

Semiconductors, Geopolitics and AI

CFA Society of Nebraska

November 21, 2024

Background

- NZS Capital is a Denver, Colorado based boutique managing Global Growth and Global Technology strategies
- NZS → Non-Zero Sumness or win-win outcomes for the ecosystem
- 5 person investment team previously managed Global Technology and Innovation strategy at Janus Henderson Investors
- AUM ~\$3B across primarily institutional clients

Agenda



Why Semiconductors?



Industry Overview and Value Chain



AI and Nvidia



Geopolitics

Why Semiconductors?

The Building Blocks of the (Digital) Economy

The AI Boom Runs on Chips, but It Can't Get Enough

'It's like toilet paper during the pandemic.' Startups, investors scrounge for computational firepower.

Fridges, microwaves fall prey to global chip shortage

By Josh Horwitz

March 29, 2021 3:01 AM MDT · Updated 3 years ago

BUSINESS | AUTOS INDUSTRY

Chip Shortages Still Plague Toyota, Some Other Auto Makers

Japanese car maker trims full-year production plan by 500,000 vehicles, although it foresees record output

By River Davis [Follow](#)

Updated Nov. 1, 2022 6:09 am ET

Chip shortage affects ag industry — and, no, it's not the potato kind

By Ashley Estes

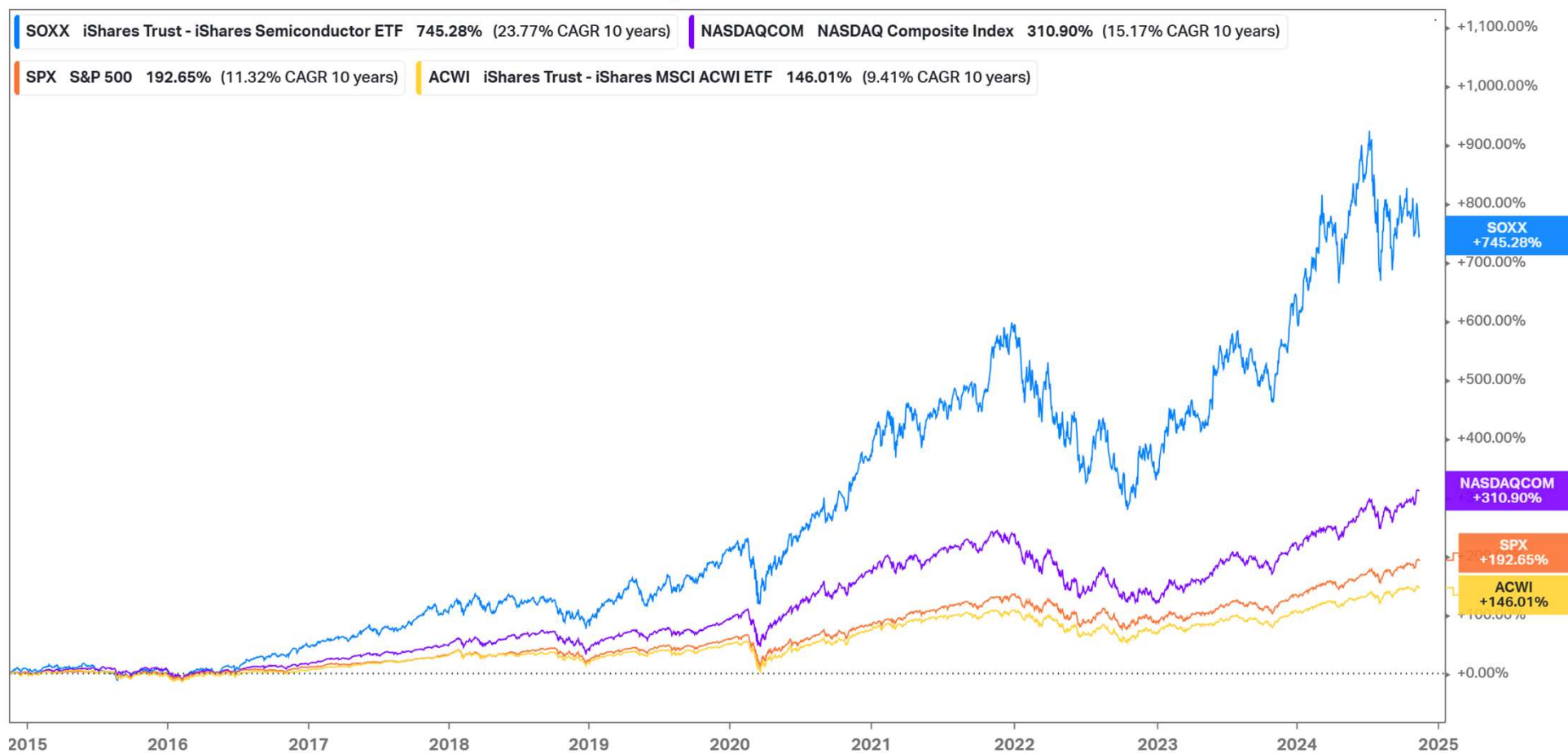
it 2:30 pm CDT

DAVOS AGENDA

Global chip shortages: Why supplies must be prioritized for healthcare capabilities

May 24, 2022

Semiconductor 10-year Stock Performance



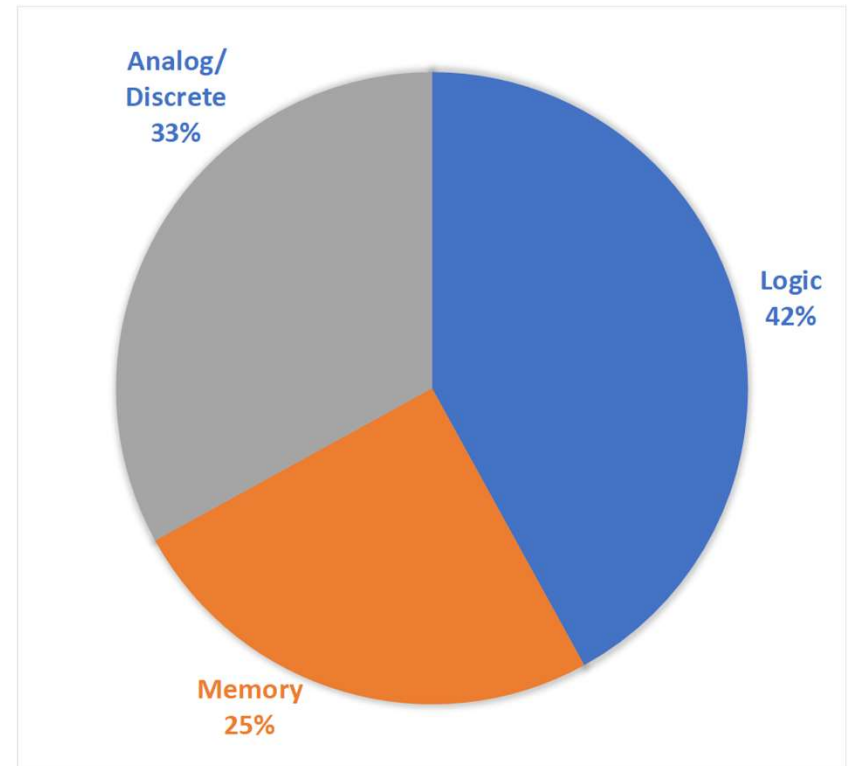
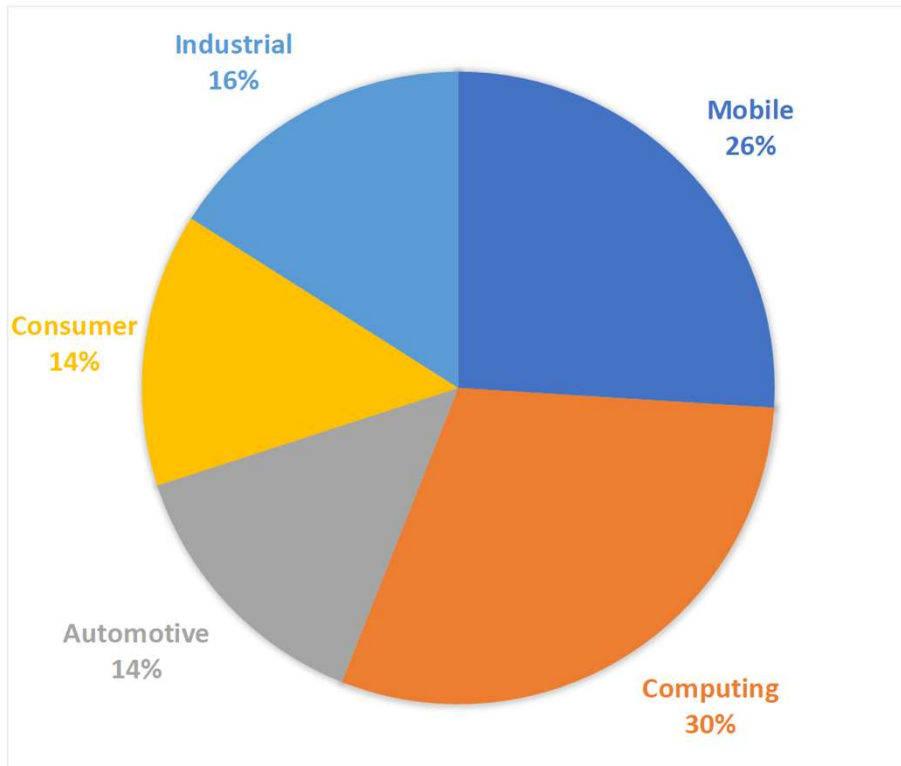
Value Creation in Chip-Related Stocks

Ticker	Name	Total Return (10Y)
NVDA	NVIDIA Corporation	31117%
AMD	Advanced Micro Devices Inc.	5228%
AVGO	Broadcom Inc.	2395%
CDNS	Cadence Design Systems Inc.	1537%
SNPS	Synopsys Inc.	1207%
KLAC	KLA Corporation	1128%
LRCX	Lam Research Corporation	987%
TSM	Taiwan Semiconductor Manufacturing Co.	945%
AMAT	Applied Materials Inc.	828%
ASML	ASML Holding	652%

