Ted and Logan Webinars on High-Tech Industries

Global Semiconductor Industry: Up-to-Date View

Edward A. Snyder and Logan Bender

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Ted and Logan Webinars on High-Tech Industries

Edward A. Snyder

Ted is the William S. Beinecke Professor of Economics and Management at the Yale School of Management. He has applied IO frameworks to over thirty industries and product markets in the course of his academic and professional career. This set includes liquid crystal displays, video streaming, payment systems, pharmaceuticals, optical disk drives, and modem chips used in smartphones. He studied economics at the University of Chicago. He served as Dean of three business schools and founded the Global Network for Advanced Management.

Logan Bender

Logan is a CFA charter holder and Yale MBA (specialization in asset management). During his career as a global technology investor and research analyst at Putnam and First Analysis, Logan has specialized in high-tech industries including software, internet platforms, and semiconductors, with particular emphasis on the U.S. and China. Logan also has experience with venture investment focusing on series A and B stage investments in vertical SaaS, human capital technology, and other high growth differentiated software businesses.

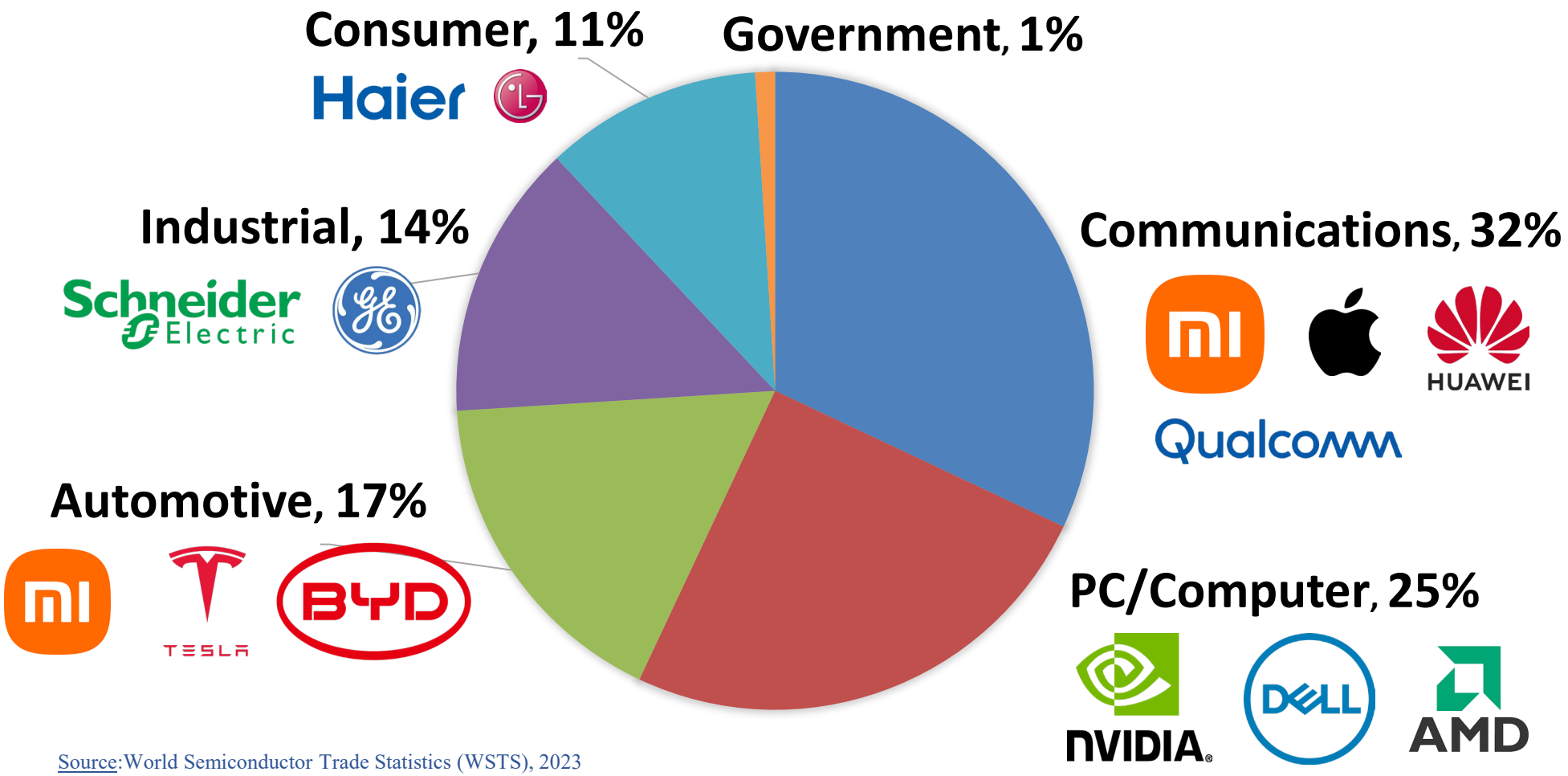
Six Questions

1. What's driving demand for semiconductors? Who's purchasing?
2. How does the semiconductor supply chain work (stages, specializations of firms, how firms transact)?
3. Who are the leading firms at each stage?
4. Which firms capture the most value?
5. Why do some firms succeed while others struggle?
6. Do firms with high market shares have "market power"?

Quick Background

- The industry began in 1958, when Texas Instruments first integrated multiple electrical components on a silicon chip.
- Slow industry development. Then demand grew dramatically because of advances in chips and complementary inputs.
- Now semiconductors – also known as “chips” power every sector and are central to AI, EVs, defense, clean energy, etc.
- Typically, the number of leading edge firms at each production stage is small.
- "Semis” are an important component of the China-US rivalry.

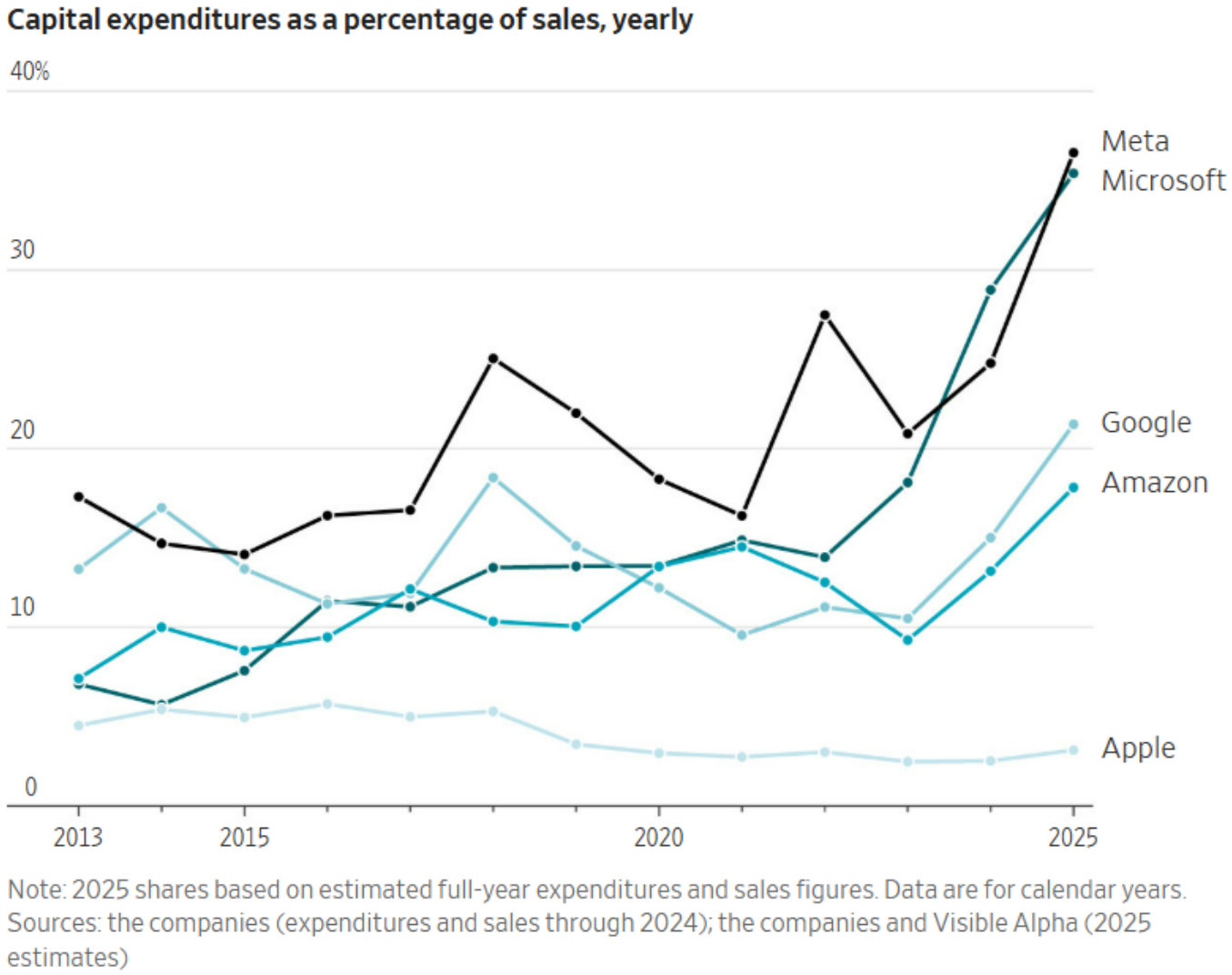
Demand



Source:World Semiconductor Trade Statistics (WSTS), 2023

Semiconductors are Everywhere

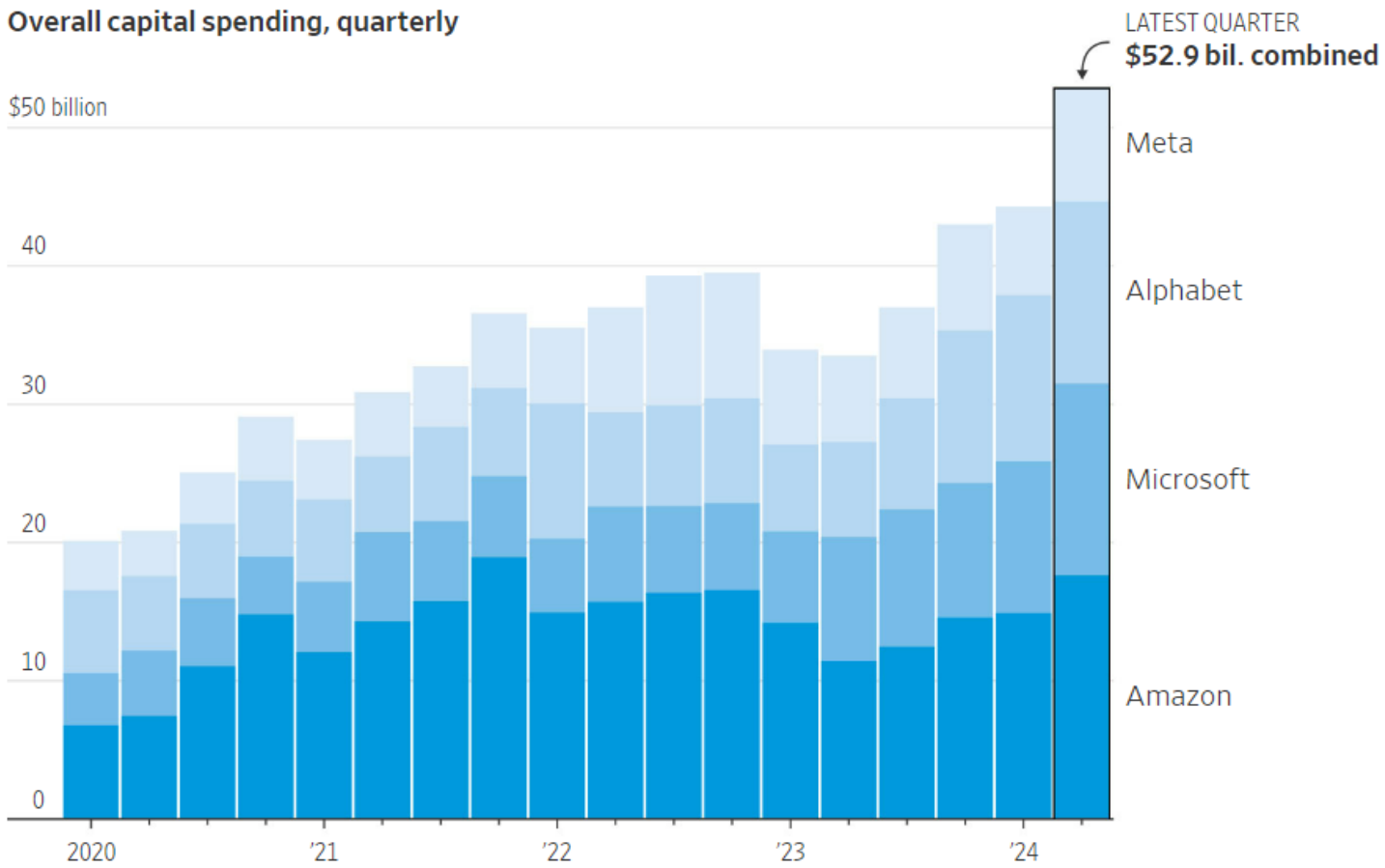
US Tech Companies Are Investing 40% of Sales on Capital Expenditures Related to Semiconductors



