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UNDERSTANDING THE INVESTMENT FUNDAMENTALS OF THE SEMICONDUCTOR SECTOR

By Alan Lok, CFA; Eunice Chu, ACCA; and Guruprasad Jambunathan, FRM

One sure-fire way to kill any technology-related conversation is to talk about vacuum tubes. Bear with us though, because they're incredibly important. Before there were semiconductors in our electronic gadgets, we used vacuum tubes. Both vacuum tubes and semiconductors carried out the same function, but the vacuum tube was a monster that required immense physical space and energy. And at its height, the vacuum tube technology was employed in the ENIAC, the world's first digital computer, built in 1946. It weighed over 30 tons, consumed 200 kilowatts of electricity, but was somewhat unreliable.

Semiconductors changed all that. The chip that powers your mobile phone and computer is made possible with semiconductors, which are minute and consume significantly less power compared to vacuum tubes. Without these ingenious semiconductors, there would be no internet, no tech giants, no international space stations, and definitely no Facebook. Simply put, they allowed us to progress into the information age.

Today semiconductors continue to drive our digital economy; our increasingly technology-reliant society needs even more circuits, chips, and microchips. Semiconductors are also the foundation of the "Industrial Revolution 4.0" as necessary components of the growing number of smart production facilities connected with the Internet of Things (IoT).

In this investment framework, we will first take you on an exploratory journey through the global semiconductor industry landscape, now worth almost US$500 billion in annual sales. Thereafter, we will proceed to give you an analytical framework to assess investment opportunities in this sector.

A COMPLEX GLOBAL ECOSYSTEM

In a nutshell, the semiconductor value chain comprises six stages, beginning with research and development, followed by design, manufacturing, assembly, testing and packing, and finally, distribution. This is a complex value chain spanning different continents; in fact, a global R&D cum supply chain ecosystem is how the industry is organised, as it is impossible for one country to try to house all six stages in a single location and excel at every stage.

On the demand side, consumers unceasingly insist on more features, greater reliability, and higher speed. This has resulted in higher R&D expenditure (R&D on average consumes about 15% to 20% of revenue) in a bid to improve on current models. On the supply side, fierce competition dictates that the eventual manufacturing, testing, assembling, and packaging must be of sufficient scale to enjoy low unit cost.

Satisfying both criteria requires completely different sets of logistical infrastructures, not to mention human resources and working environments. And this is why chip designers such as Intel, AMD, and ARM are in the US Silicon Valley, whereas manufacturers and assembly lines like Foxconn and Flextronics are in China. The industry has optimised production through a globally interdependent ecosystem that pools up the best each country or economy can offer. However, this arrangement may change in the future following the US ban on China's technology champion, Huawei. Chinese companies will definitely attempt to develop their own chips and machines that manufacture these chips, including chip designing capabilities.

A SHIFTING LANDSCAPE

In addition to being complex and in production in multiple continents, the industry is also far from static. Currently, integrated device manufacturers (IDM) such as Intel, Micron, and Samsung continue to dominate the landscape. However, fabless foundries (which focus exclusively on design while outsourcing fabrication) such as AMD, Qualcomm, and Broadcom are slowly but surely evolving into a force to be reckoned with. This shift is inevitable as products become ever more sophisticated, increasing the need for further specialisation.

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FUNDAMENTALS AMONG INCREASING COMPLEXITY

The reach, complexity, and ever-changing landscape of the semiconductor industry present a challenge for investors looking to gain exposure to firms within the industry. How do you make sense of an industry with so many fast-moving sections and uncover the fundamental factors they need to create a robust analytical framework?

Answering that question is precisely our key objective, and we will begin by categorising a company by its position on the value chain.

A LINK IN THE CHAIN

The first step is to determine the position of a company on the value chain: Is it an integrated device manufacturer doing both design and fabrication, or a fabless foundry, or a semiconductor foundry? While there are many factors common to all three, there are also differences; so it is integral you know where a company lies on the value chain.