Industry Background

Industry Snapshot

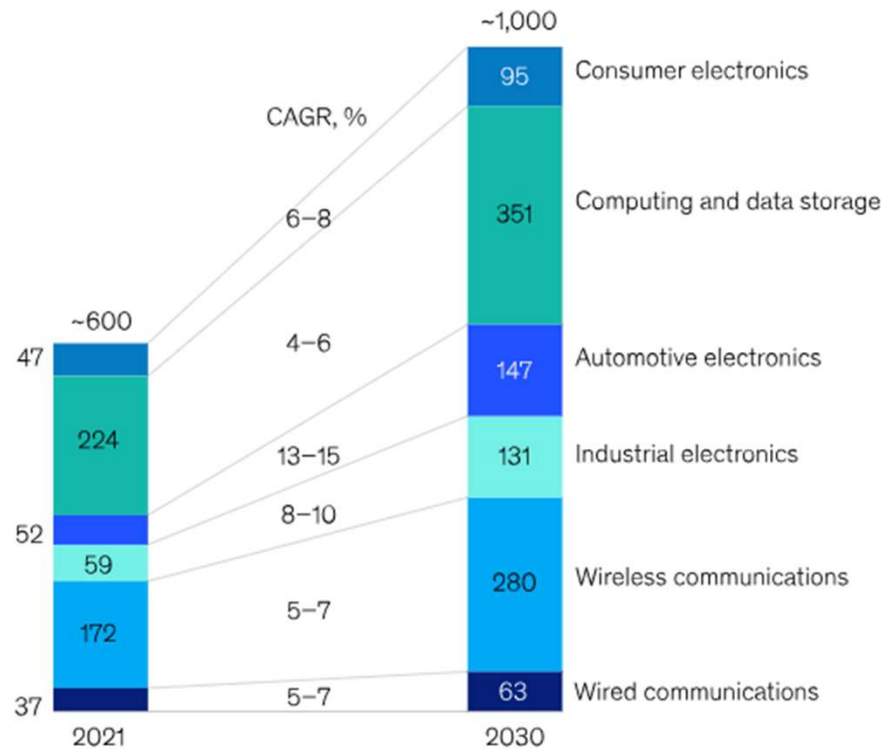
- The global semiconductor industry achieved \$527B in revenue in 2023



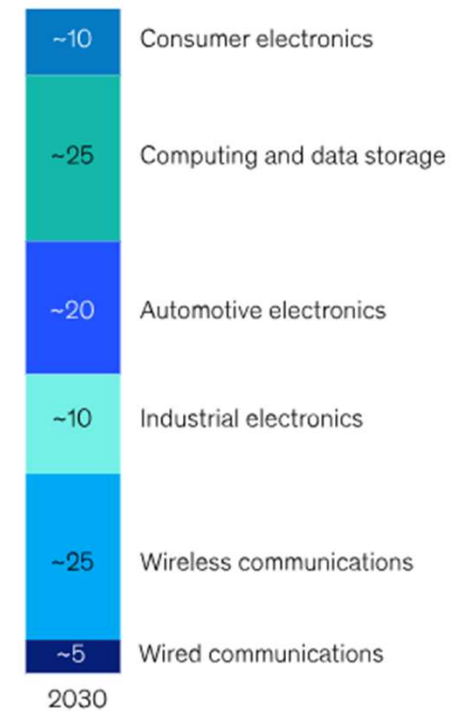
Outlook - \$1T by 2030

The semiconductor market is expected to reach \$1 trillion in value by 2030.

Global semiconductor market, \$ billion



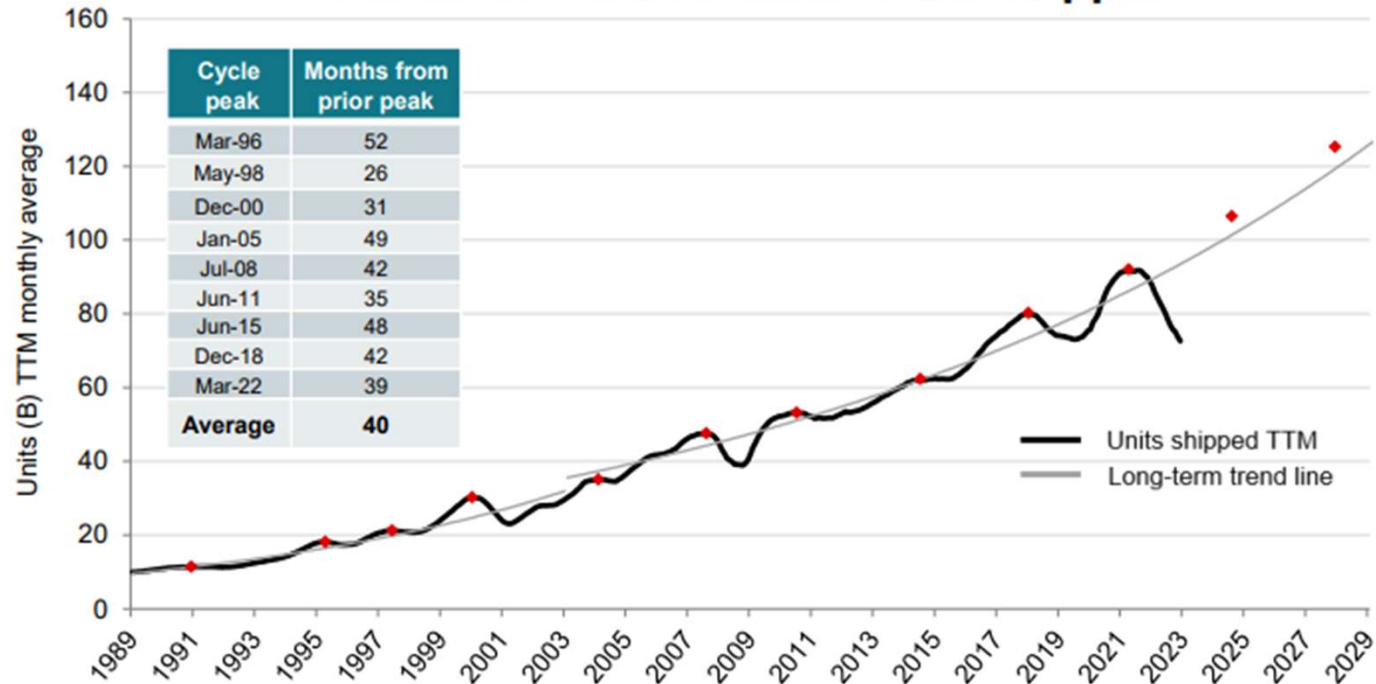
Growth contribution per vertical, %



Source: McKinsey

Industry Cyclicalty

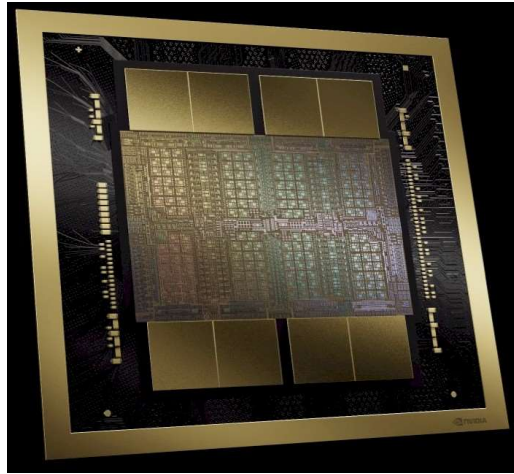
Semiconductor market units shipped*



* Source: WSTS excluding memory trailing twelve months

Semiconductor Value Chain

Logic: The Brains of Any Electronic System



Nvidia B100 GPU: ~\$35,000



Apple A17 Pro: ~\$130



Integrated Device
Manufacturer

Fabless Chip Companies

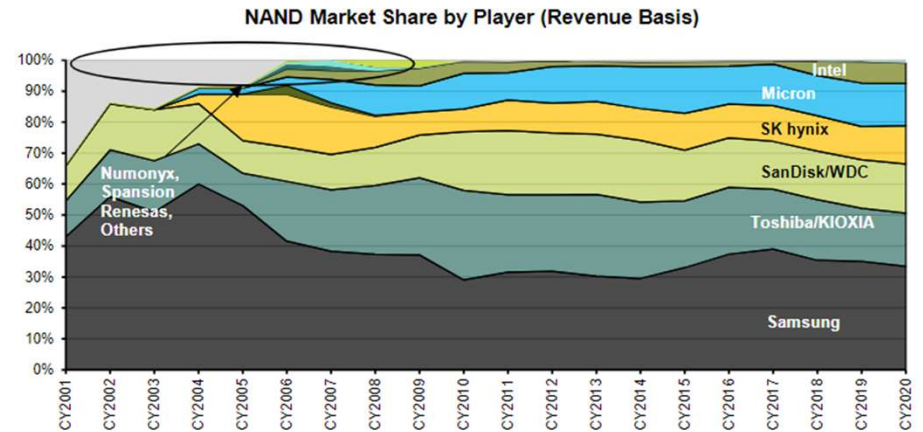
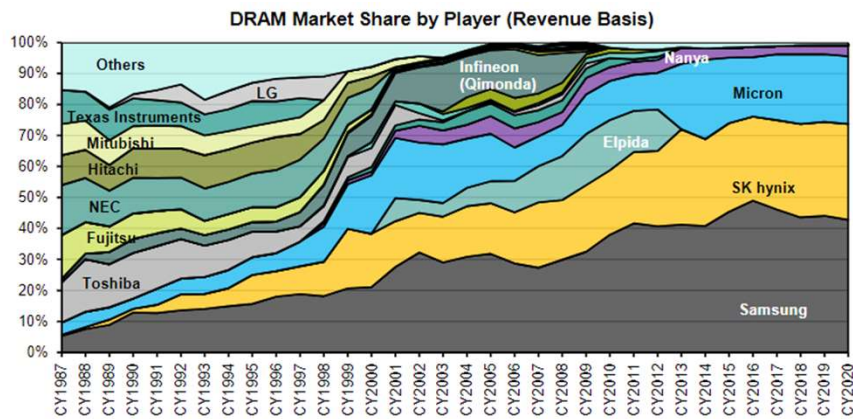