Source: the Wall Street Journal

The AI Spending Spree, in Charts

Tech giants and investors are shoveling cash into artificial intelligence amid questions about whether it will pay off



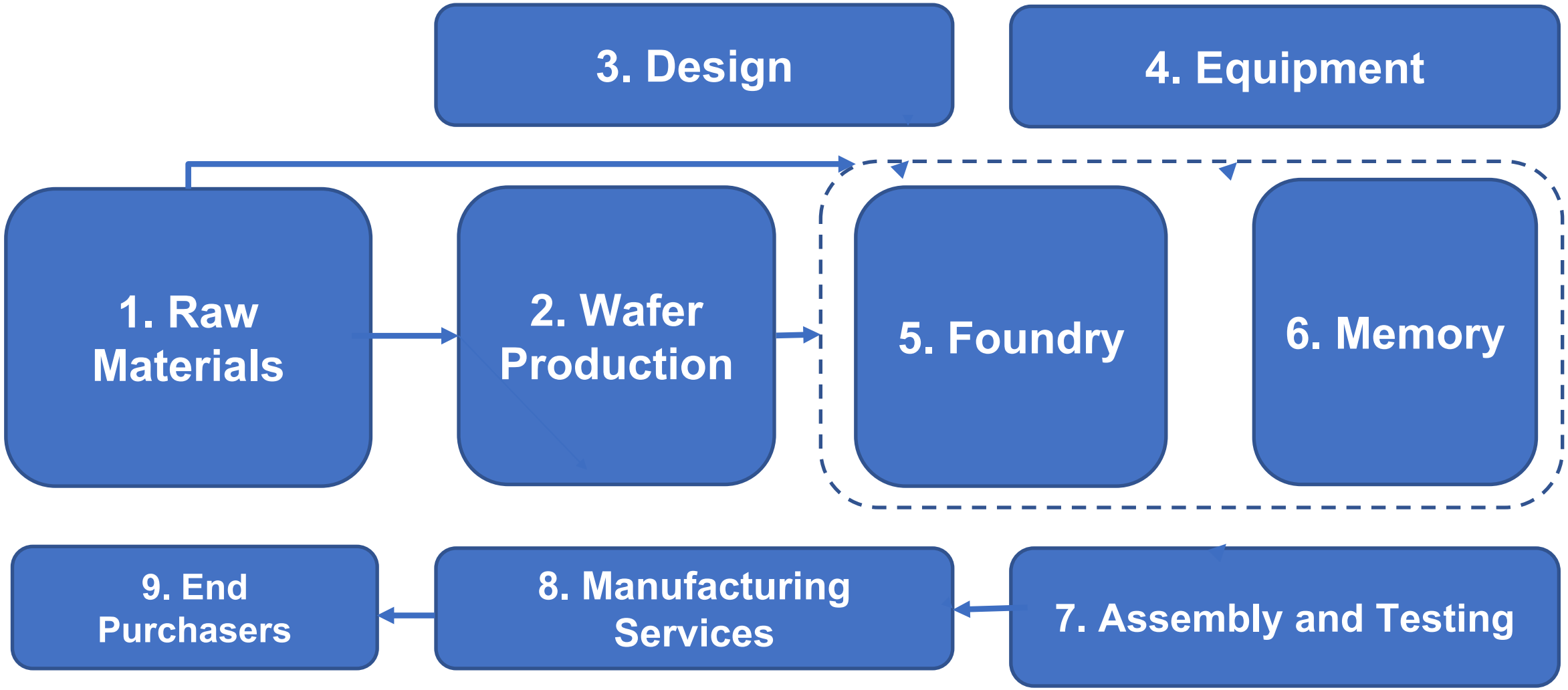
Source: The Wall Street Journal

Not Just the Magnificent Seven: Oracle

"Oracle shares surged by as much as 43% Wednesday after the software company said it won several billion-dollar contracts in its latest quarter"

Source: *Oracle Shares Skyrocket as Software Giant Scores Massive AI Deals*, The Wall Street Journal (Sept .10, 2025); Google Stocks

Stages of Production

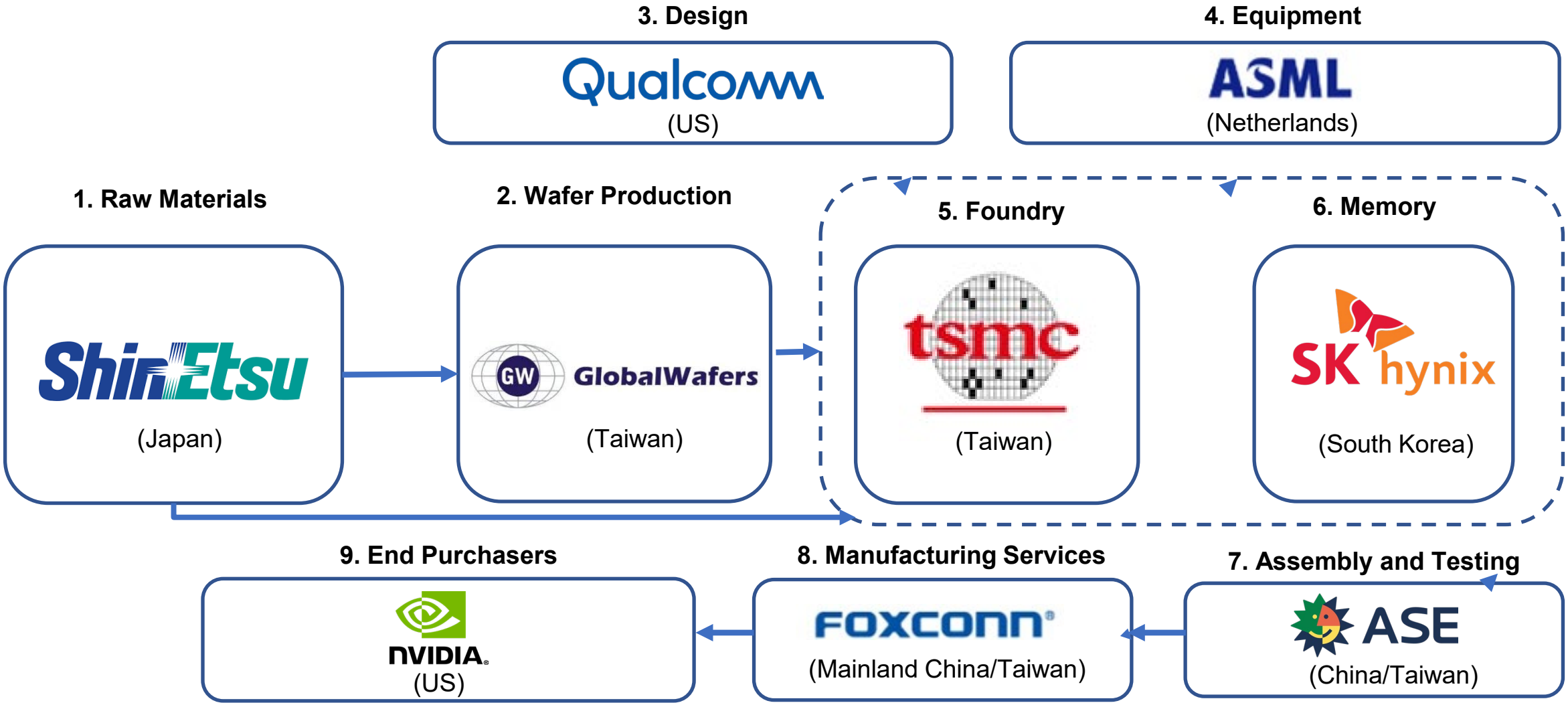


We Identified a Sample of Leading Firms across the Stages of Production

1. Raw Materials	2. Wafer Production	3. Design
1. Shin-Etsu	6. Siltronic	8. Synopsys
2. SUMCO	7. GlobalWafers	9. Qualcomm
3. Wacker Chemie		10. Cadence
4. MP Materials		11. Arm
5. Lynas		