From there, look at the company's presence across the various market segments: memory, logic, or standard chips. Find out exactly what products are in its portfolio and which end-user market each product serves.

GETTING A GRASP OF THE MARKET STRUCTURE

Next, get a feel of the market structure the company is operating in. Generally, the industry is one where high buyer concentration is not uncommon. It is essential to learn just how concentrated are buyers in a company's end-user markets. Are there only a few large buyers, and if so, what effect does that have on the firm?

Demand cyclicality is another crucial element to consider. Establish how various macroeconomic factors might affect product seasonality. Factors like GDP growth, consumer sentiment, corporate spending, and changes in disposable income could all have a significant impact on demand and pricing.

Speaking of pricing, you should also study the firm's strategies – these would typically vary according to where a product lies in its life cycle. An excellent way to do this is by researching a company's peers or competitors pricing policies. While you're at it, survey the competitive landscape: Is it more concentrated or fragmented? How is market share distributed, and what are the barriers to entry?

PRODUCT DEMAND AND PRICING

Now that you've grasped the market structure, it's time to delve into company-level factors. Examine its shipment among various end-user markets and product segments. Scrutinise shipment growth expectations, including how much demand a company estimates will be driven by the product upgrade cycle, market expansion, or new products and markets.

You've already studied general pricing strategies. Now, examine how a company stacks up. Is the company taking advantage of its pricing power? Or is the company suffering from pricing pressure? Peer analysis will help shed light on this; dig deeper to inspect if it has higher pricing power compared to its competitors. If the company is enjoying higher pricing ability, determine the reasons for this ability. It could include presence of proprietary technology, intellectual property, or uncommon products, technology, or manufacturing techniques.

Finally, understand its pricing along the product life-cycle curve. Do pay particular attention to how long it can sustain higher prices before the inevitable drop.

OPERATIONAL AND FINANCIAL METRICS

Cost structures must be examined. Review both fixed and variable costs across the company's product line and contrast those numbers with its competitors. Other financial metrics you should closely look into include free cash flow generation as well as gross, operating, and net margins. Given the international nature of the industry, don't neglect examining the foreign exchange hedging strategies, if any at all.

Depending on a company's position in the value chain, there are specific queries you should make. For instance, if the company is an IDM, does it also offer contract manufacturing services to third parties, and if so, what percentage of the foundry capacity is being utilised? Thereafter, do perform a margin comparison between the two.

For fabless foundries, work out how vulnerable the company might be to increasing concentration in fabrication capacity. Supply chain risks are real, especially given the interconnected global supply chain. As for semiconductor foundries, explore metrics like foundry capacity, utilisation, downtime statistics, and the lag time between capital expenditure and revenue generation.

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ENVIRONMENTAL, SOCIAL, AND GOVERNANCE FACTORS

While the semiconductor industry is not a significant contributor to greenhouse gas emissions, the manufacturing process still requires the use of perfluorocarbons (PFCs), which have a greater impact on global warming compared to carbon dioxide. Critics of the industry also point to potential groundwater pollution, although official statistics show otherwise.

As such, a large part of assessing environmental, social, and governance factors in the industry comes down to environmental issues. Does the company routinely measure its environmental footprint? What are its consumption and emission statistics, and what steps is it taking to reduce its footprint? Enquire into whether it has a concrete strategic roadmap on the environmental front, and probe its track record in this area.

The company's supply chain also deserves your scrutiny. Given the long-reaching supply chain, investigate whether any dubious minerals could have been used in its manufacturing process. More importantly, examine the method it uses to track its suppliers to ensure no inadvertent use of such minerals.

LONG-TERM DEMAND GROWTH

Being a driver of the digital economy has its drawbacks; technology evolves at a rapid pace, and even dominant incumbents can fall if they don't keep up. Two primary structural demand drivers you need to take into account are markets and technology. Consider emerging markets with relatively low penetration levels of internet and smartphones – a company's presence in such markets might be a long-term growth driver.