Systems Companies

Analog: Interacting with the Physical World



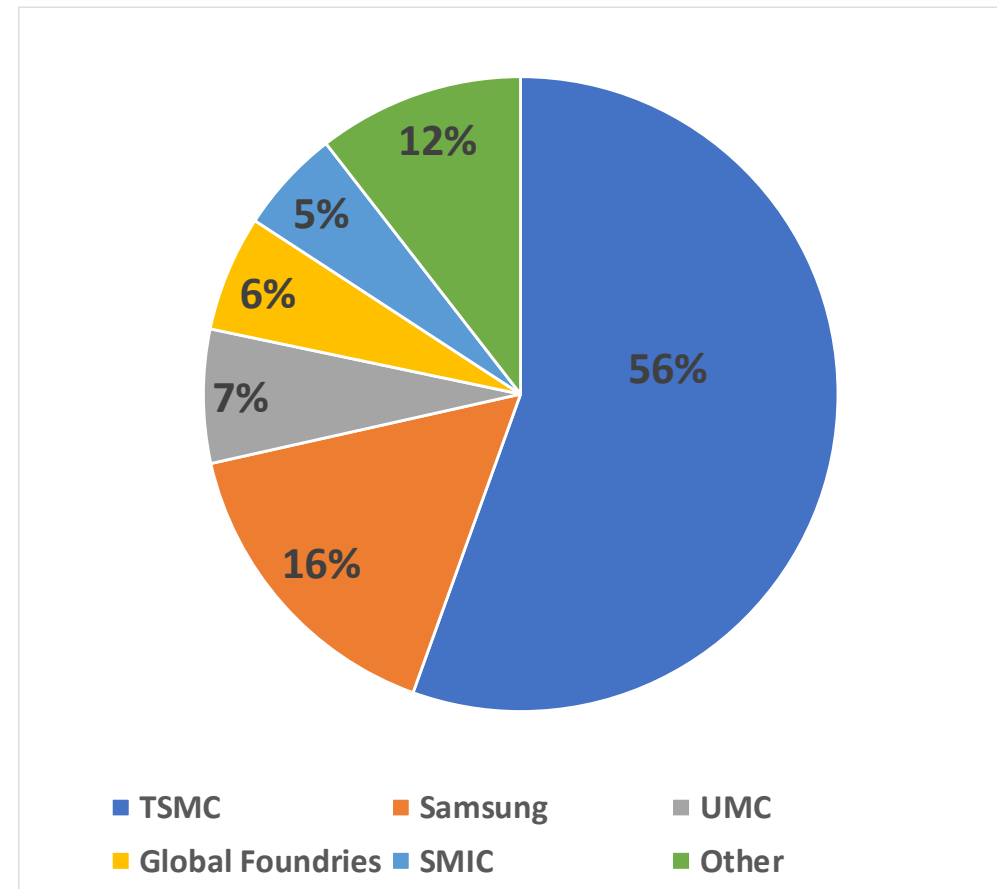
Memory: More Commoditized and Consolidating Markets



Source: Bernstein Research

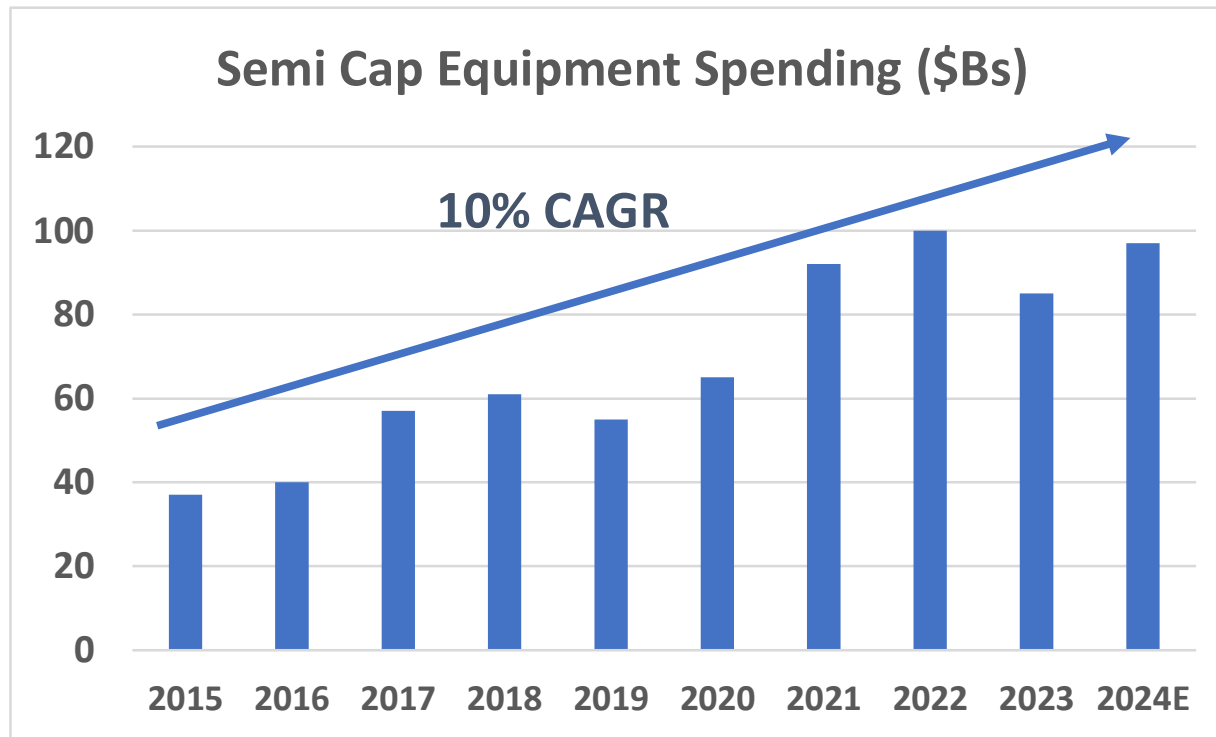
Foundries: Third Party Manufacturing

- Scale: TSMC spent ~USD6B in R&D and ~USD32B in CapEx in 2023
- TSMC has spent ~USD200B in CapEx over the last decade
- TSMC has >90% market share of advanced chips