Continued in the Appendix

Leading Firms at Each Stage

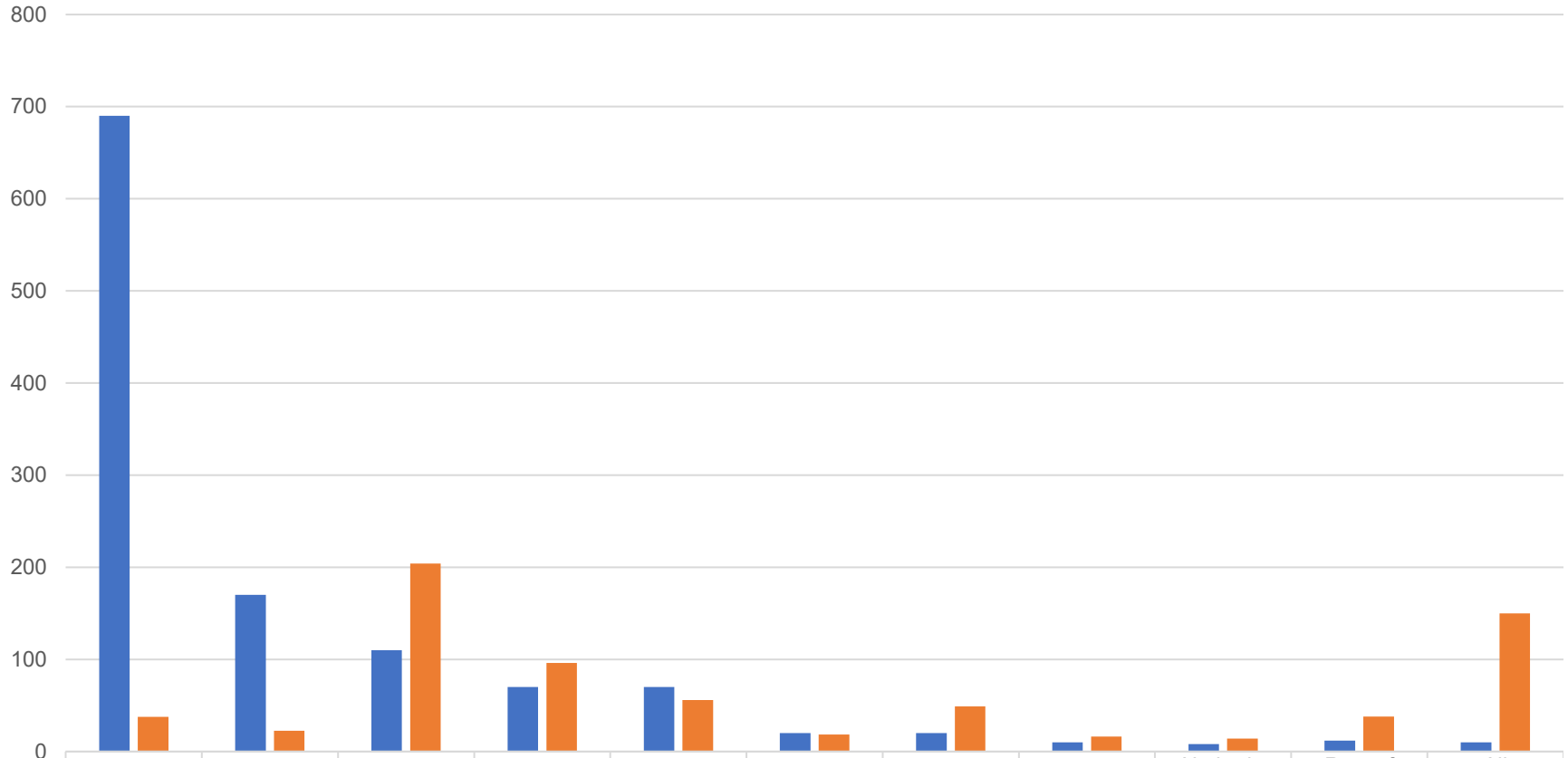


Source: …

Supply Chains: Complicated and Global

1. Long Lead Times involving multiple stages of production.
2. Most firms are highly specialized, e.g., TSMC, NVIDIA, ASML. SK Group.
3. Top Firms are not located in the same country or region, e.g., TSMC and Qualcomm.
4. Mismatch between Producing and Consuming Countries.

Production versus Consumption Across Countries

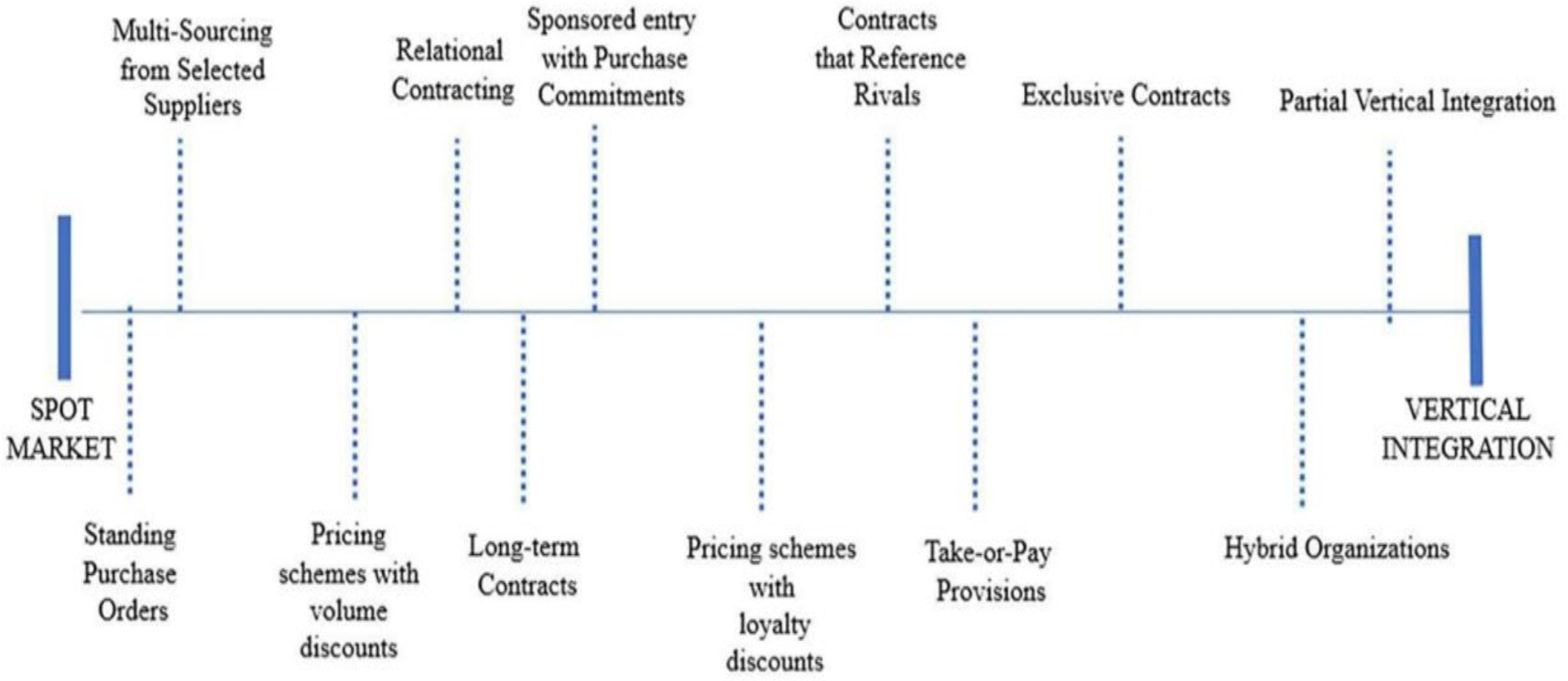


	Taiwan	South Korea	China	USA	Japan	Malaysia	Singapore	Germany	Netherlands	Rest of EU*	All others**
Production Volume (chips, 2022, USD billions)	690	170	110	70	70	20	20	10	8	12	10
Market Volume (chips, 2025 est, USD billions)	37.7	22.45	204	96.12	56	18.54	49.06	16.37	14.22	37.85	150.1

Source: …

Production Volume (chips, 2022, USD billions) Market Volume (chips, 2025 est, USD billions)

How Do Firms Transact?



Source: Snyder, Edward. (2022). The Vast Space in Which the Vertical Merger Guidelines Lived. The Antitrust Bulletin. 67. 0003603X2211031. 10.1177/0003603X221103114.

Percentage Increase in Market Cap 2015-2025 of Publicly Traded Firms at Each Stage of Production

	% Change
1. Raw Materials	77%
2. Wafer Production	306%
3. Design	307%
4. Equipment & Materials	712%
5. Foundry	660%
6. Memory	276%
7. Assembly and Testing	164%
8. Manufacturing Services	43%
9. End Purchasers	652%

Historic Increases in Market Cap

	% Change
1. Raw Materials	77%
2. Wafer Production	306%
3. Design	307%
4. Equipment & Materials	712%
5. Foundry	660%
6. Memory	276%
7. Assembly and Testing	164%
8. Manufacturing Services	43%
9. End Purchasers	652%

Value is captured by End Purchasers

For example, Apple captures disproportionate value by packaging ~$150 worth of semiconductors into a $700+ iPhone.

Chip Type	Estimated Value (USD)
Memory	$17-22
Microcomponents	$28-45
Logic	$45
Analog	$17
OSD (Opto, Sensor, Discretes)	$31-35
Total	~$150

Firms That Are Capturing the Most Value

	M-Cap (USD Billion)	
Company	**2015**	**2025**
Intel	163	91
Samsung Electronics	154	288
TSMC	110	1117
Qualcomm	74	174
ASML	39	309
SK Hynix	18	122
Micron	15	129
Synopsys	7	73
Cadence	6	84
UMC	4	20

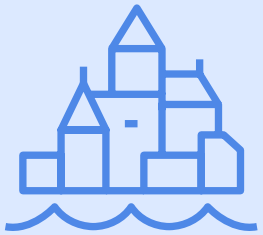
Answer:

Company	% Change
TSMC	919%
ASML	686%
SK Hynix	562%
Micron	784%
Intel	-44%
UMC	359%
Samsung Electronics	87%
Synopsys	963%
Qualcomm	132%
Cadence	1258%

Hypotheses about Leading Firms

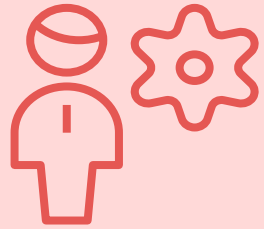
1. Compete and Win

Develop superior products and strong partnerships to surpass peers.



2. Moats

Develop competitive advantages from complementary products and IP.



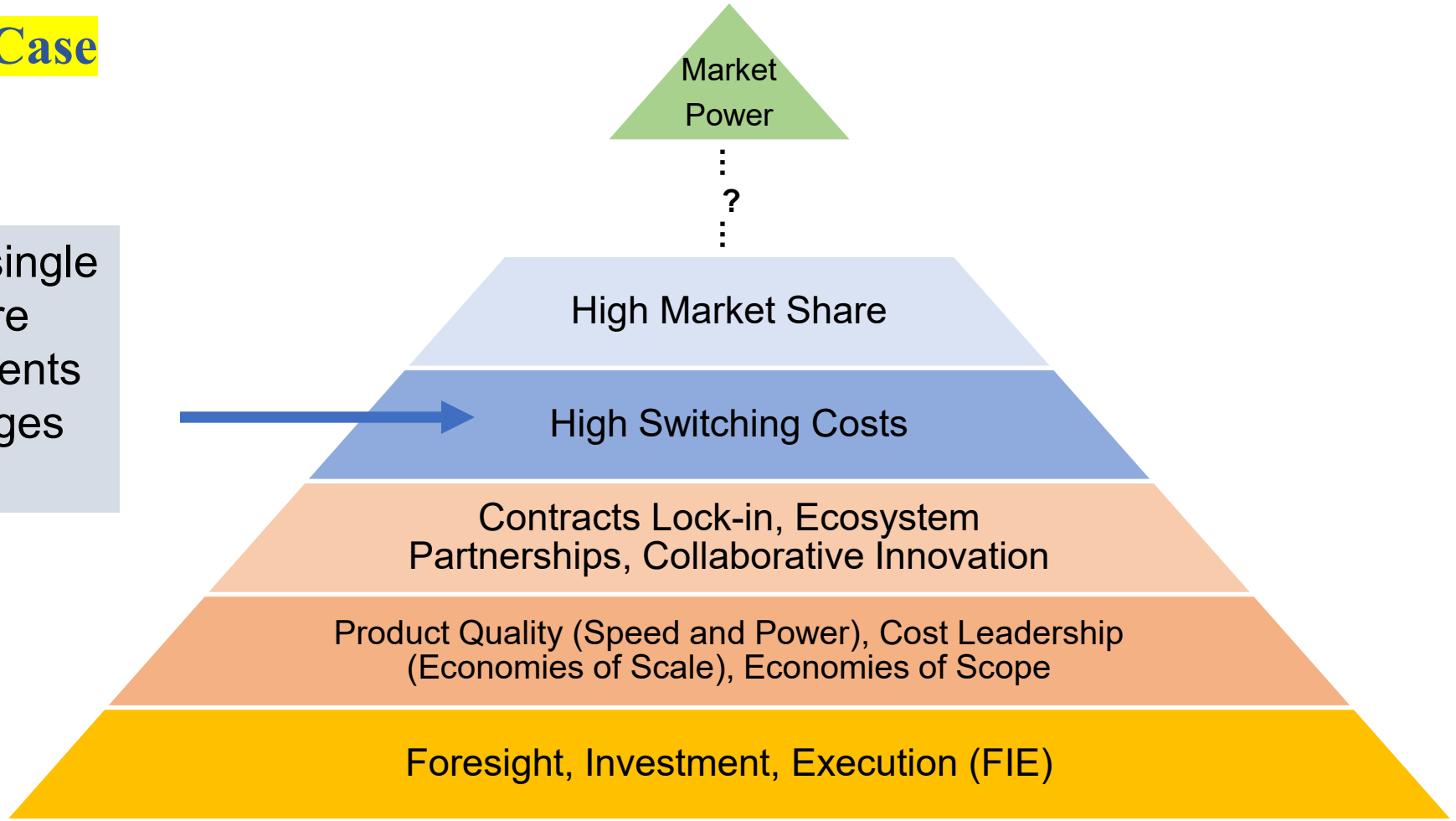
3. Anti- Competitive Behavior

Suppress rivals and manipulate supply chains to maintain dominance.