On the technology side, the data show bit-density growth slowing across the board. Find out how the company is planning to tackle this issue. Will it be through financial measures, facility upgrades, or investments into emerging technologies such as machine intelligence and IoT?

We wrote this framework to provide you with a systematic way to cut through the evolving complexity of the semiconductor industry. These guidelines may be short and sweet, so use them as your base from which to launch your analysis and give yourself a head start on your investment journey.

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Sector Analysis: A Framework for Investors

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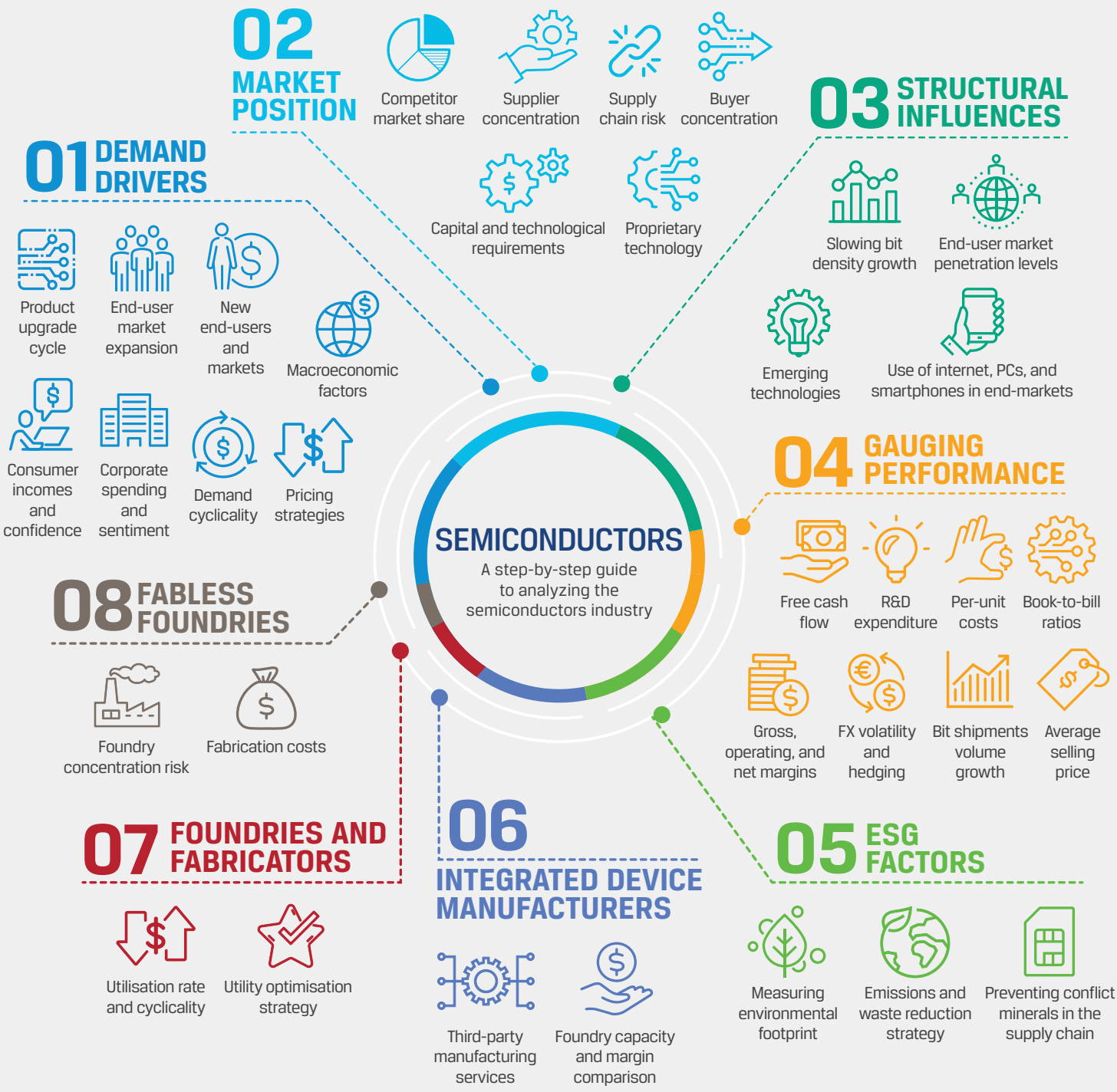