Source: IDC

Capital Equipment



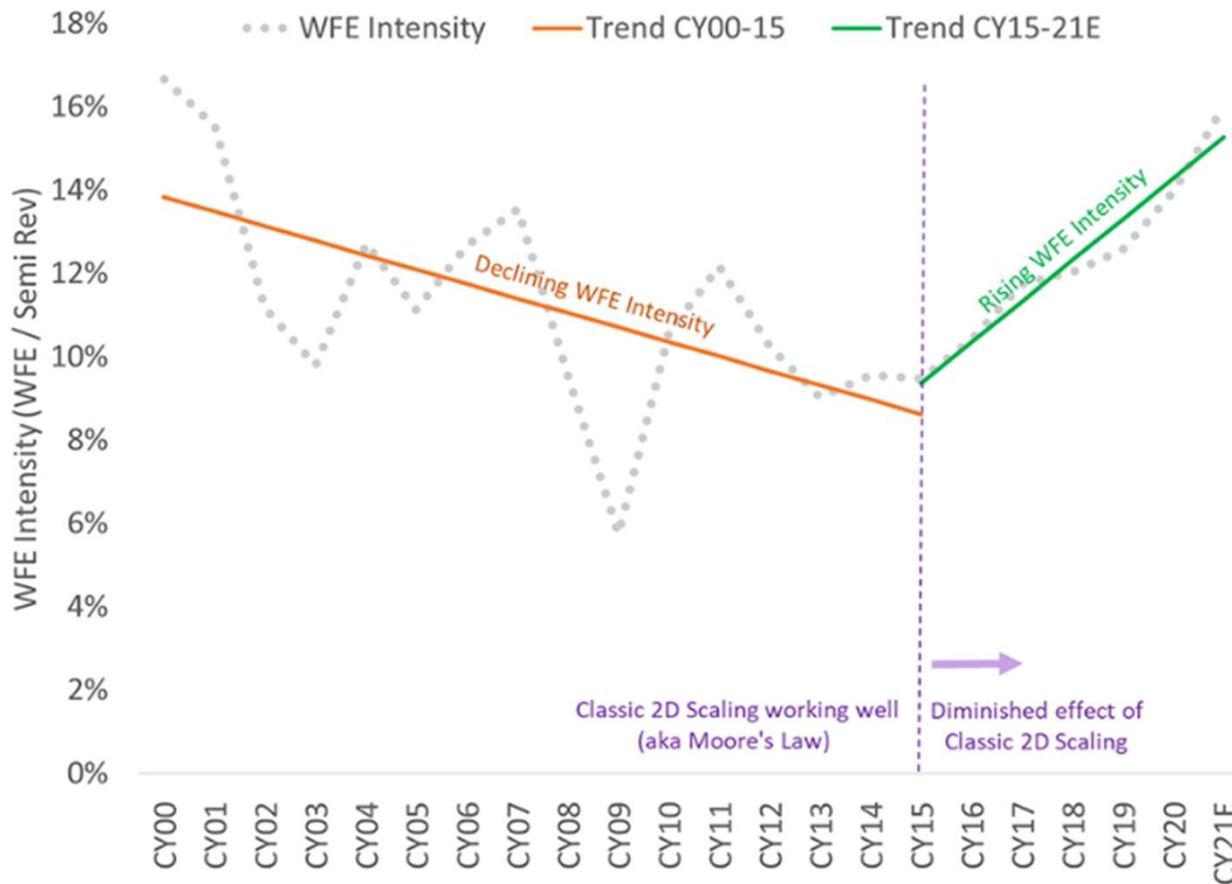
TOKYO ELECTRON

Lithography

Process Control

Etch and Deposition

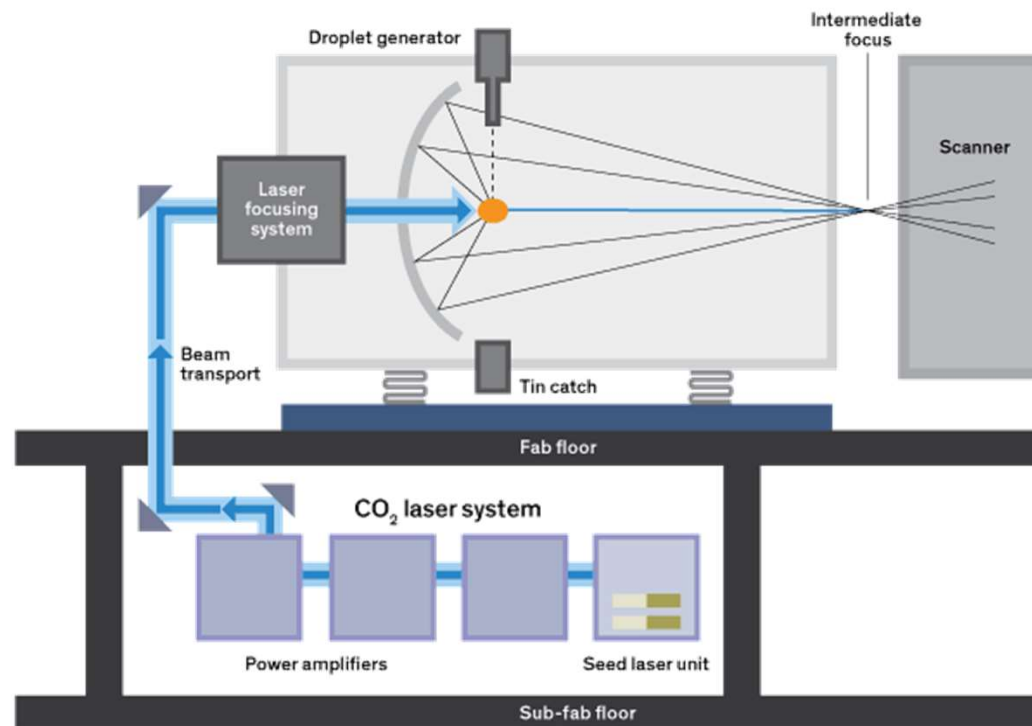
Capital Intensity is Increasing



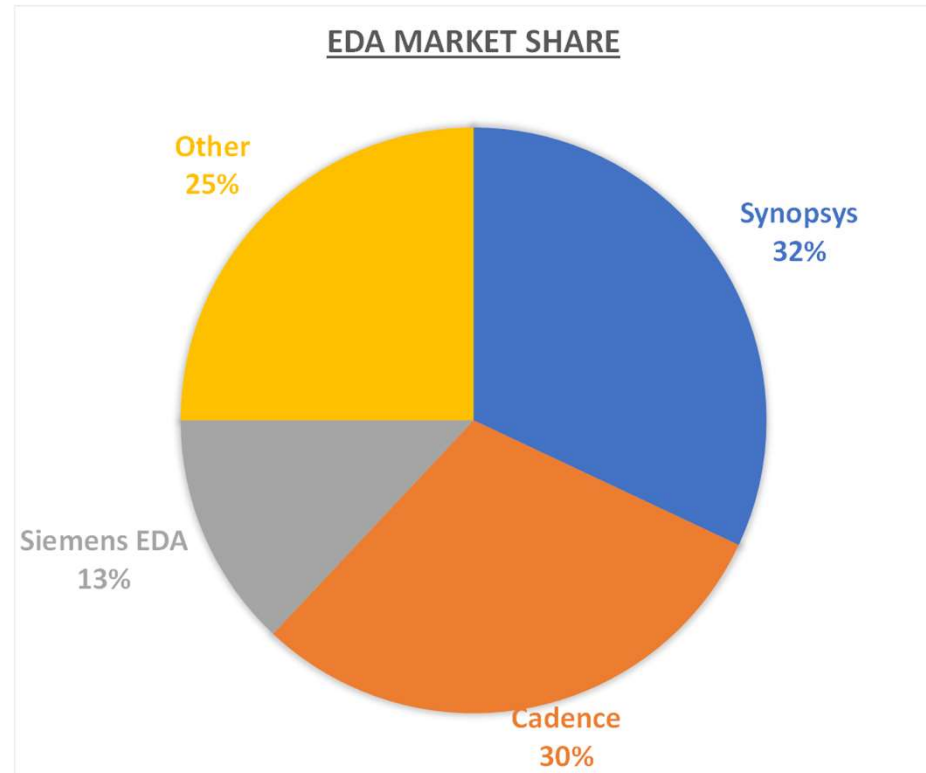
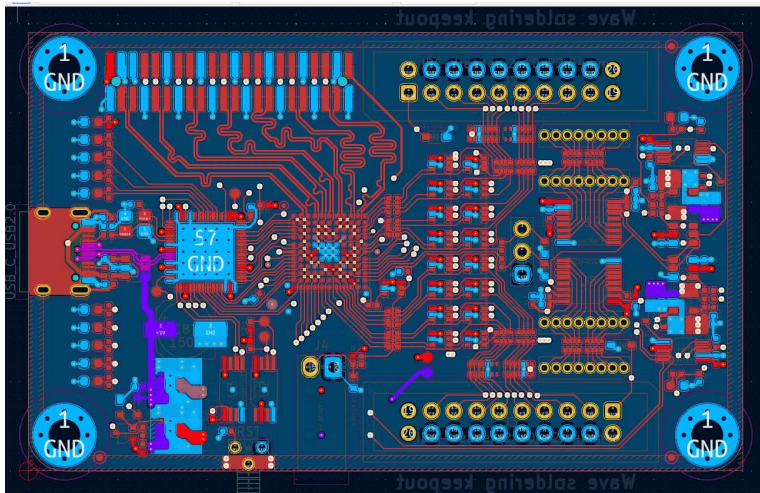
Source: Applied Materials

ASML and the Magic of EUV

“Shooting an arrow from the earth and hitting an apple on the moon”



EDA: The Software that Enables Chip Design



Source: Trendforce, MIT Technology Review

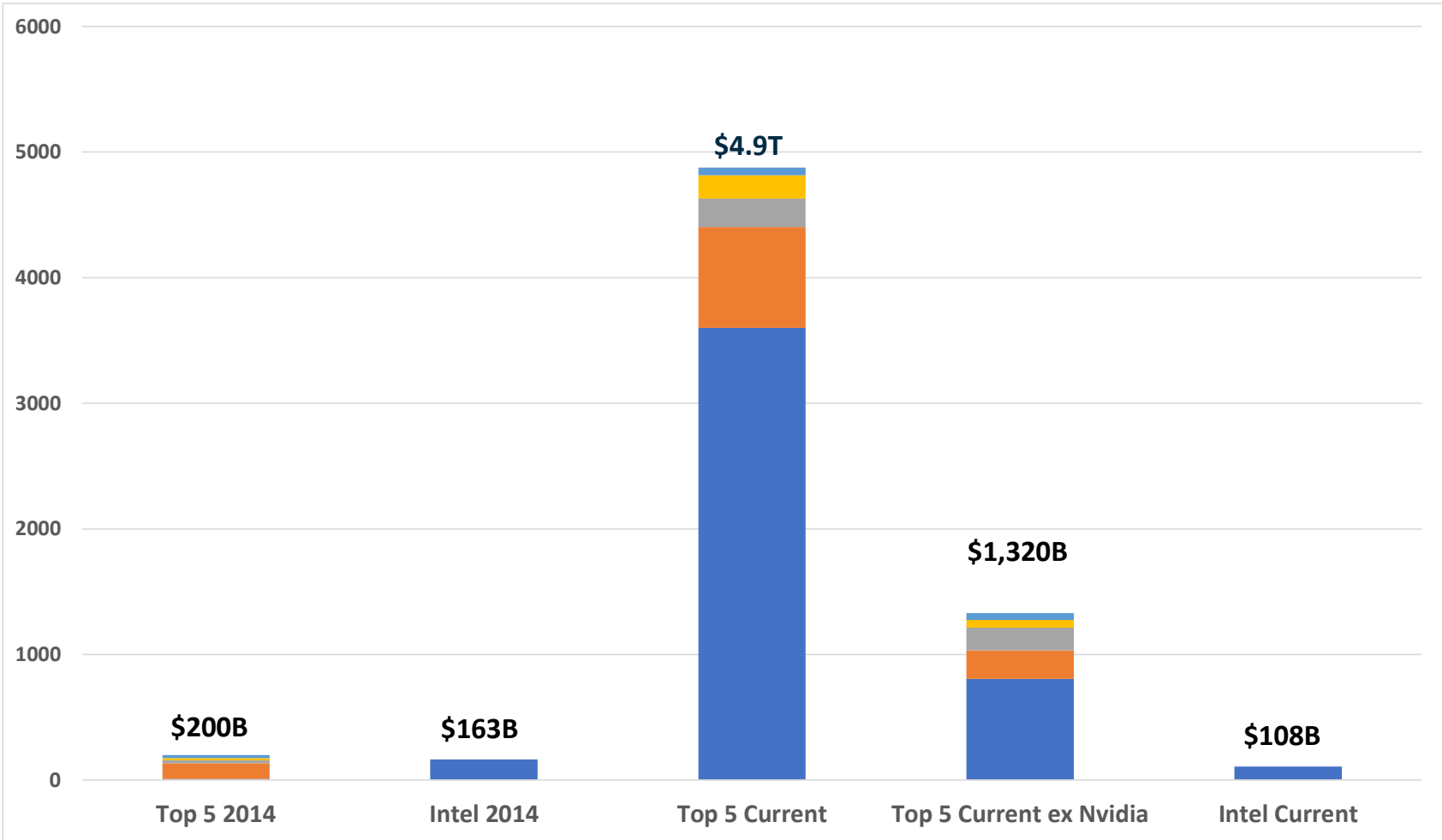
The Foundry/Fabless Model

EDA Software	 
Chip Designer (Fabless Chip Company)	    
Manufacturing (Foundry Partner)	 
Semiconductor Equipment (SPE/WFE)	    

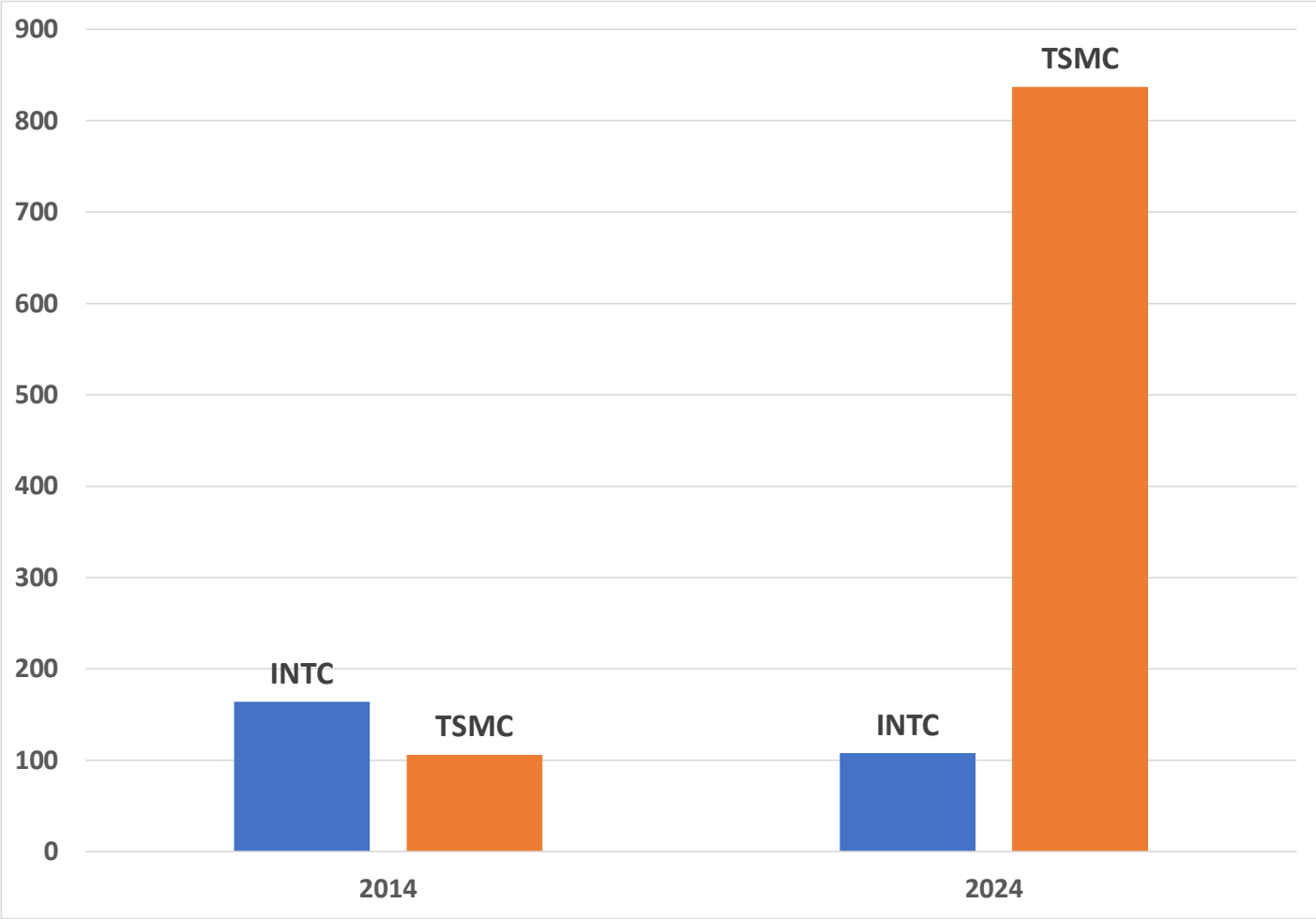
The Integrated Device Manufacturer (IDM) Model

