability for the next generation 2nm chips, set to premier in 2024.

Manufacturing capacity is especially important, because even the older technologies remain in use for a long time. There are still 280nm chips in demand, an architecture developed in 1997, and 16nm (available since ~2015) or larger chips still account for >45% of revenue presently. This trend shows that it is important to maintain adequate manufacturing capacity for many different chip architectures, and therefore more manufacturing capacity is needed to keep up with innovative new architectures. TSMC clearly understands this, and plans to invest tens of billions of dollars into new fabs across the world.

Catalysts and Risks

Catalysts

Faster than expected development of higher end technologies

It is hard to fully quantify the ultimate growth potential of the next generation end markets such as GenAI, 5g, cloud computing, IoT, EVs etc. however, what we do know is that Moore's law continues to (mostly) persist, and as these markets grow, TSMC will be a direct beneficiary as they are the only firm capable of producing the next generation chips in a sustainable and profitable manner. If, as has been the case many times in the past, new technologies advance more quickly than predicted in the next few years, the estimates in the model will prove to be low.

Semiconductor market bottom

Misunderstanding of how crucial the company is in the global supply chain for chips has caused the company to decline from ATH of ~\$145 since early 2022. Since the semiconductor industry is historically cyclical, the street is over-punishing the stock. We believe that thought the industry has become less traditionally cyclical, the COVID supply chain disruption and overstocking as a result has caused ripples that look like a cycle of the past. Since this bottom action often precedes a large run up, if it continues we see it as a boon for TSMC

Cooling in geopolitical tensions/China Derisking

China met with the US last week, and we once again see military to military communication, which can remove the "accident risk" that we believe has been unduly punishing TSMC's stock. Geopolitical risk is real (see more in risks below) but we believe that due to how integral TSMC is to global technology, both the US and global technology firms that rely on TSMC would be very loath to allow China to get anywhere close to nationalizing TSMC. Further, as tensions between the US and China cool, this risk eases.

Risks

China invading Taiwan

This is clearly one of the larger risks of investing in TSMC. China has been engaged in saber rattling about invading Taiwan. However, we view this risk as less severe than most, and we believe the street may be overestimating this risk Since they are such a global leader in the semiconductor space, and because they have some monopolistic/oligopolistic control over some of the most advanced

semiconductor production, TSMC being taken over/nationalized in any sort of China Taiwan invasion would set the rest of the world back decades in terms of silicon manufacturing capabilities.

The US Government has repeatedly indicated that they would not allow this to happen, for obvious national security technological readiness reasons. As well, US China tensions, after a period of choppiness, are moving back in the right direction with Xi's visit to San Francisco and meeting with Biden. Even if tensions revert and deteriorate, any sort of Taiwan invasion will likely result in WWII, in which case we will have larger problems to worry about than a TSMC investment.

TSMC has also hinted in the past that they have strong countermeasures in place should China invade, and therefore China knows that invading might cause TSMC to simply leave with their people and destroy their fabs, in which case China would not accomplish their goal.

As well, because many massive technology companies (Apple, NVIDIA, etc) rely heavily on TSMC for their chip manufacturing, the systemic risk of losing TSMC to the global technology supply chain would be catastrophic, and therefore any and all companies in this supply chain would also suffer greatly in the event of TSMC going away. Therefore, we believe that though China invasion risk is real, both the likelihood and drastic consequences should one occur mean that it should not prevent us from investing in such a blue-chip, financially strong company with a great history, strong financials, and an ever expanding technological and CAPEX moat.

The AI chip trend fizzles out/doesn't live up to expectations

The AI market is still quite new, and so it is hard to predict how demand will evolve, and if the technology will take hold across industries in the time period that stocks are pricing in. Because the exponential growth of AI is priced into many stocks (though TSMC less than companies like NVIDIA), there is risk to the investment if this market is overestimated by the street.

We believe that this is unlikely however, since we're already seeing increased demand, and all of the hyperscaler companies (Microsoft, Meta, Amazon, NVIDIA, etc) are investing hugely into the space. The GenAI models only get harder and harder to train as time goes on, and the current cutting edge is estimated to require over \$300mil in hardware. Thus we see this risk as small.

Competitors outstrip TSMC in terms of R&D

This risk would be that Samsung or Intel (or another Chinese fab) can replicate the manufacturing process of TSMC and take market share, especially in cutting edge chips where TSMC currently dominates. However, for the reasons laid out in the report above, while this is technically possible, it is highly unlikely in our view, as the industry continues to follow Moore's law, and TSMC's moat grows ever larger both in terms of manufacturing process knowledge and CAPEX leads.