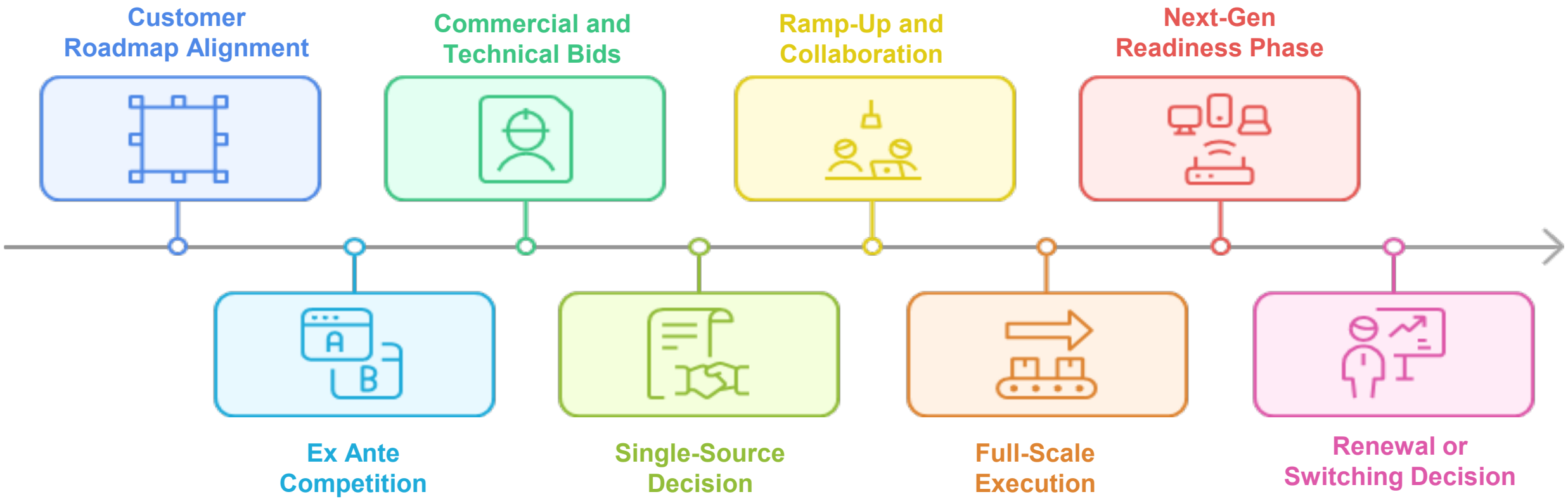
Our Review of 6 Cases Supports Hypothesis 1

"Compete and Win" Case

Most contracts are single source. Durations are 1.5-5 years. Incumbents have some advantages at renewal.



How does competition work? Long Processes



Firms can win or lose at multiple points in the competitive process.

1. May fail at qualification stage.
2. May lose out at the bidding stage.
3. May fail at the collaboration stage / may not achieve a design that matches customers' future needs.
4. May fail to secure a single-source contractual relationship.
5. May fail at the execution stage.

Incumbent Suppliers

1. They gain valuable know-how.
2. They may gain intellectual property (patents).
3. They may develop trust and good working relationships with customer
4. But incumbency does not guarantee future success.
    - Apple changed suppliers for their modem chips several times.
    - Samsung lost their edge with memory chips.
    - Intel faltered badly while TSMC built its reputation for excellent execution.

What do Market Shares mean?

1. Market shares are the sum of individual contractual relationships.
2. Market shares at any point in time are outcomes of winning the “ex ante” competition to get contracts, i.e., stages before entering into a contract.
3. Sustained high market shares over time reflect:
    a) Continued success with ex ante competition to win new customers.
    b) Successful execution that favors contract renewals.
    c) Ability to anticipate future demand and implications for product specifications.
    d) Investment in capabilities to design and deliver next generation products

Firms Win And Lose Because of Foresight, Investment, And Execution

1. Becoming “qualified” as a potential supplier.
2. Initial contracting.
3. Successful collaboration with the customer.
4. Excellent execution.
5. Investments in new capabilities.
6. Co-development for next-gen chips.
7. Contract renewal.

High Stakes: For Companies

Companies cultivate competition (downstream and upstream)

1. **Support New Entrants:** NVIDIA backed Micron's entry into HBM3 to reduce dependency on SK Hynix.
2. **Diversify Foundry Partners:** AMD and Qualcomm use multiple foundries (TSMC, Samsung, GlobalFoundries) to avoid lock-in.
3. **Co-Invest in Tools:** Intel, Samsung, and TSMC co-invest to secure supply and curb ASML's monopoly power, ensuring fair contracts and pricing.
4. **Fabless firms favor neutral foundries like TSMC over vertically integrated firms.**
5. **Use Multiple Assembly Firms**: Apple, NVIDIA, and MediaTek work with ASE, Amkor, and JCET to reduce packaging vendor risk.

High Stakes: For Countries

Nations want to become self-reliant and don't want others dominate the semiconductor value chain.

1. **United States**: CHIPS Act (~$52B) to boost domestic manufacturing; TSMC investing $100B, Samsung building 2 Texas fabs with $4.7B in federal grants.
2. **European Union**: EU Chips Act (~$47B) launched to strengthen local chip production.
3. **Japan**: ~$5.4B committed to Rapidus—a state-backed venture building a 2nm fab by 2027 with IBM and industry support.
4. **China**: "Big Fund" Phase III (~$47.5B) backing SMIC, YMTC, and the domestic chip ecosystem.
5. **South Korea**: K-Chips Act offers tax credits (up to 50% for RandD); part of a $470B chip cluster plan through 2047.
6. **India**: Backing new fabs like Tata's ~$3.6B plant in Assam to build a domestic semiconductor ecosystem.

Global Tensions

Trump plans 100% tariff on chips, unless companies build in US

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Taiwan detains TSMC staff for alleged theft of key technology trade secrets

Nvidia AI chips worth $1bn smuggled to China after Trump export controls

Reuters World Business Markets Sustainability Legal More

Trump administration pressed Dutch hard to cancel China chip-equipment sale - sources

By Alexandra Alper, Toby Sterling and Stephen Nellis

Source: …

Questions and Our Answers

1. What's driving demand for semiconductors? Who's purchasing?

   AI, EVs, cloud, defense, clean energy, smartphones, and everything.

2. How does the semiconductor supply chain work (stages, specializations of firms, how firms transact)?

   Global chain. Highly specialized. 9 production stages. 37 leading firms.

3. Who are the leading firms at each stage?

   See slides 10-12.

Questions and Our Answers

4. Which firms capture the most value?

   End purchasers like Apple and BYD

   TSMC, ASML, SK hynix, …

5. Why do some firms succeed while others struggle?

   Short answer: Foresight, Investment, Execution (FIE).

6. Do firms with high market shares have “market power”?

   No.

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Appendix

We Identified a Sample of Leading Firms across the Stages of Production

4. Equipment	5. Foundry	6. Memory
12. ASML 13. Applied Materials 14. Lam Research 15. KLA	16. GlobalFoundries 17. SMIC 18. UMC 19. TSMC 20. Intel	21. Micron 22. SK Hynix

Source: …

We Identified a Sample of Leading Firms across the Stages of Production

7. Assembly and Testing	8. Manufacturing Services	9. End Purchasers
23. Amkor 24. ASE Technology	25. Pegatron 26. Flex Ltd 27. Foxconn	28. Apple 29. Nvidia 30. Samsung Electronics 31. Tesla 32. Microsoft 33. Alphabet (Google) 34. Amazon 35. Oracle 36. BYD 37. Tencent