EDA Software	 
Design + Manufacturing	
Semiconductor Equipment (SPE/WFE)	    

The Fabless Ecosystem Won



The Foundry + Fabless Model Won (cont)



Nvidia and AI

GPUs made their AI breakthrough in 2012

- The AlexNet CNN made a major breakthrough in classifying images by using GPUs

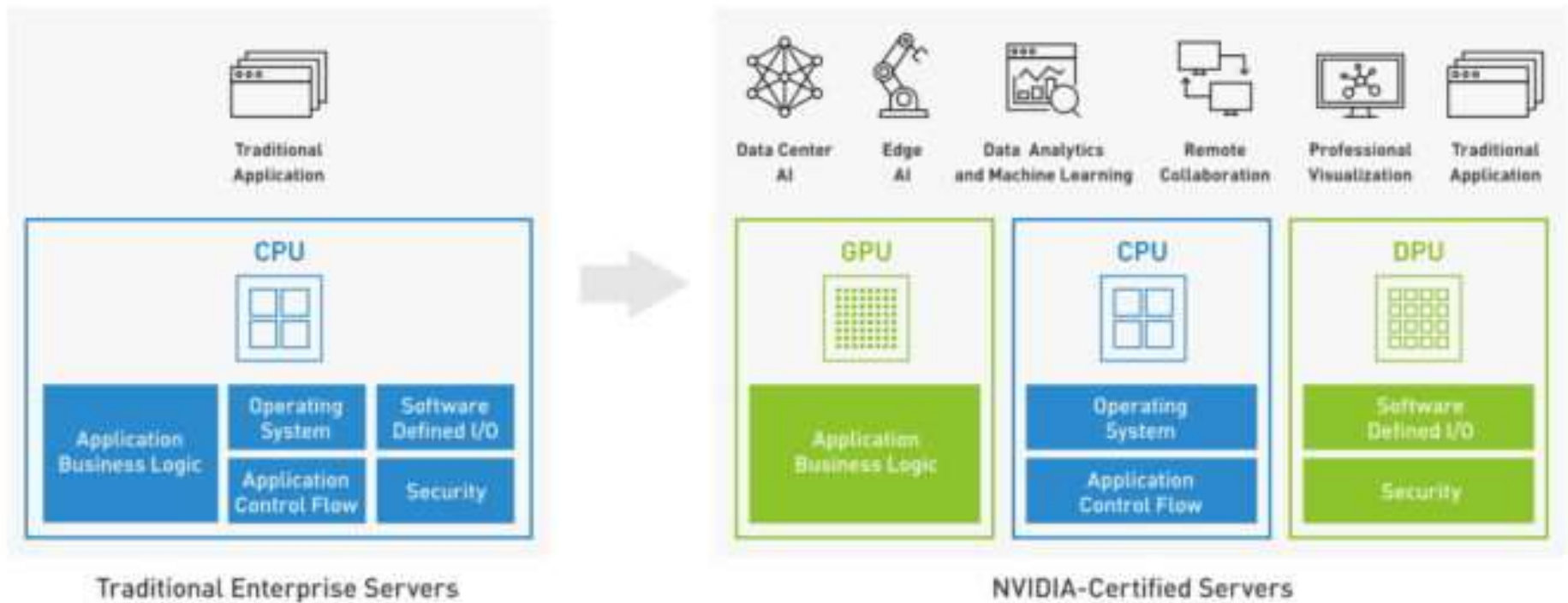


The AI Monopoly

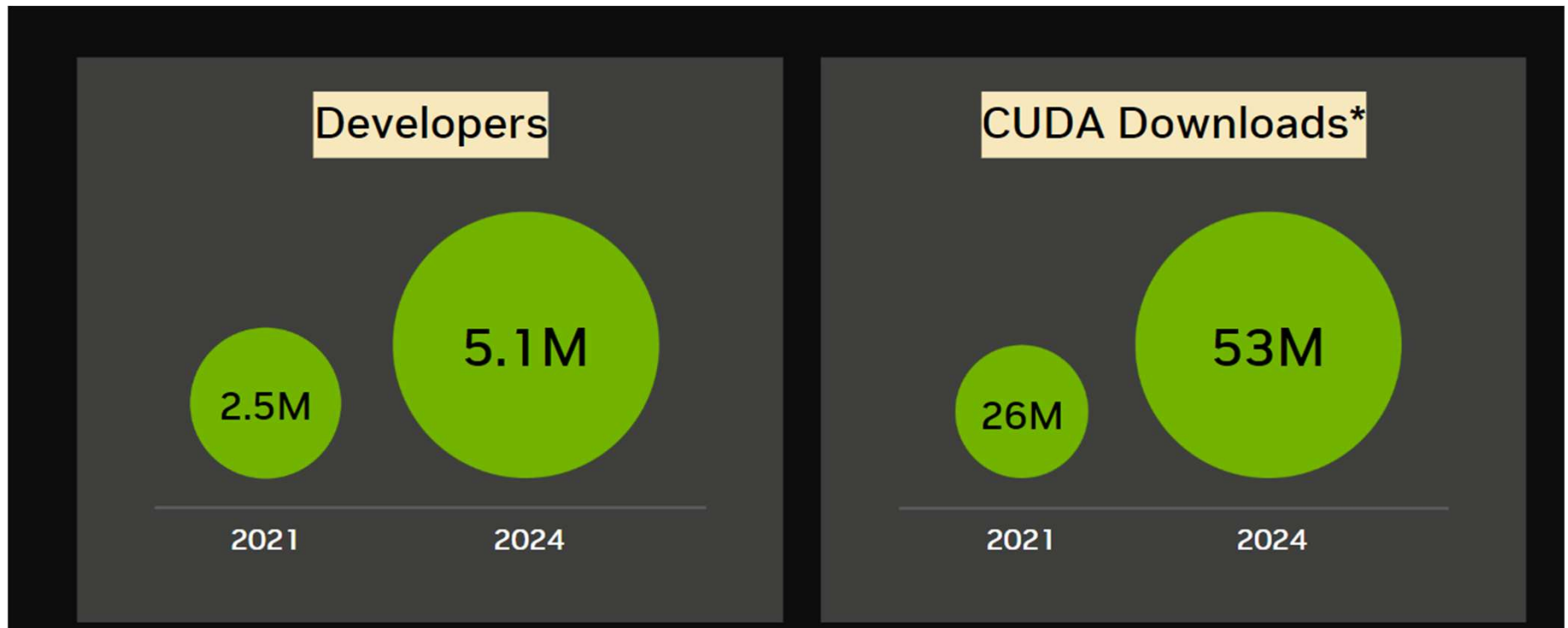
- Nvidia has >90% market share in the processing for training AI models
- Generative AI investment has fueled an unprecedented acceleration in Nvidia's business