Comps

Intel, Samsung

	EV/Rev	EV/EBIT	EV/EBITDA	P/E
Average	2.45x	15.16x	8.25x	14.35x
Median	2.45x	15.16x	8.25x	14.35x
33th Percentile	2.1x	11.57x	7.55x	11.67x
50th Percentile	2.45x	15.16x	8.25x	14.35x
66th Percentile	2.79x	18.55x	8.92x	16.88x
Enterprise Value Median	219,312	692,812	481,788	
Enterprise Value 33th	187,424	528,573	440,574	
Enterprise Value 66th	219,312	692,812	481,788	
Enterprise Value 54th	249,325	847,390	520,577	
Debt	31,444	31,444	31,444	
Excess Cash	48,582	48,582	48,582	
Shares Outstanding	5,190	5,190	5,190	
Price Based on Median	\$45.56	\$136.79	\$96.13	\$127.76
Price Based on 33th Percentile	\$39.41	\$105.15	\$88.19	\$103.89
Price Based on 50th Percentile	\$45.56	\$136.79	\$96.13	\$127.76
Price Based on 66th Percentile	\$51.34	\$166.58	\$103.61	\$150.22

Comps: EV/EBITDA	
2024 EBITDA	58,373
Comps	14.4x
EV	837,731
Debt	31,444
Cash	48,582
Equity Value	854,869
Shares outstanding	5,190
Stock price	\$164.71
Discount	0%
Discounted stock price	\$164.71
Current Price	\$99.58
Upside	65.41%

Comps: EV/EBIT	
2024 EBIT	45,685
Comps	15.2x
EV	692,812
Debt	31,444
Cash	48,582
Equity Value	709,950
Shares outstanding	5,190
Stock price	\$136.79
Discount	0%
Discounted stock price	\$136.79
Current Price	\$99.58
Upside	37.37%

Comps: P/E	
EPS	\$ 8.90
Comps	14.4x
Price	\$127.8
Discount	0%
Discounted Stock Price	\$ 127.76
Current Price	\$99.58
Upside	28.3%

Multiple Weight		
Multiple	EV/EBITDA	EV/EBIT
Price	\$164.71	\$136.79
Weight	50%	50%
Target	\$ 150.75	
Current	\$99.58	
Upside	51.4%	

See model for details/larger view

DCF

Final DCF Price Target

	Weight	Price
Perpetual Growth Method	30.0%	\$96.0
Exit EBITDA Method	70.0%	\$157.2
DCF Target Price		\$138.8
Current Price		\$99.6
Upside		39.4%

See Excel model for details

Appendix

FAQ/IR Responses (Answers Paraphrased)

Question: Will TSMC be able to achieve the projected margin expansion given the higher production costs of producing chips outside of Taiwan at the global fabs?

IR Answer: The reason for geographical expansion is customer demand for such, and therefore the entire market understands that premium pricing will be charged on these chips and is ready to accept this in exchange for decreased geopolitical risk and proximity. The US government has said they will help TSMC defray these increased costs through subsidies, and this is what spurred the Arizona Fab, which is complete pending tools and engineers. All this said, expect 3-5 years before fab efficiency equals that of Taiwan.

Question: How will TSMC decide on pricing, both in Taiwan and abroad?

IR Answer: TSMC sits down with big partners each year to discuss their needs for the coming year, and then it is able to decide on pricing based on this. Because the large partnerships are so sticky given TSMC's basic monopoly, pricing power is high here.

Question: Will the global silicon subsidies be a problem for/create competition with TSMC?

IR Answer: The raw capital expenditure of TSMC stands up to the entire size of the subsidies, and further TSMC will reap a good portion of those subsidies. Therefore, the subsidies and global tailwinds will not hinder TSMC through competition, and indeed competing with TSMC in terms of CAPEX remains impossible even with these subsidies.

Question: Share based comp/comp structure?

IR Answer: The vast majority of comp is cash bonuses. Based on shareholder return/dividends for executives, and revenue growth, gross margins, and ROE for other bonus eligible employees. Many executives are 20+ year tenure, some don't work for money because they're already wealthy.

Question: CAPEX Looking Forward?

IR Answer: Two most important business decisions are CAPEX and R&D spend. TSMC focuses on a much larger time horizon (the next ~10 years) when planning CAPEX such that they can at least partially anticipate the growth in demand.

Question: Discuss TSMC's moat

IR Answer: TSMC has a ~30% market share in the early 2000s, now it is so large they don't often report it in fear of anti-trust issues. They believe they have such a large gap over competitors in the space, and they have become so large, that more and more partners will choose TSMC and therefore they will only snowball in the future.