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Common to the Sector

1. Product portfolio and end-user markets

a. How much presence does the company have across the different market segments? These include memory, logic, standard chips and system on a chip.
b. What are the various products in the company's portfolio?
c. What are the end user markets for each of the company's products?
d. How does the performance and price of the company's products compare with that of its competitors?

2. Which factors impact demand for the company's products?

a. How much volume and revenue does the company derive from different end-user markets and product segments?
b. What is the company's volume growth expectation for its end-user markets and product segments?
c. How much demand is driven by the product upgrade cycle of the company's end-user markets?
d. How much demand is driven by expansion in the company's end-user markets?
e. What is the demand that arises from newer end-user products and markets?

3. How cyclical and seasonal is the demand for the company's products?

a. What macroeconomic factors affect cyclical demand for the company's products?
b. What is the impact of GDP growth and expectations?
c. How much of the company's revenue is derived from the consumer and corporate end-user segments?
d. What is the impact of changes in disposable incomes and consumer sentiment on demand from the consumer segment?
e. What is the impact of corporate spending and outlook on demand from the corporate segment?

4. What are the factors affecting the pricing of the company's products?

a. What pricing strategies are adopted in the industry?
b. What is the company's pricing strategy and how does it vary from that of its peers?
c. Does the company have different pricing strategies for new, mature and legacy products?
d. What is the typical duration after which the company considers a product as a mature and, subsequently, a legacy offering?

5. The drivers of structural growth

a. What are the penetration levels of the company's end-user markets and products across various regions and countries?
b. What are the penetration levels of the internet, PCs and smartphones?
c. Which end-user markets and products have the potential for structural growth?
d. Which regions and countries offer space for structural growth?
e. What are the emerging technologies, such as Machine Intelligence and Internet of Things, that could drive long-term growth?
f. In the light of these opportunities, how do the company's product portfolio and capabilities compare with those of its competitors? Are there gaps?
g. Where applicable, how does the company intend to fill these gaps and build the required capabilities?

6. Trends in bit density growth

a. What is the company's strategy to counter a potential slowdown in bit density growth?
b. Is the company exploring any technologies that could tackle any slowdown?
c. Does the company intend to upgrade its design and fabrication facilities?

7. The competitive situation in the company's industry

a. How concentrated or fragmented is the market for the company's products?
b. What is the market share of the top three/ top five players across the different products where the company has a presence?
c. Which factors facilitate or inhibit the entry of new players?
d. What are the capital and technology requirements for new players to enter the market?

8. What are the company's product, technology and competitive strengths?

a. Does the company possess a unique or uncommon product, technology or manufacturing technique?
b. Does the company possess a significant competitive advantage in any product segment?
c. Does the company own any proprietary technology or intellectual property (IP) in any product segments or manufacturing technique?
d. How many patents does the company own? What are the current or potential applications that these can be used for?
e. Is the company involved in any disputes relating to patents and IP?

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9. New technology

a. Does the company prefer in-house R&D, acquisitions or licensing?

10. What is the level of buyer concentration in the company's end-user markets?

a. What is the company's share of top three/top five buyers in its product segments?
b. How much pricing pressure does the company experience due to buyer concentration? How does it manage this?

11. How much pricing power does the company have?

a. What is the company's market share in different product segments and across the various end-user markets that it caters to?
b. Does the company have a leading presence in any product segments or end-user markets?
c. Are there areas where the company's product pricing power is higher than its peers? What gives the company this advantage?
d. Typically, how long is the company able to sustain the initial higher prices of its new products?
a. How much of the lifetime volume of a typical product is the company able to sell at the initial higher price?