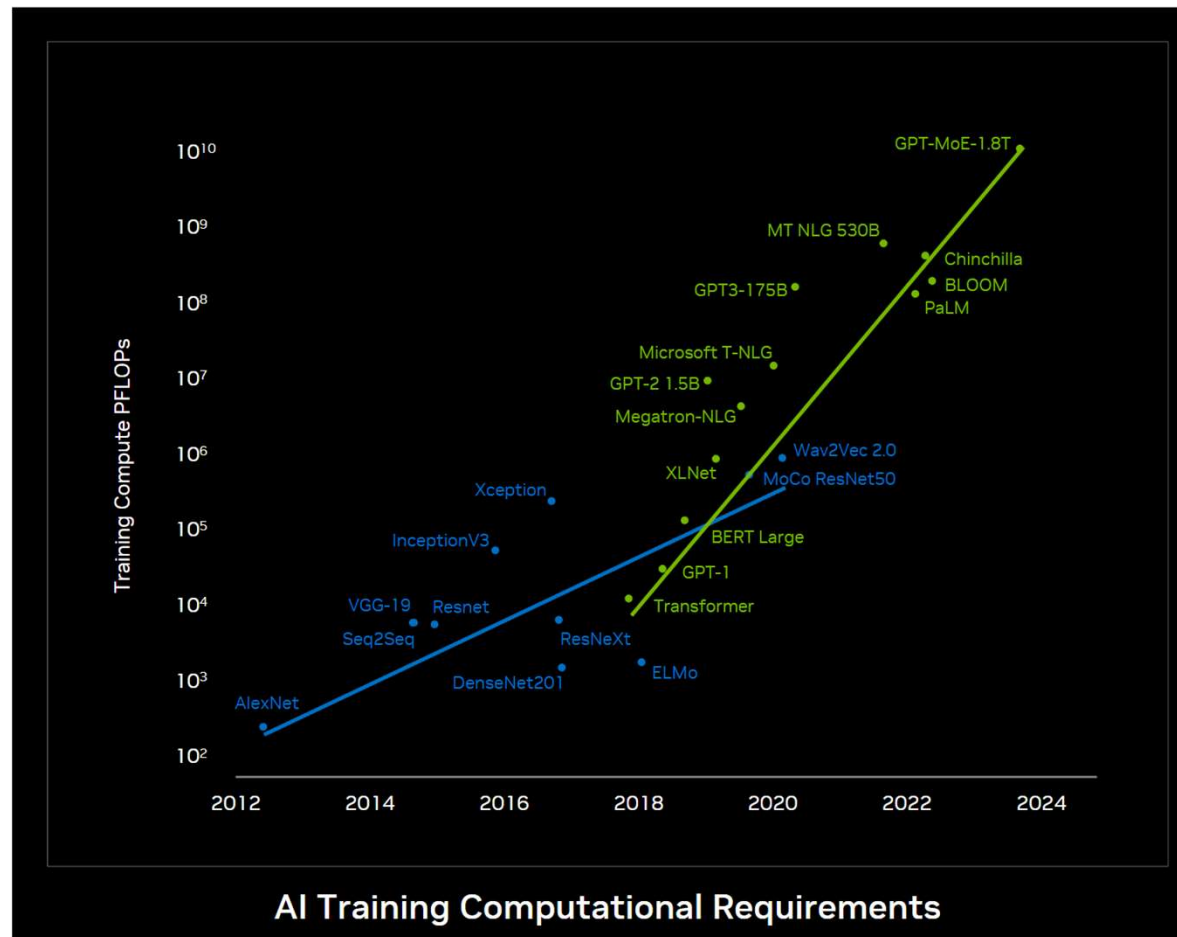
Nvidia isn't just supplying GPUs



CUDA is the de facto model for AI



Compute intensity of new AI models



Source: Nvidia

AI model costs increasing by 10x

Estimated training cost and compute of select AI models

Source: Epoch, 2023 | Chart: 2024 AI Index report

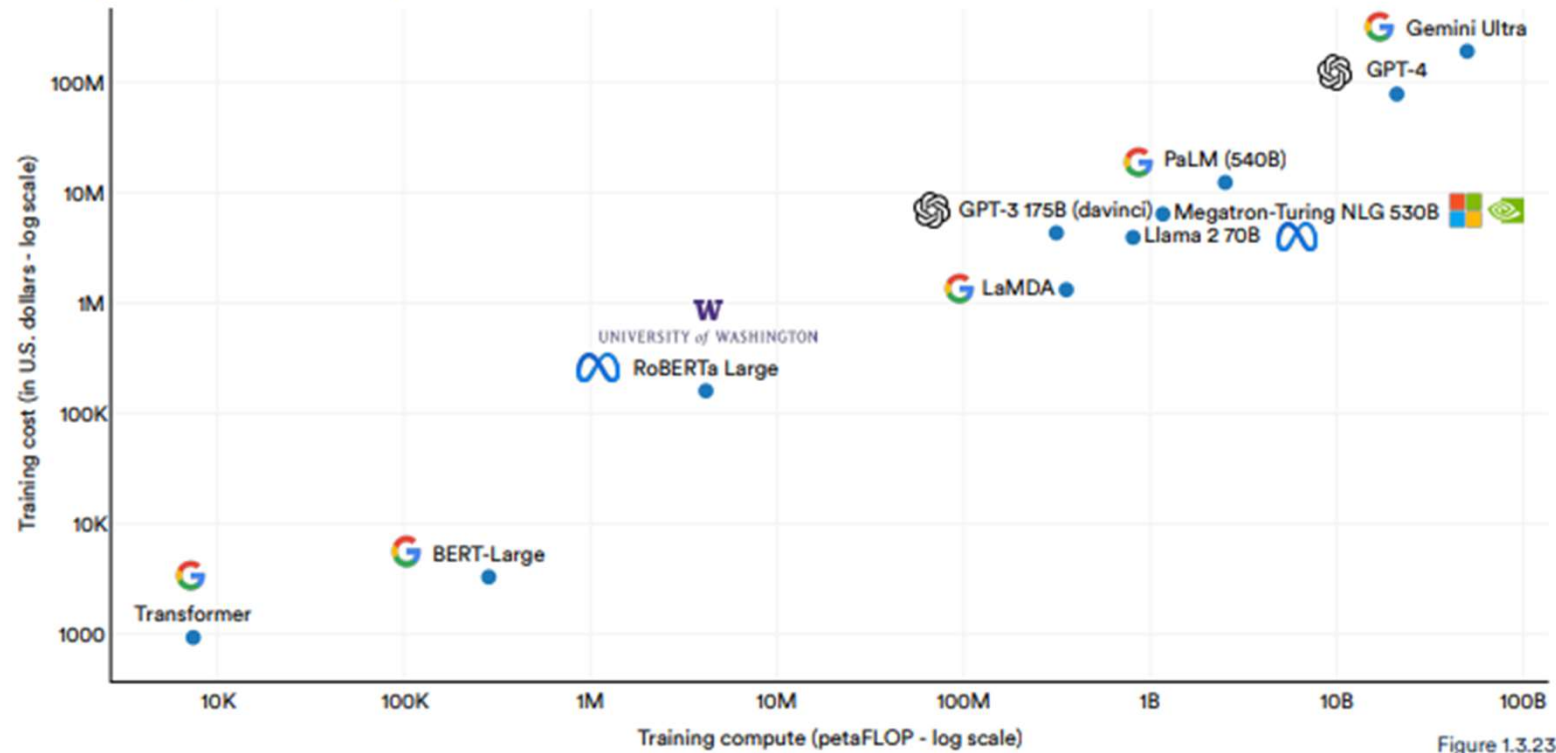
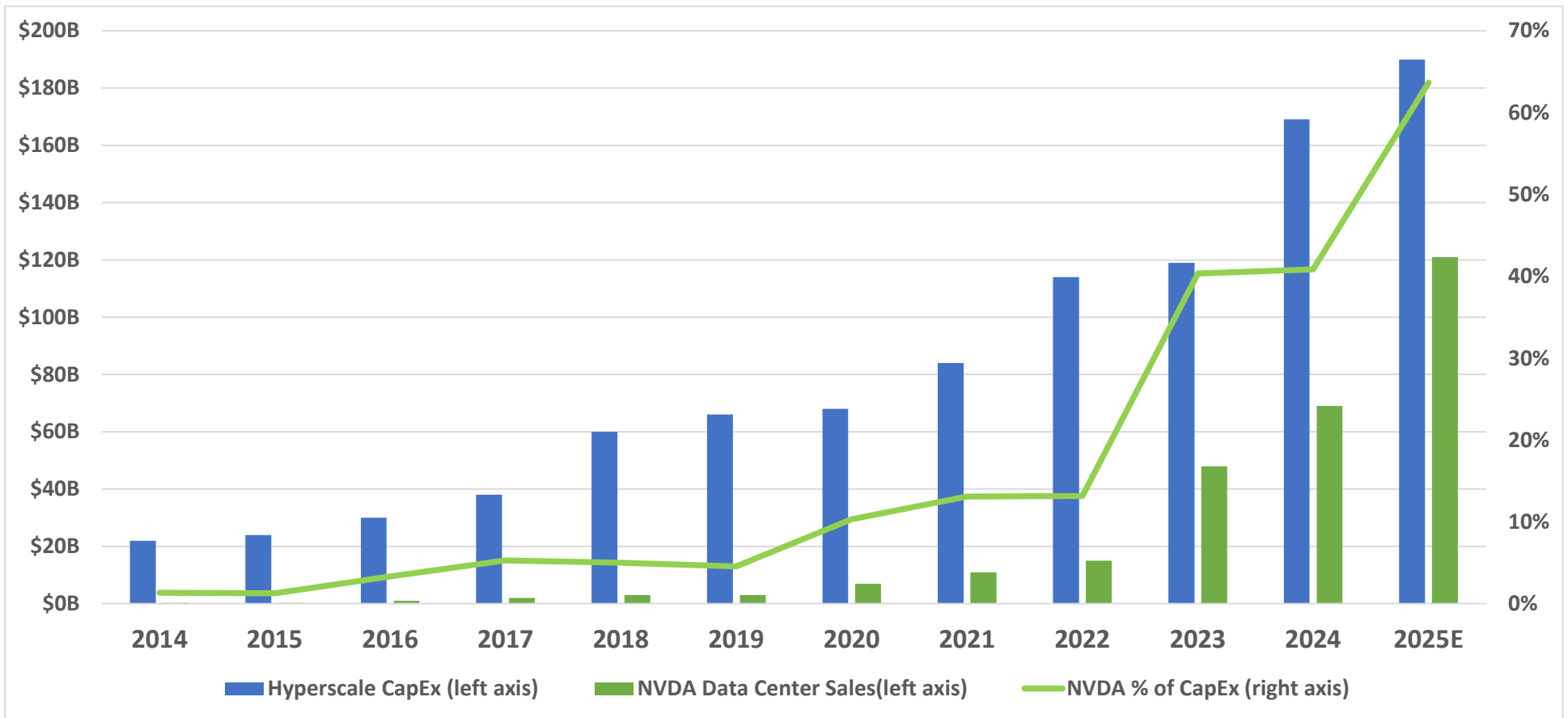