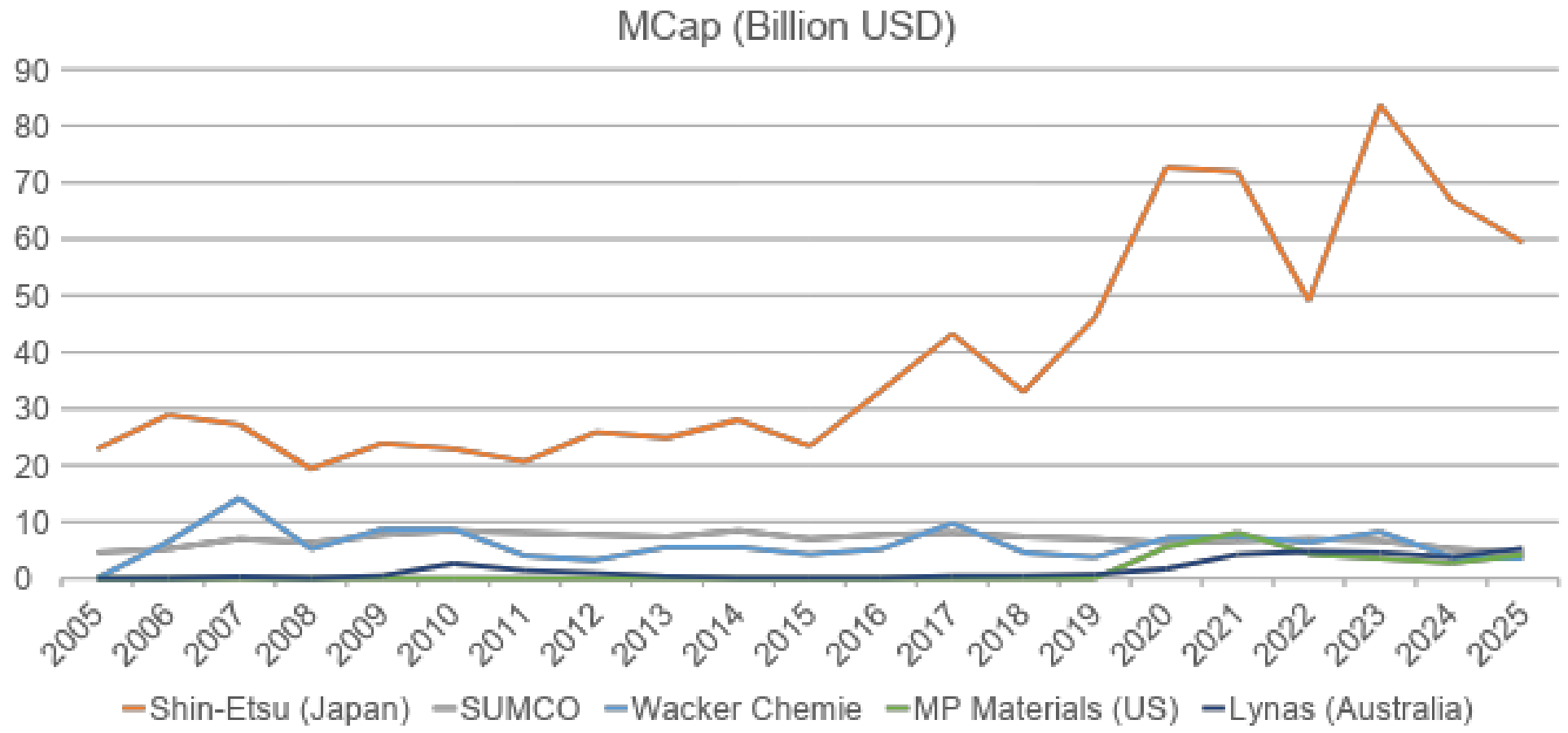
Source: …

Market Cap Growth Across Segments

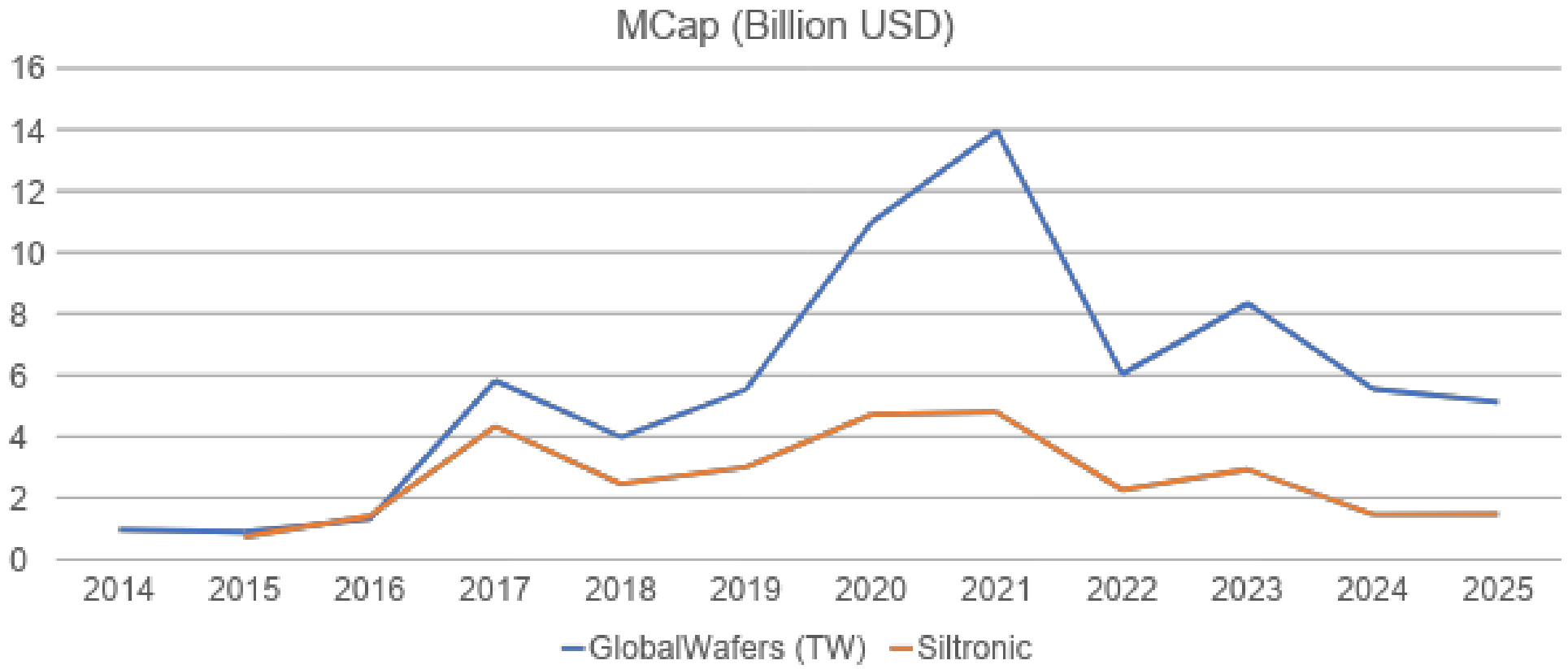
Segment	No of Representative Companies	Average Correlation in MCap Growth
1. Raw Materials	5	0.37
2. Wafer Production	2	0.83
3. Design	4	0.94
4. Equipment & Materials	4	0.98
5. Foundry	5	0.44
6. Memory	2	0.98
7. Assembly and Testing	2	0.91
8. Manufacturing Services	3	0.88
9. End Purchasers	7	0.86
Total	**34**	**Average = 0.8**

Source: Agrawal, H., & Snyder, E. P. (2025). *Big gainers, smaller players: Pricing power and commoditization in the semiconductor industry* (Working paper).