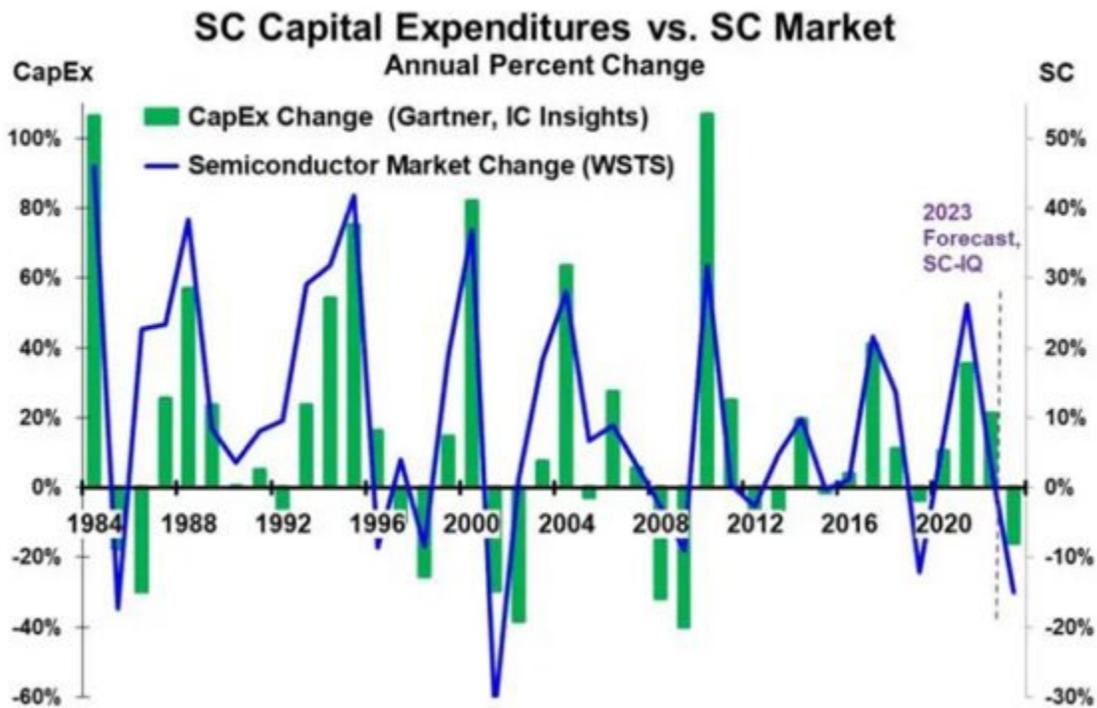
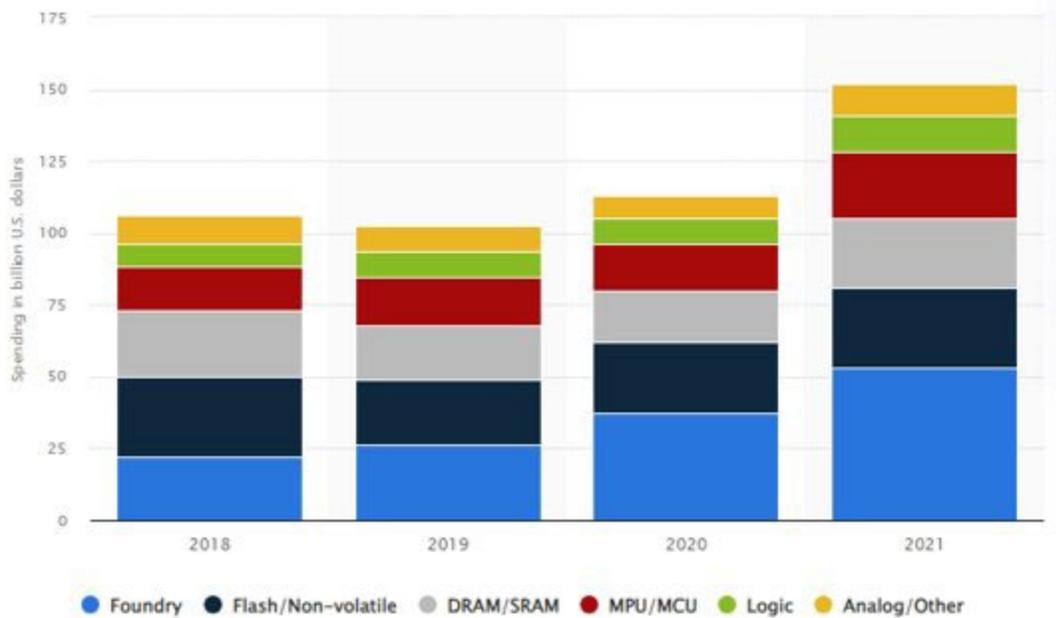
Management and Management Compensation

Worldwide Top 10 Foundry Companies, 2022 Market Share



Source: IDC 2023

TSMC's Revenue by Customer: CY2022		
Customer	Revenue (\$M)	Revenue (%)
Apple	\$ 17,454	23.0%
Qualcomm	\$ 6,754	8.9%
AMD	\$ 5,767	7.6%
Broadcom	\$ 5,009	6.6%
NVIDIA	\$ 4,781	6.3%
MediaTek	\$ 4,250	5.6%
Intel	\$ 3,870	5.1%
Marvell	\$ 1,821	2.4%
NXP	\$ 1,138	1.5%
Unisoc	\$ 926	1.2%
Omnivision	\$ 911	1.2%
Sony	\$ 835	1.1%
Amazon	\$ 721	1.0%
STMicro	\$ 650	0.9%
Cirrus Logic	\$ 576	0.8%
Infineon	\$ 570	0.8%
TI	\$ 530	0.7%
Synaptics	\$ 501	0.7%
On Semi	\$ 450	0.6%
Analog Devices	\$ 417	0.6%
Mobileye	\$ 395	0.5%
Google	\$ 379	0.5%



TSMC's Yearly Capital Expenditures



Source: Bloomberg/TSMC



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Chips and Science Act Info

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