12. How has the company performed on operational measures? How does this compare with that of its peers and how is this expected to evolve?

a. What is the company's volume growth in terms of bit shipments?
b. Have there been any changes in the company's average selling price for its different products?
c. What is the company's book-to-bill ratio? How does this vary across products?
d. What are the company's per-unit fixed and variable costs?

13. Performance on financial measures – how does this compare with that of the company's peers?

a. What are the company's gross, operating and net margins?
b. How much free cash flow does the company generate as a percentage of sales?
c. What is the company's expenditure on research and development (R&D) as a percentage of its sales?
d. What is the company's hedging strategy to manage volatility in its input costs and foreign exchange?

Integrated (design and fabrication) semiconductor makers

14. Does the company run both semiconductor design and fabrication operations?

a. Does the company offer contract manufacturing services to third parties?
b. If so, how much of the company's foundry capacity is used for contract manufacturing versus the manufacture if its own products?
c. What is the company's mix of volume and revenue from contract manufacturing versus end-to-end products?
d. How do the margins from the company's two operations compare?

15. What is the company's expenditure on R&D (including the design of its own products) versus the technology used in manufacturing and fabrication? How does this compare with that of its peers and how is it expected to evolve?

a. Which manufacturing process and techniques are the company most bullish on over the next 3–5 years?
b. Which product segments is the company focusing its R&D efforts on currently?
c. Which end-user markets does the company target with its R&D efforts?

16. How much is the company's capital expenditure as a percentage of sales? How does this compare with that of its peers and how is it expected to evolve?

a. What is the company's capex in its fabrication facilities (fabs)?
b. What is the ratio of this as capex a percentage of sales derived from the fabs?

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Silicon foundries/ semiconductor fabricators (fabs)

17. What are the company's typical capacity utilization rates?

a. How cyclical and seasonal is the rate of utilization?
b. How does the company optimize utilization?
c. How does the company forecast demand for its fab capacity?

18. Details of the company's fab capacity

a. How much fabrication capacity does the company own?
b. How much capacity is it adding? When are these new capacities expected to be ready for production?
c. How does the company forecast capacity requirements and plan for expansion?

19. The operational performance and capital efficiency of the company's fabs?

a. What is the typical operational downtime rates of the company's fabs?
b. How much yield is the company able to achieve per unit of silicon wafer processed in its fabs?
c. What is the typical lead time before the company's capex (on fabs) starts to generate revenue?
d. What is the company's medium and long-term capex outlook by technology?
e. What is the company's capex-to-sales ratio?
f. How much free cash flow does the company generate as a percentage of capex invested?

Fabless semiconductor makers

20. How vulnerable is the company to the rising concentration of fabrication capacity?

a. How many different foundries does the company outsource fabrication of its products to?
b. How much does the company pay for the fabrication of its different products, at different volumes?
c. How vulnerable are the company's margins to increases in fabrication costs due to increasing concentration of capacity?
d. How does the company manage the supply-chain risks that arise out of fabrication capacity concentration?

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Environmental, social and governance factors (ESG)

21. What are the company's ESG principles, practices and track record?

a. Does the company perform a life cycle assessment of its products to estimate its environmental footprint?

b. What is the energy consumed by the company's products in operation? What measures does it use to quantify this? What is the firm's roadmap for improving efficiencies?

c. How much packaging material does the company use while shipping its products? Does the company have plans to reduce packaging and use recycled material?

d. Does the company have a strategy for managing the e-waste generated by its products?

e. What is the emission, energy, water consumption and pollutant release intensity of the company's manufacturing processes? What steps is it taking to improve performance on these fronts?

f. Does the company use any conflict minerals in its products or manufacturing processes? How does it track and ensure these minerals are sourced in a fair and transparent manner?