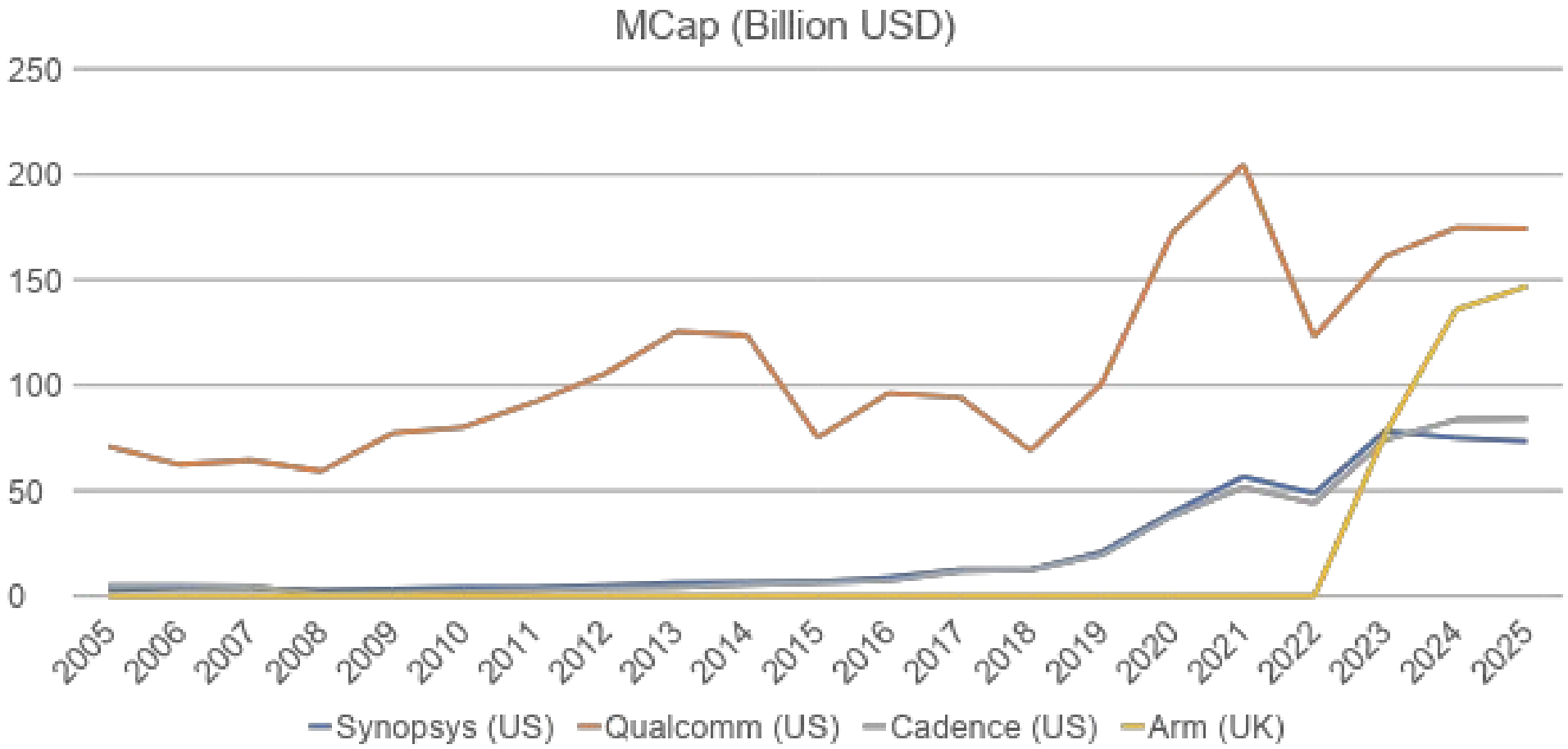
1. Raw Materials



2. Wafer Production



3. Design


MCap (Billion USD)
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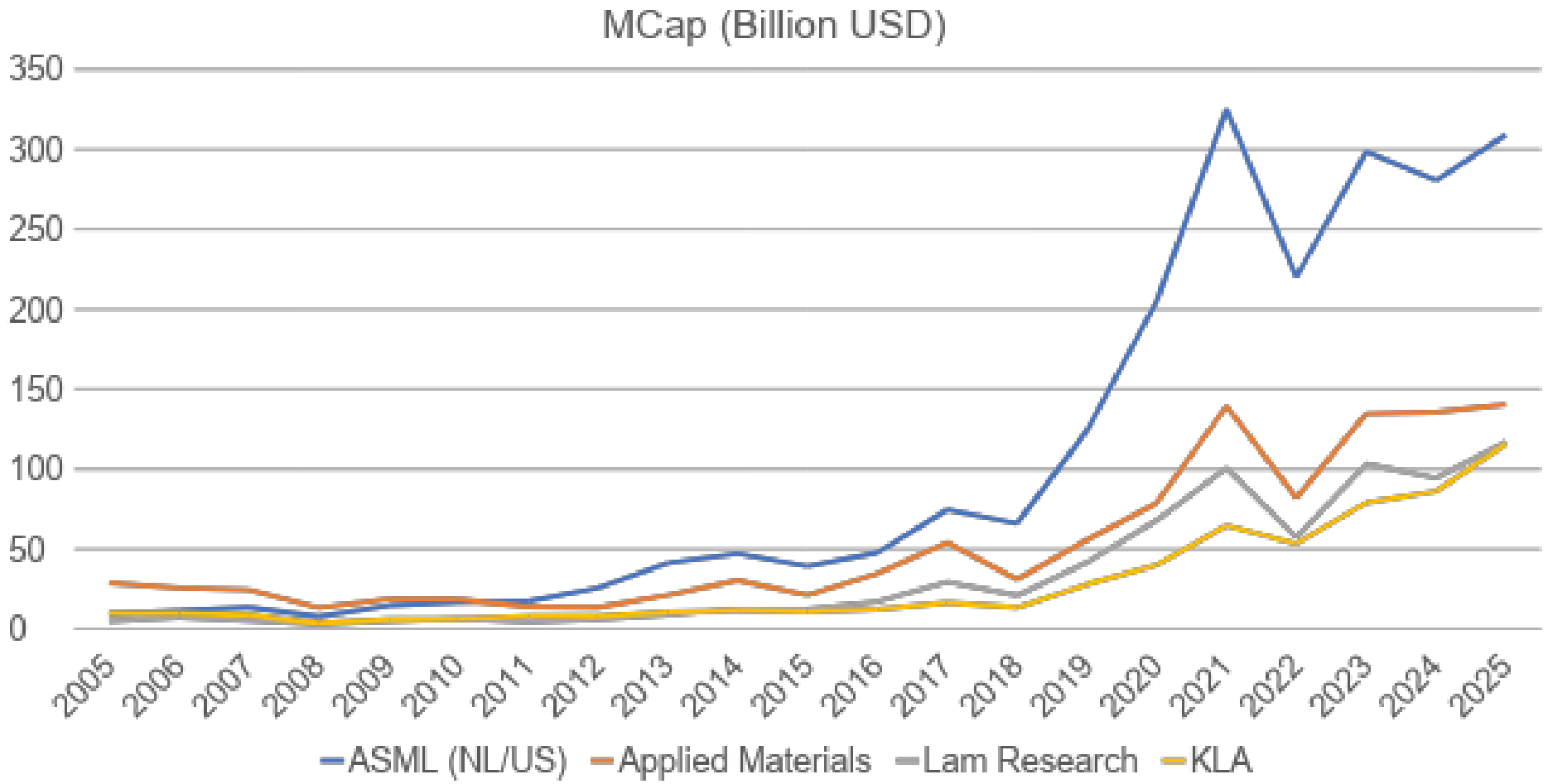
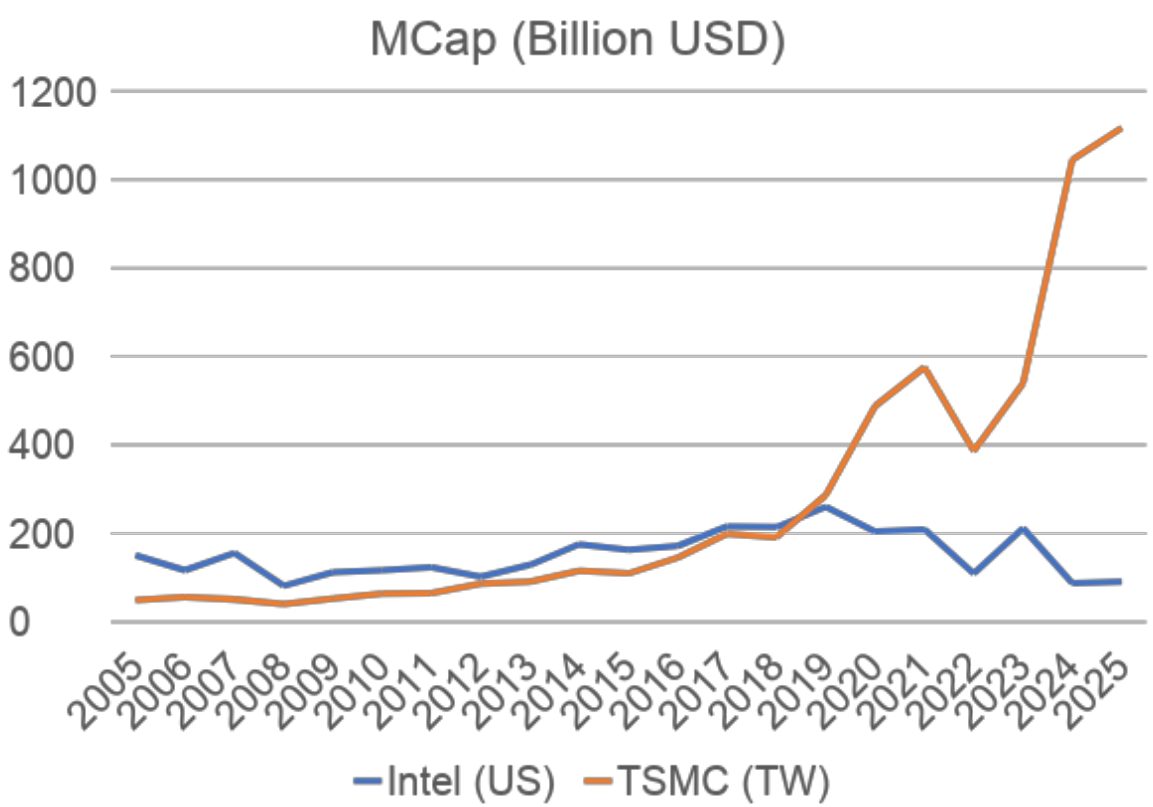
2025
Synopsys (US)
Qualcomm (US)
Cadence (US)
Arm (UK)

4. Equipment and Materials



5. Foundry


MCap (Billion USD)
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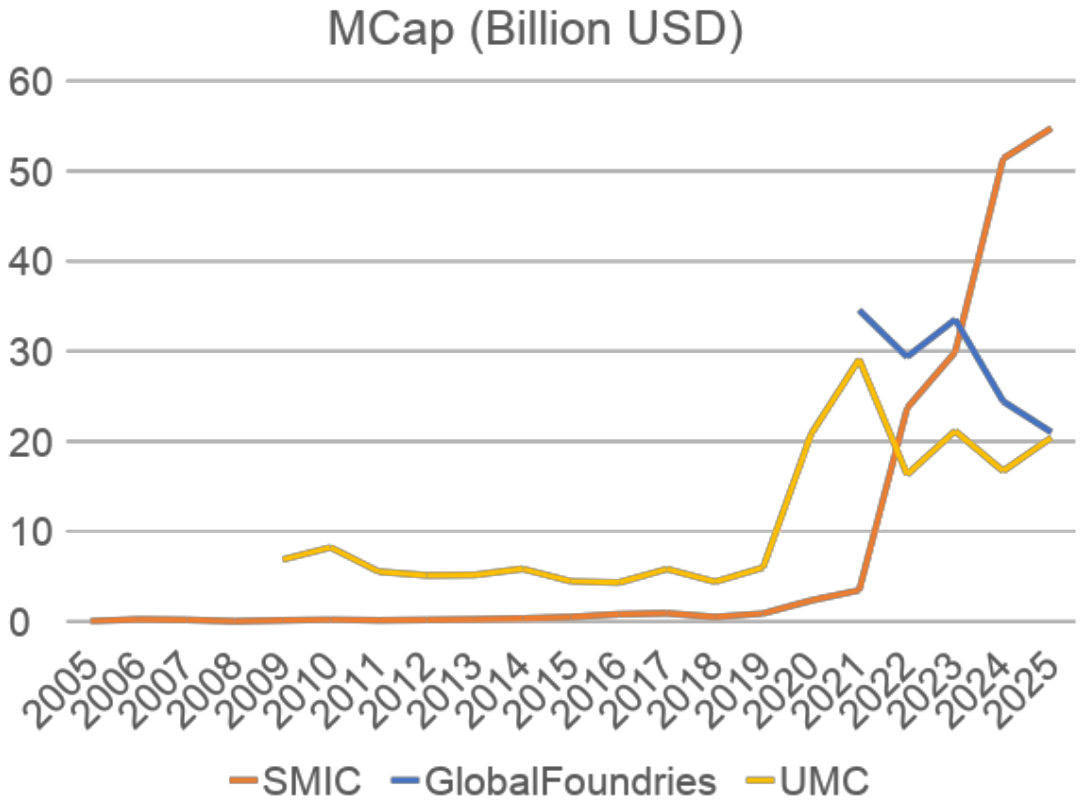
Intel (US)
TSMC (TW)


MCap (Billion USD)
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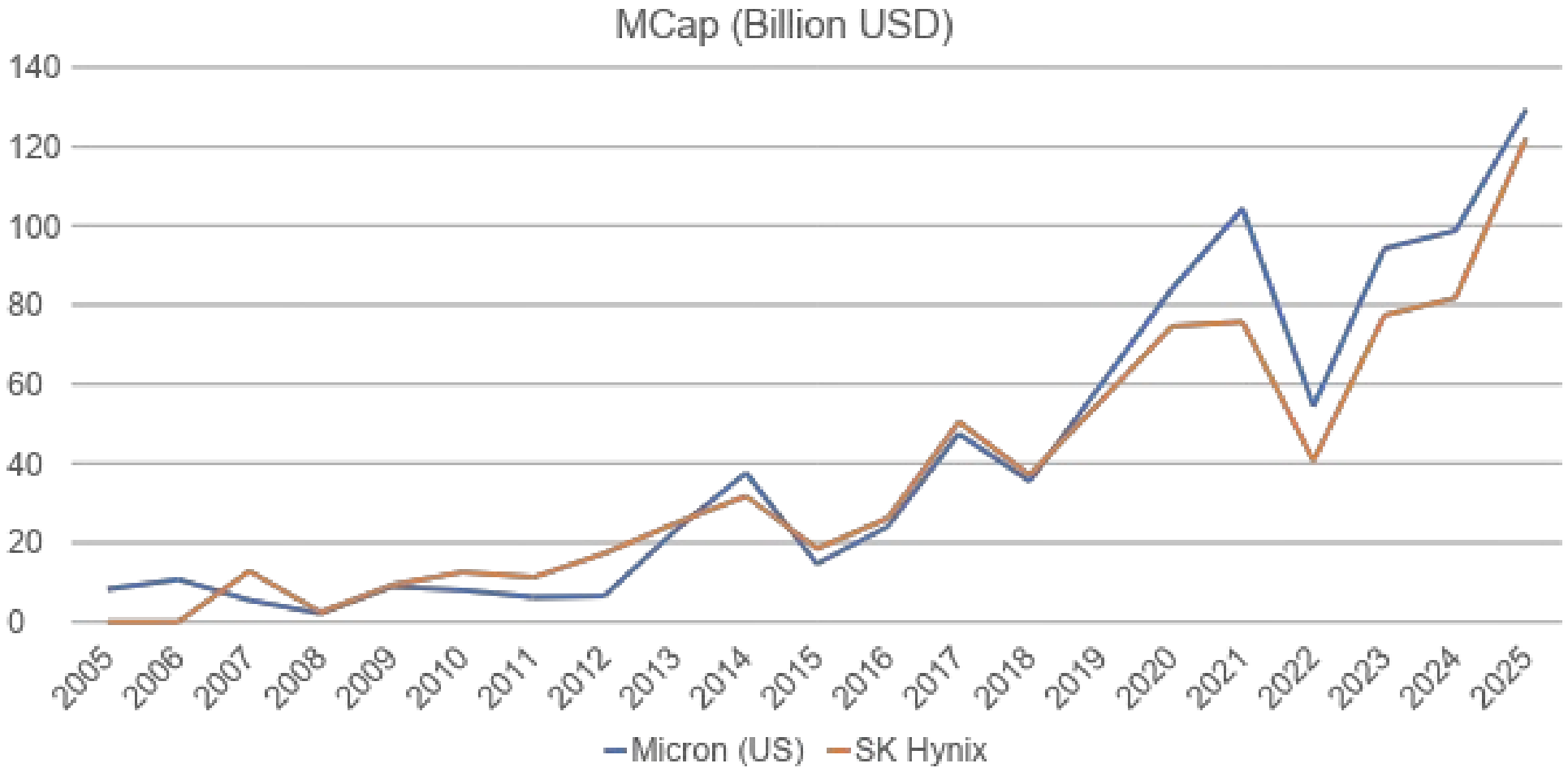
SMIC
GlobalFoundries
UMC