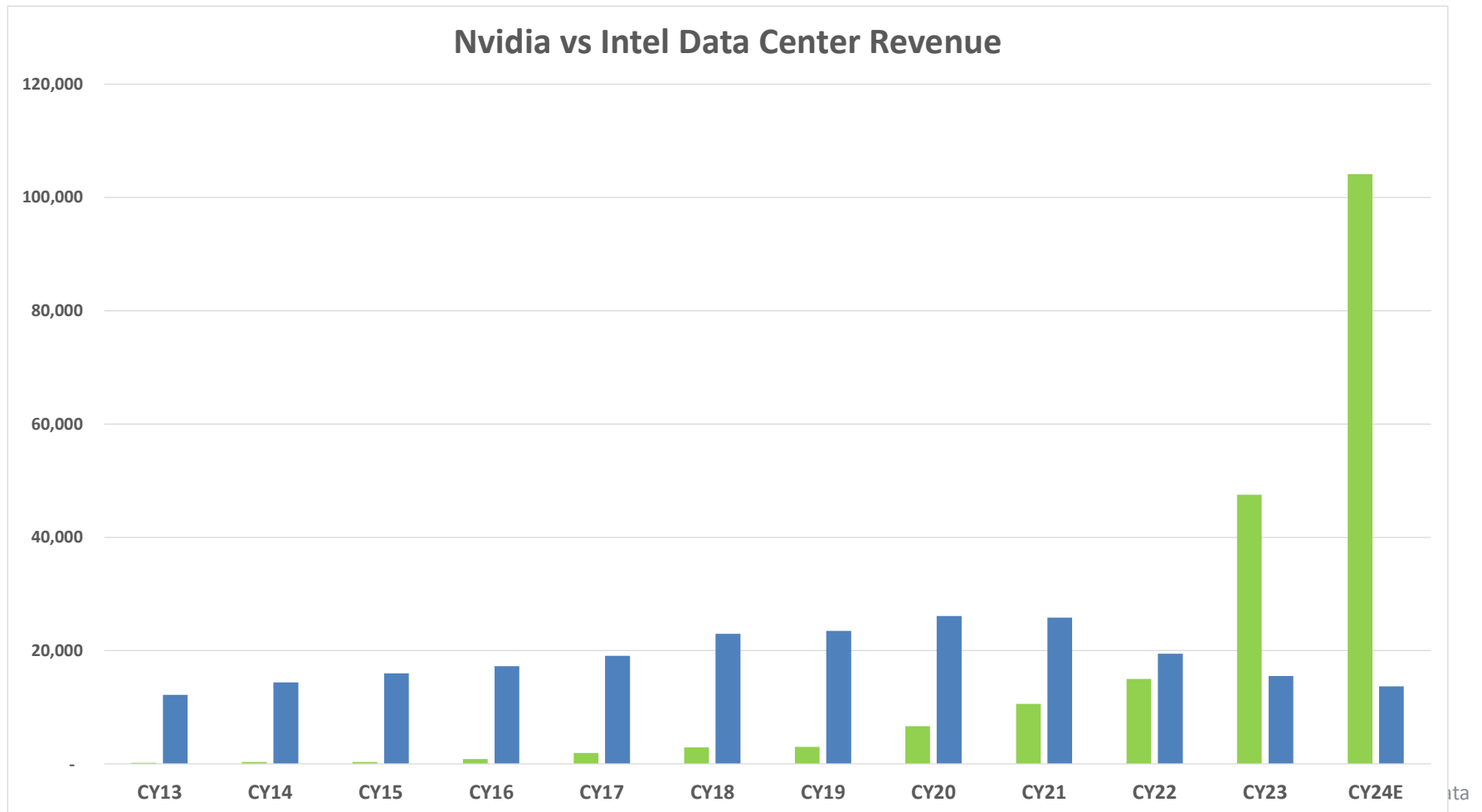
Figure 1.3.23

Source: Stanford AI Index Report

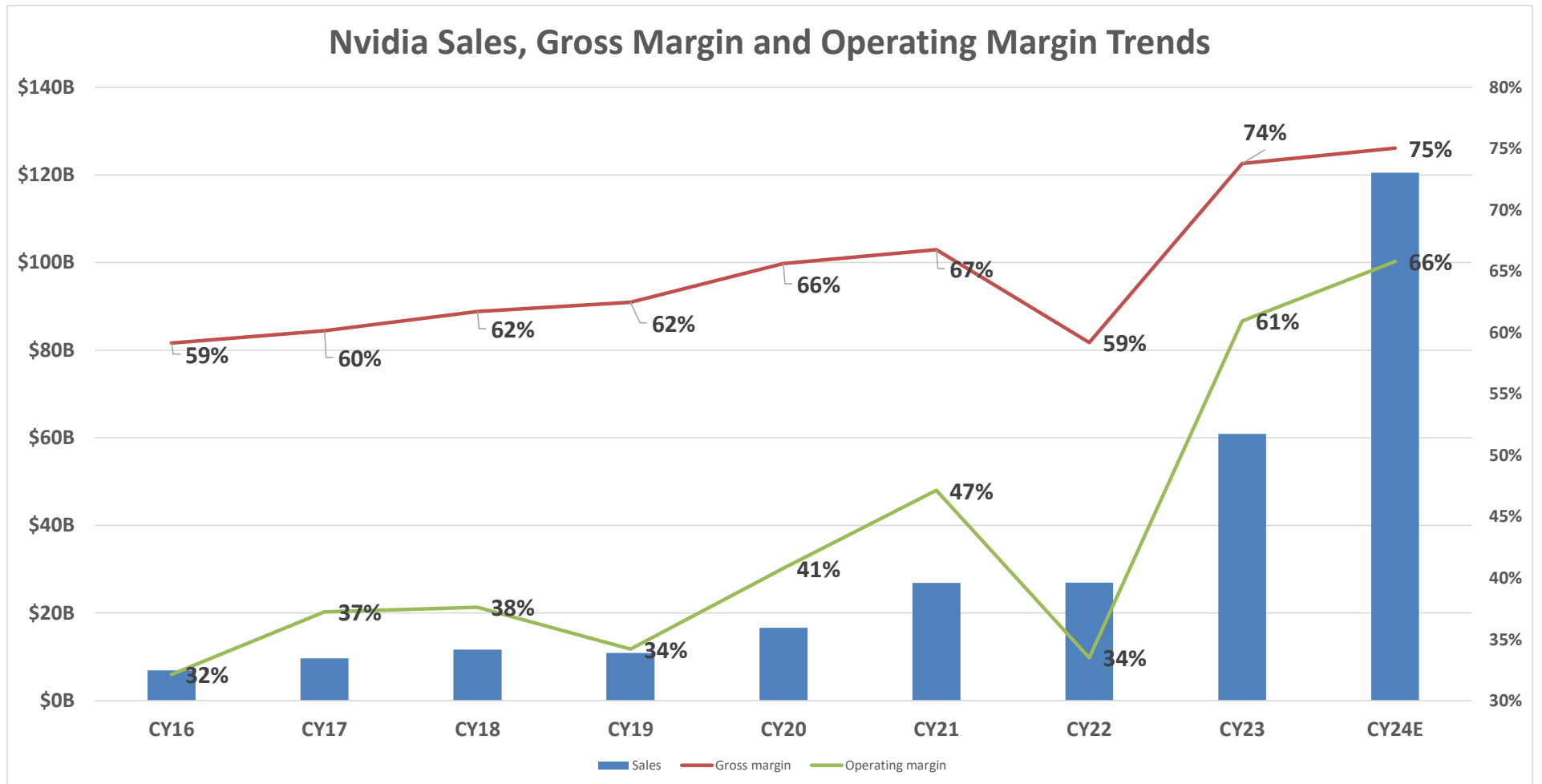
Nvidia gaining share of Cloud CapEx



Nvidia is now dominating Intel



Nvidia Profitability



Is AI a Business Model?

AI's \$600B Question

The AI bubble is reaching a tipping point.
Navigating what comes next will be essential.

BY DAVID GAMB
PUBLISHED JUNE 20, 2024

	Q4 2023 ESTIMATE	Q4 2023 ACTUAL	Q1 2024 ACTUAL	Q4 2024 ESTIMATE
NVDA Data Center Run-Rate Revenue	\$50	\$74	\$90	\$150
Data Center Facility Build and Cost to Operate	50%	50%	50%	50%
Implied Data Center AI Spend	\$100	\$147	\$181	\$300
Software Margin	50%	50%	50%	50%
AI Revenue Required for Payback	\$200	\$294	\$363	\$600

Source: Sequoia Capital

Other Outstanding Questions

- Will model scaling continue to hold?
- How do we solve the data problem and is synthetic data sufficient?
- Will other model architectures or training hacks emerge to limit compute intensity?
- Is Nvidia vulnerable to competition

Geopolitics



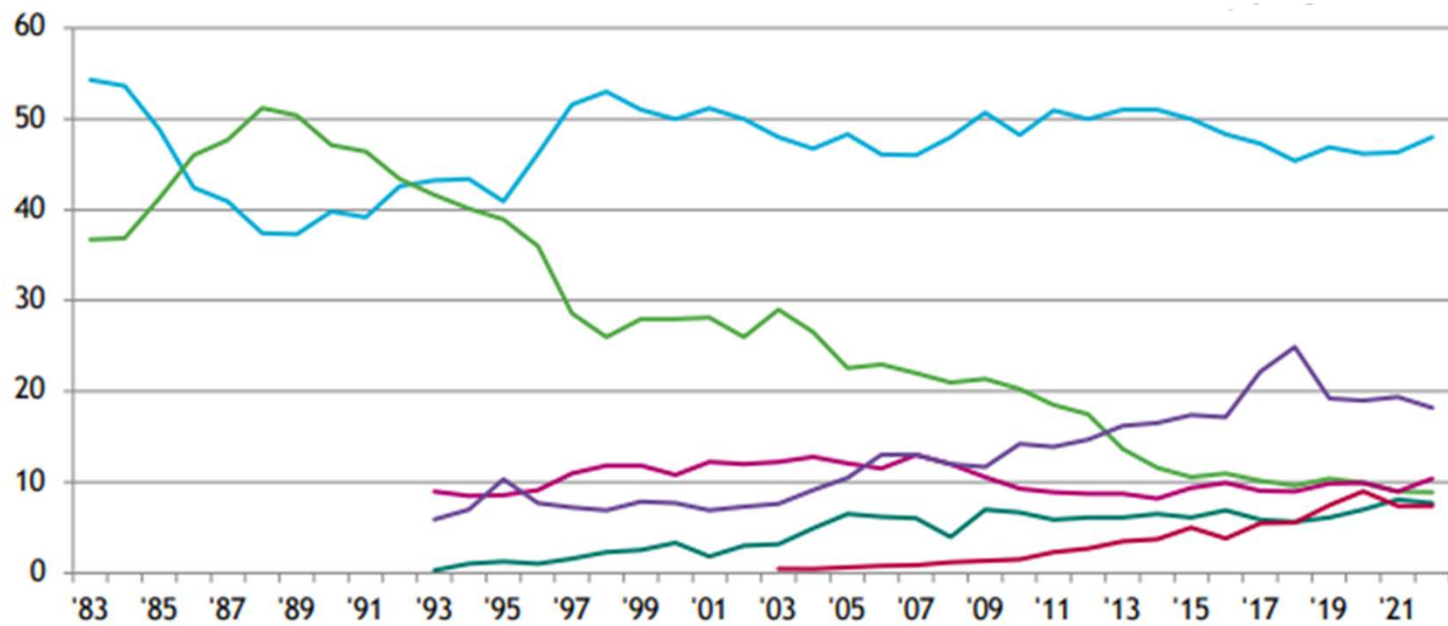
How a handful of chip companies came to control the fate of the world

By Brinton Johns and Jon Bathgate, June 28th 2020

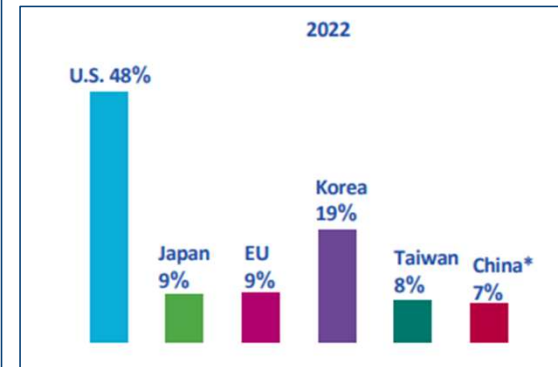
Key Themes

- Taiwan's position in semiconductor manufacturing is an existential risk to the global economy
- The US wants to limit the PRC's progress in compute, particularly in AI, that could threaten national security
- Semiconductor export controls have emerged as a tool for the US to protect its interests, but with a cost
- China's "Made in China" efforts have yielded mixed results