6. Memory


MCap (Billion USD)
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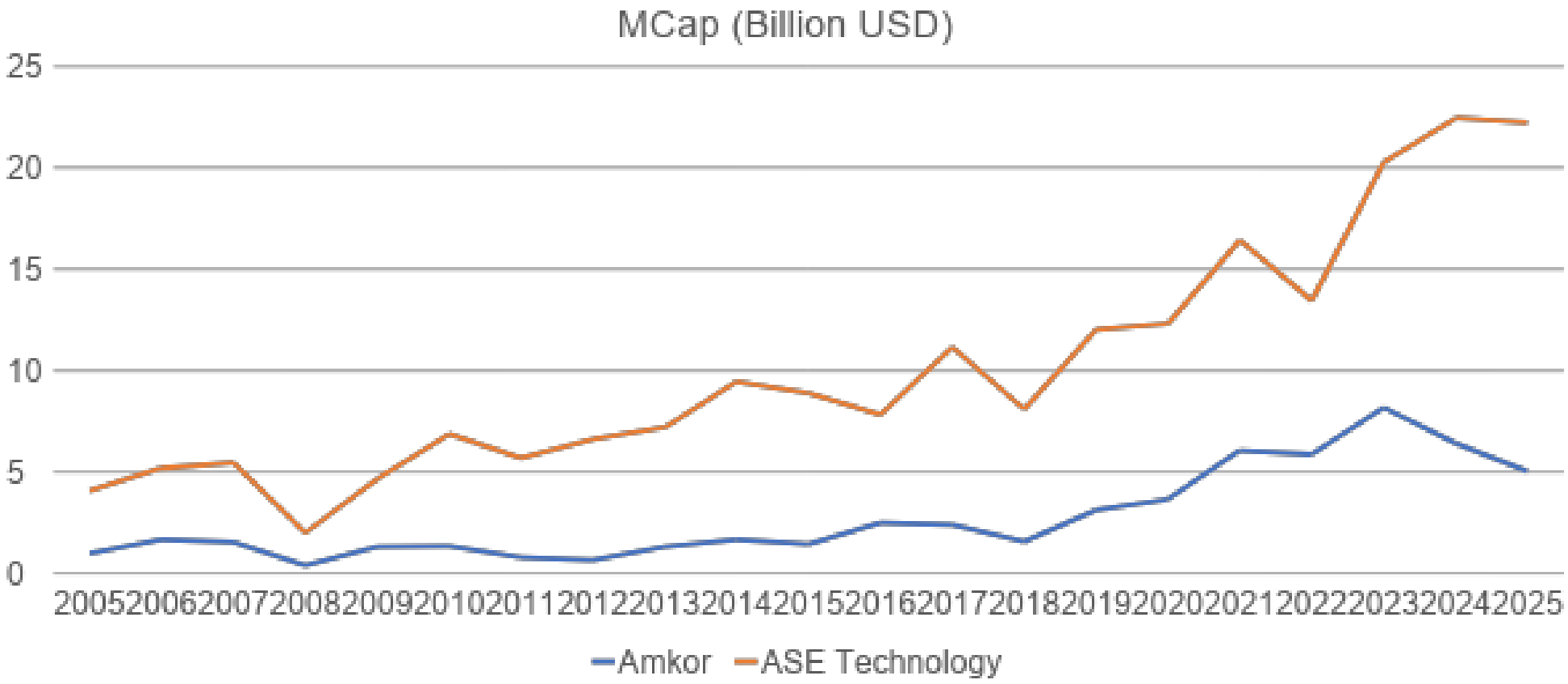
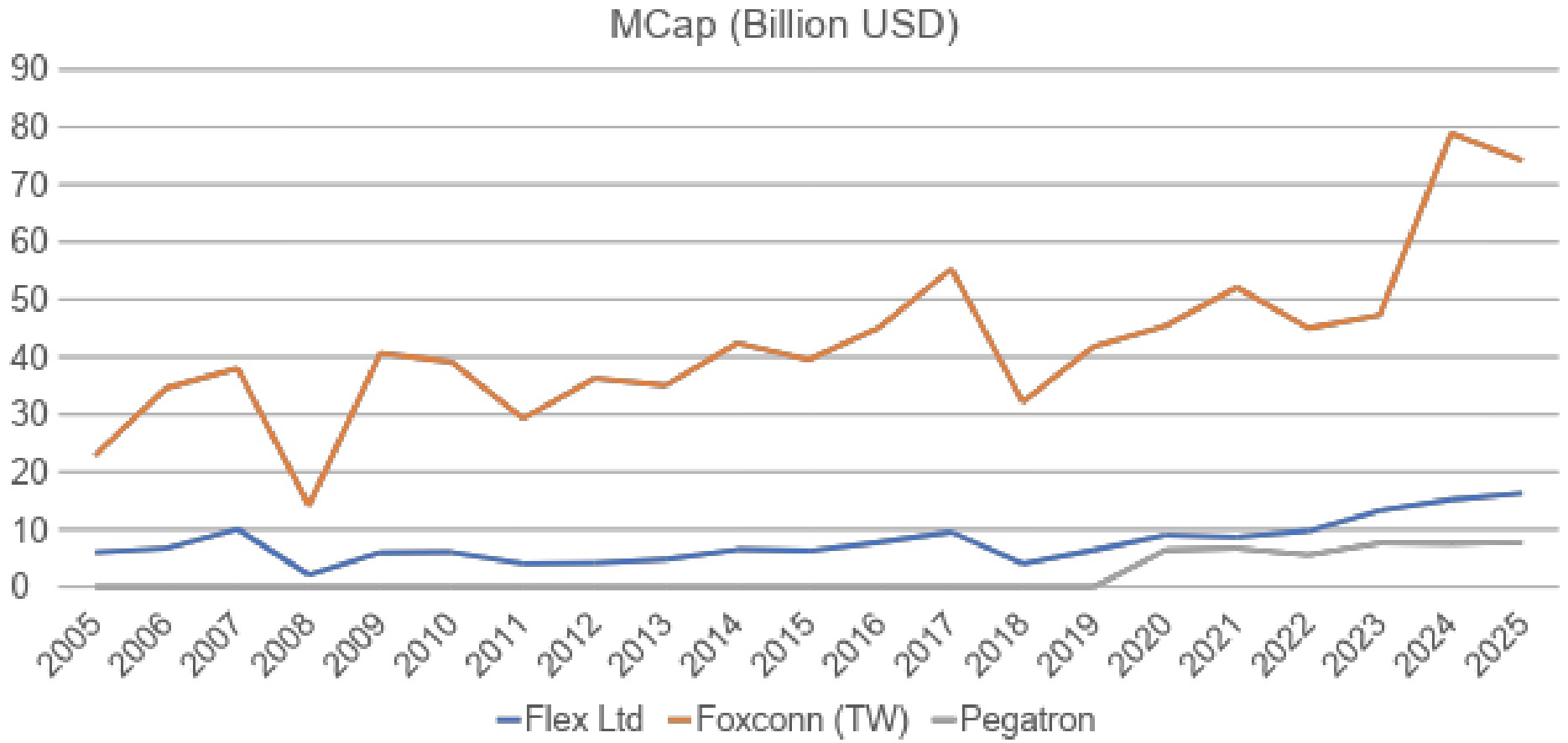
2025
Micron (US)
SK Hynix