Evolving Revenue Share by Region

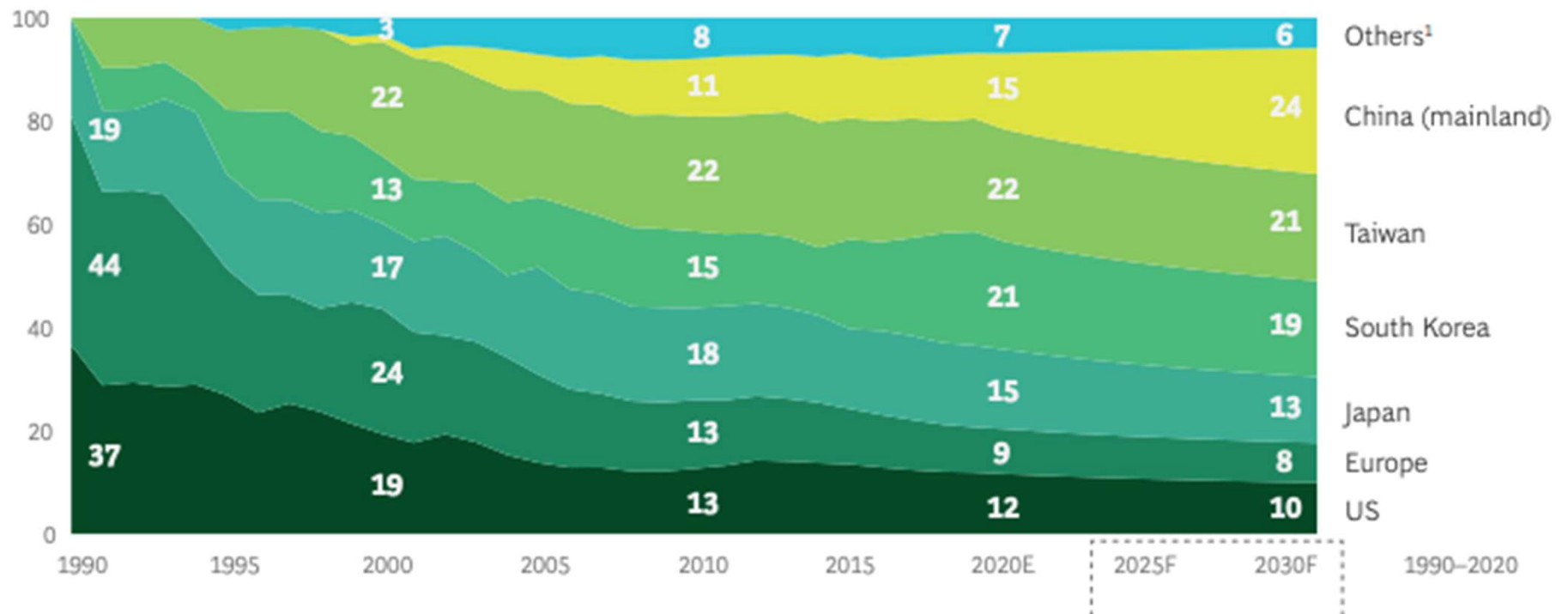


Source: World Semiconductor Trade Statistics (WSTS), Omdia, and SIA Estimates.



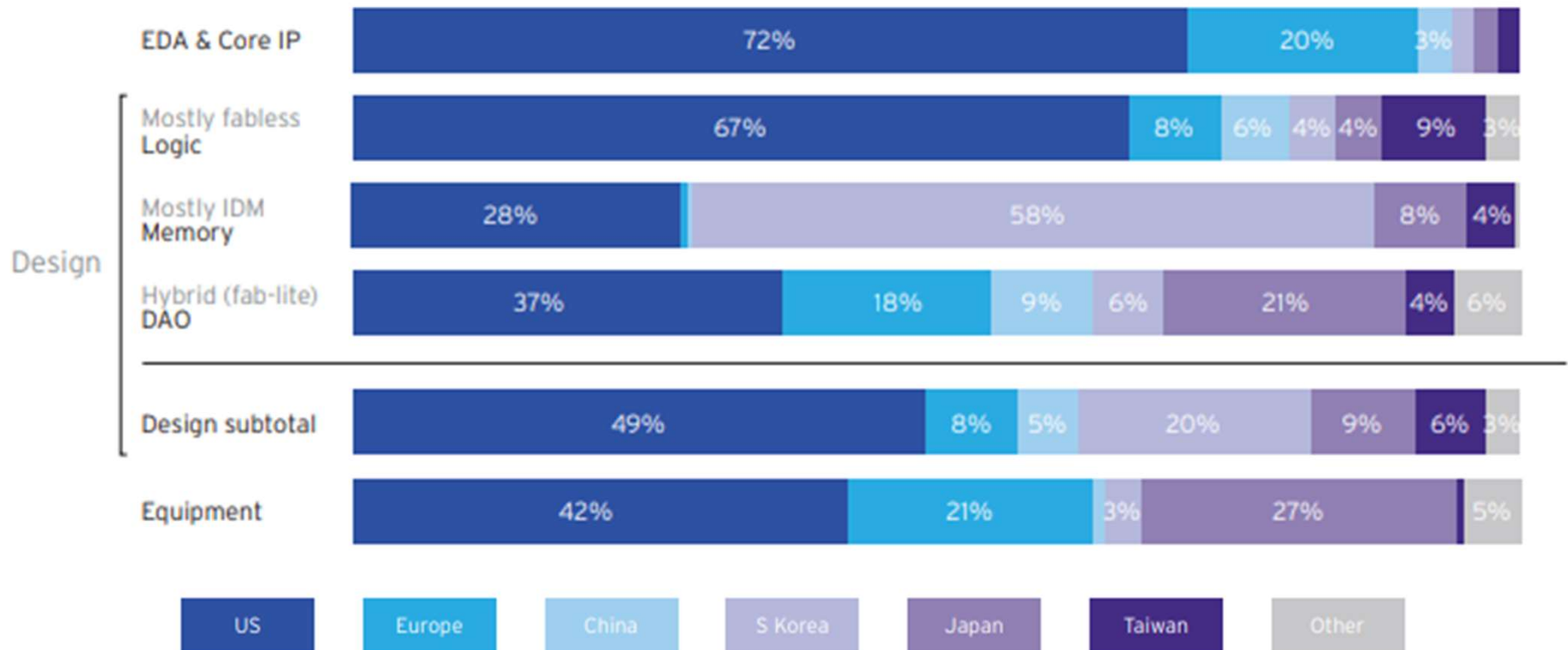
US and Europe Manufacturing Concerns

Global manufacturing capacity by location (%)



Source: BCG

The US has dominant share in key technologies



Source: BCG

Industry Reliance on Taiwan

- Roughly 2/3 of contract manufactured chips are built in Taiwan
- >90% of advanced chips are built by TSMC in Taiwan (!!!)
- CHIPS Act and similar global policy support is aimed at diversifying supply chains but significantly more support is needed

Onshoring challenges

- Initial cost of overseas fab shells are 4-5x higher in the US than in Taiwan
- There is a shortage of skilled workers to operate fabs outside of Taiwan
- The complexity of the supply chain will leave key areas offshore (packaging, test, key raw materials).

Summary of Key Export Controls

- **Computing Power:** GPUs for AI beyond certain thresholds require export licenses
- **Semiconductor Production Equipment:** Any equipment that can facilitate manufacturing below the 14nm node requires an export license
- **EDA Software:** Software capable of designing chips below the 14nm node requires an export license

Export Controls Are Working... Kind Of

- Chinese companies are stockpiling and circumventing export controls
- Chinese manufacturing companies are stockpiling equipment
- Innovation pressing forward despite export controls
- Likely using pirated EDA software

US Can't Halt SMIC, Huawei's Tech Advances, Chip Guru Says

- Chinese firms like SMIC can develop new tech with old gear
- YMTC also making progress in memory chips, TechInsights says

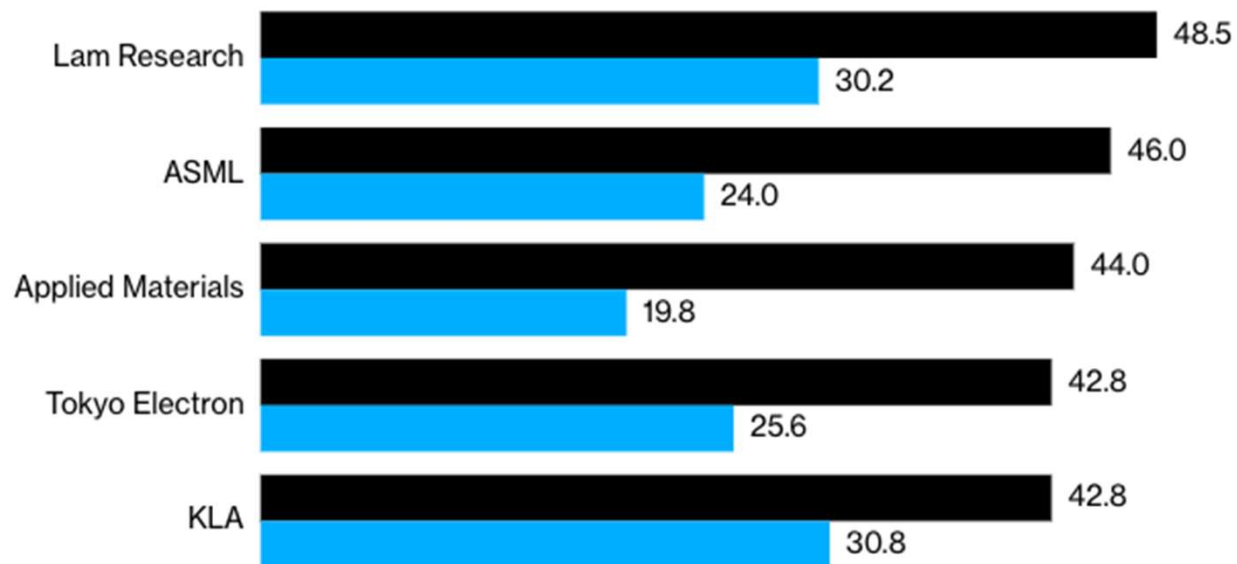
Source: Bloomberg, CSIS

China Stockpiling Equipment and Chips

China's Silicon Surge

Producers of chipmaking equipment see revenue from the country soar

■ Sept. 2023 ■ Sept. 2022



Percentage of sales from China in the September quarter

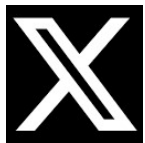
Source: Bloomberg

The Trump Administration Creates Uncertainty

- Tariffs will be disruptive to the chip supply chain
- Another wave of export controls is widely expected
- Key to watch US/China and US/Taiwan relations

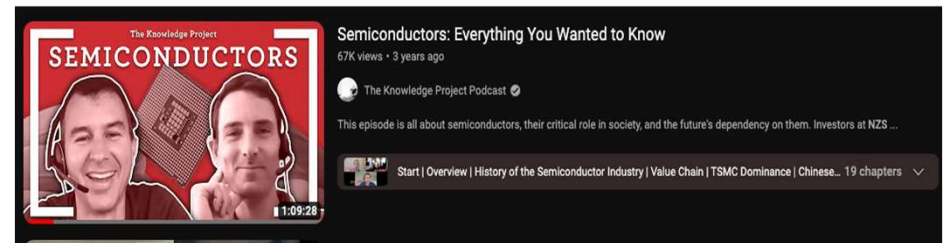
Contact and Resources

- <https://www.nzscapital.com/news/semiconductors>



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Thank You!