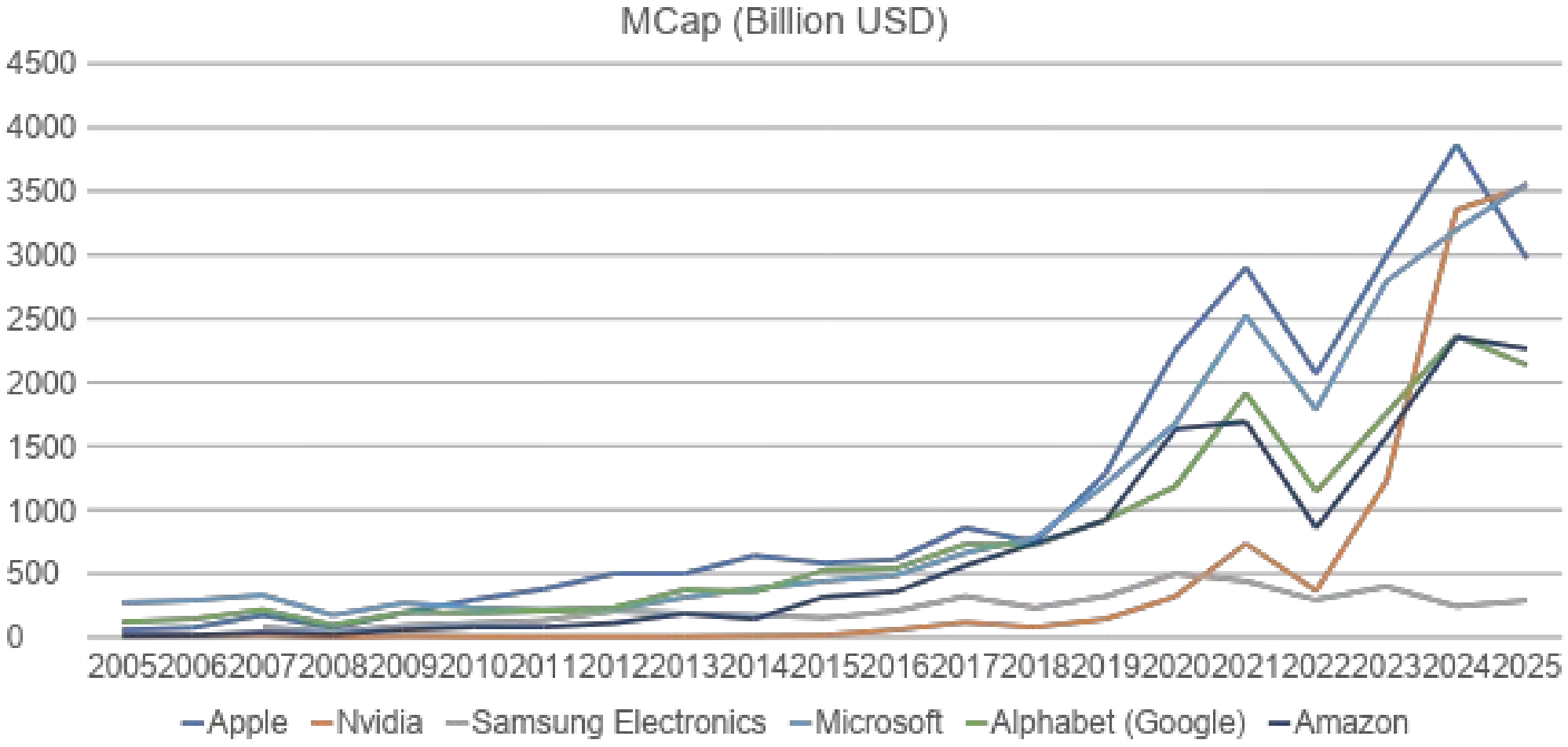
7. Assembly and Testing



8. Manufacturing Services



9. End Purchasers

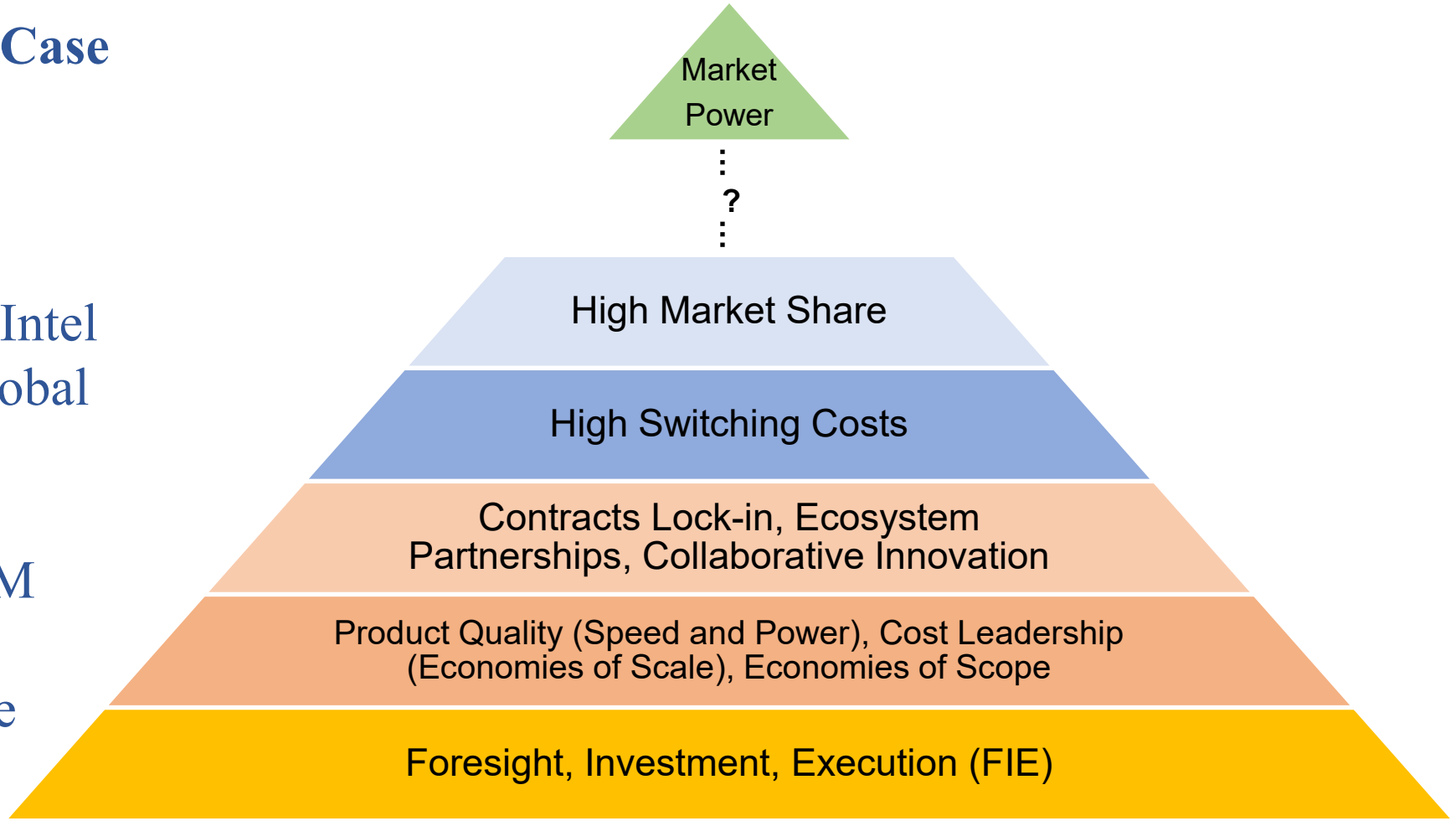


Hypothesis 1

1. “Compete and Win” Case

FIE led:

- NVIDIA to build cost leadership.
- TSMC to outcompete Intel and enjoy 67.6% of global foundry revenue.
- SK Hynix to win over Samsung in some HBM categories.
- Synopsys and Cadence to win over peers.

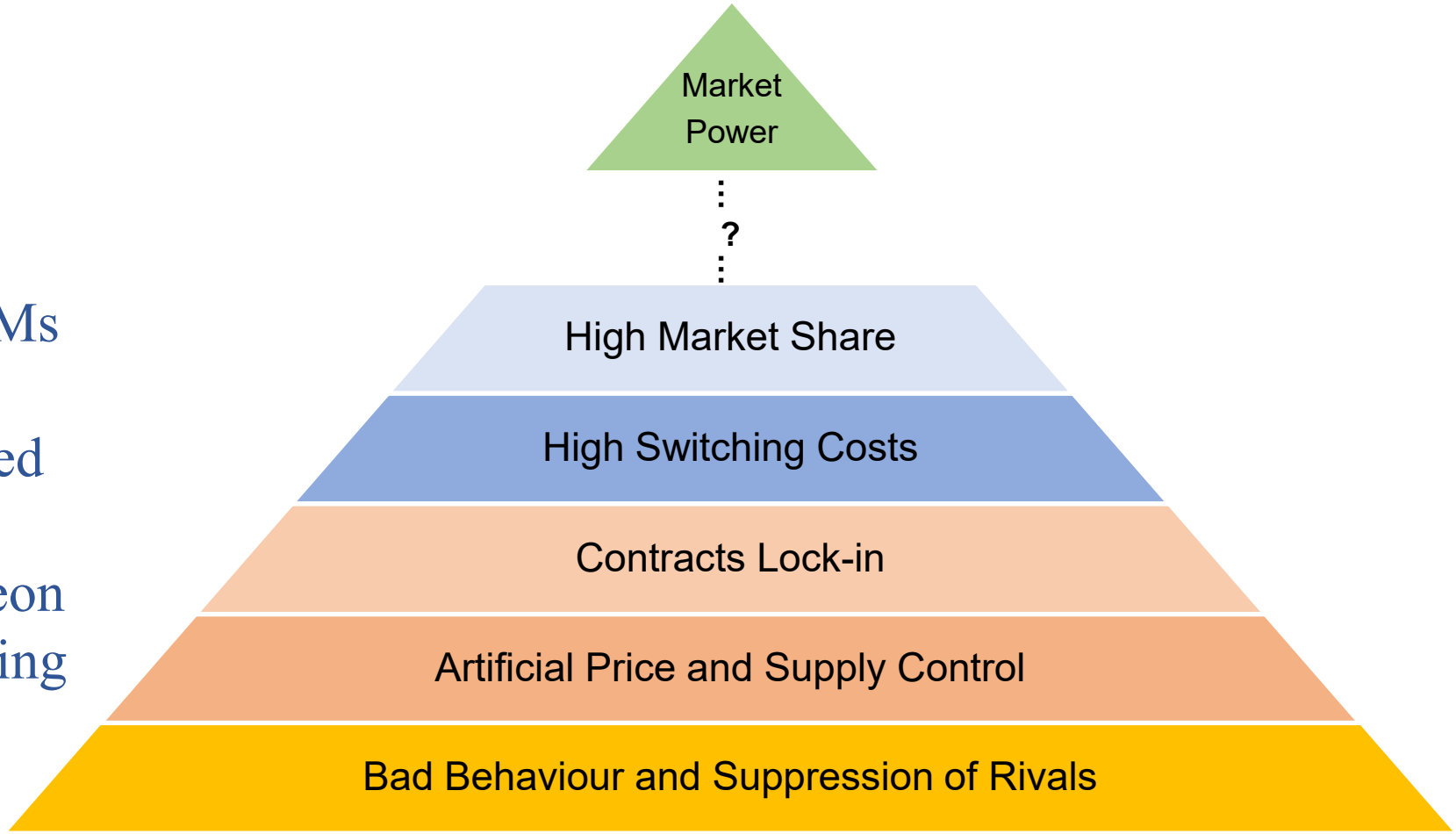


Hypothesis 2

2. "Anti-Competitive Behavior" Case

Bad Behavior led:

- Intel to abuse CPU dominance, paying OEMs (HP, Acer, Lenovo) to delay/cancel AMD-based products (2000s).
- Samsung, Hynix, Infineon to run DRAM price-fixing cartel (1990s).
- Not any thing now

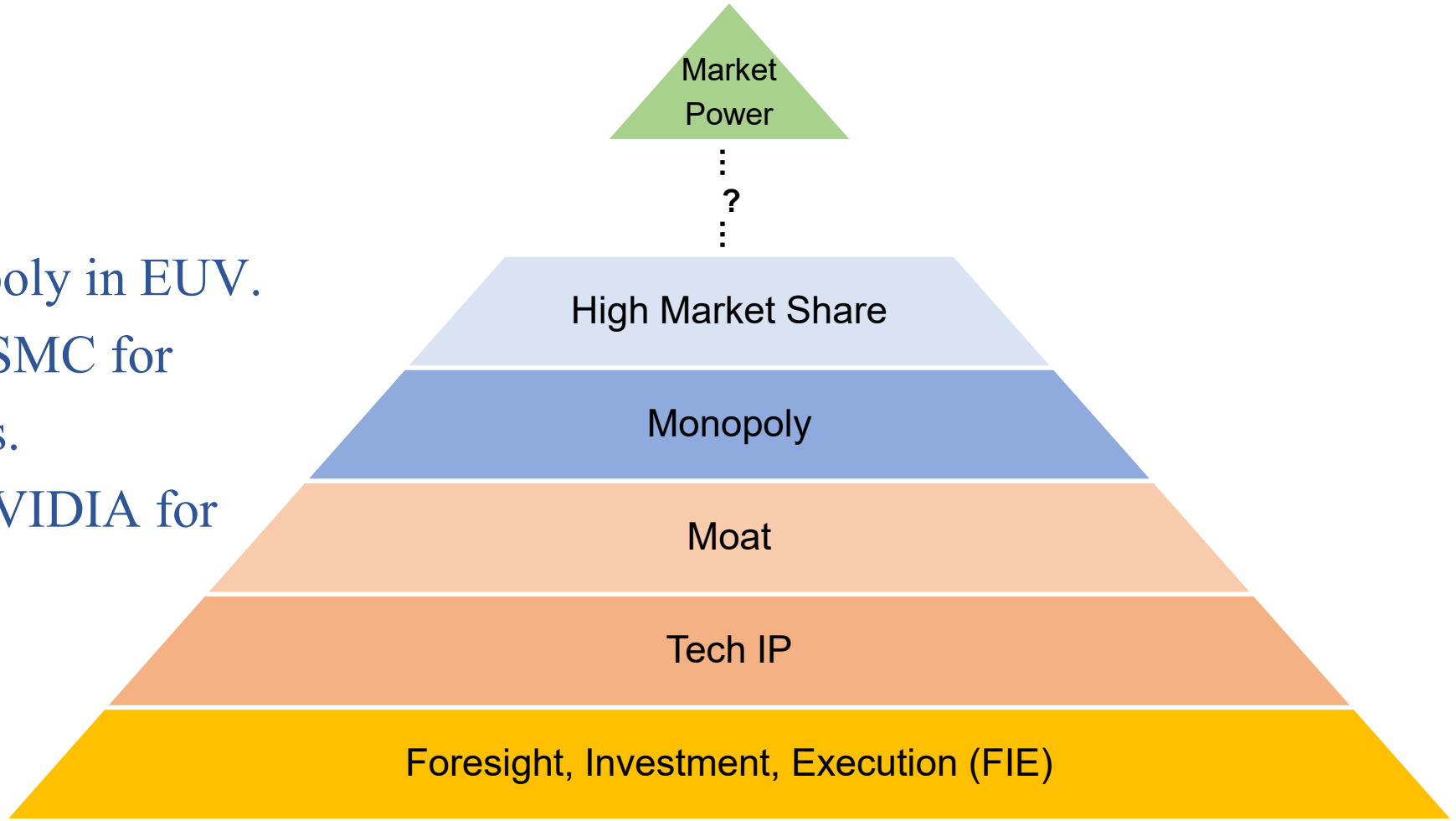


Hypothesis 3

3. “Moats” Case

FIE led:

- ASML to have monopoly in EUV.
- Near-monopoly for TSMC for advanced (3nm) nodes.
- Near-monopoly for NVIDIA for advanced GPUs.



What Types of Firms Are Capturing Most Value?

	Total M-Cap (USD Billion)	
Stage of Production	**2015**	**2025**
1. Raw Materials	35	77
2. Wafer Production	2	7
3. Design	88	479
4. Equipment & Materials	84	683
5. Foundry	33	252
6. Memory	277	1304
7. Assembly and Testing	10	27
8. Manufacturing Services	46	98
9. End Purchasers	2099	15785
Total	**2674**	**18711**