Semiconductors: A Changing of the Guard

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"While an early chip from the 1970s could fit thousands of micrometre-sized transistors, today's most advanced chips are a complex web of billions of transistors, the smallest of which are just 10nm. To get some idea of how small that is: your fingernails grew 10nm in the time it took to read the previous sentence."[1]

Background

One of the key enablers of technological progress has been the constantly shrinking size of the transistors on semiconductor chips. Smaller transistors mean that the same number of computations can be completed faster, more efficiently and at lower cost. This concept was famously outlined by Gordon Moore, co-founder of Intel, who in 1965 wrote what became known as Moore's Law.

The manufacturing process for a particular size of transistor is called a process node. Shifting to a new node is highly complex and involves significant capital expenditure. In July 2020 Intel announced that their transition to the 7 nanometre node was running a year behind schedule. This delay will have a significant impact on Intel and its competitors.

This announcement marks a changing of the guard in the semiconductor market, with leadership shifting away from Intel towards Taiwan Semiconductor Manufacturing Company (TSMC) and Samsung Electronics.

Scale Matters

Assessing the future prospects of a company requires an assessment of its industry. Manufacturing semiconductors is highly capital intensive – the industry spends USD 100bn per annum on capital expenditure. Companies also need to spend substantial amounts on R&D because each process node is more complex than the last. This means that fixed costs are very significant; utilisation is the key driver of profitability. As the costs of advancing to a new process node have increased, participants have exited, and the industry has become more oligopolistic. Industry dynamics mean that winners continue to forge ahead while losers quickly fall behind.

Semiconductor companies operate one of three different business models – they are outlined in the table below:

Name	Business Model	Major Players
Integrated Device Manufacturer (IDM)	Design and manufacture of semiconductors	Intel, Samsung Electronics
Fabless	Purely focused on designing semiconductors	AMD, Qualcomm, Nvidia
Foundry	Manufacture semiconductors for Fabless clients	TSMC, Samsung Electronics, GlobalFoundries

Historically, most semiconductor companies were IDMs. Intel is the archetypal IDM and the company believes they add significant value to customers by combining design and manufacturing. TSMC was founded in 1987 as the first dedicated semiconductor foundry – they focus purely manufacturing chips for their fabless clients. The fabless-foundry business model has several advantages relative to the IDM model:

1. Diversification: weakness in the chip design arm of an IDM will hit the profitability of the manufacturing arm. A foundry has demand from several different customers. This diversification enables them to better manage utilisation and generate higher profits;

[1] Source: ASML – leading manufacturer of semiconductor manufacturing equipment (2019 Integrated Report).

2. Technological edge: a foundry is able to spread the significant investment to reach a new node across several fabless clients. In contrast an IDM effectively has only one internal fabless client.

These advantages mean that the foundries have taken share from IDMs over time and this trend is likely to continue. TSMC is the largest foundry with ~50% market share.

Leader Falls Behind

Intel has dominated the Central Processing Unit (CPU) market for many years. They currently have over 80% market share (by revenue) in PCs and ~95% share in Servers. This strong market position has been driven by node leadership.

There are 2 main drivers of chip performance: process technology and architecture. Broadly speaking, how the chip is made and how the circuits on the chip are designed. Historically, Intel has held a process node lead over the rest of the market; this means that they could produce CPUs with smaller and more densely packed transistors. They typically reached a new node several quarters ahead of the competition allowing them to dominate the market and re-invest the profits in winning the race to the next node. This virtuous cycle has allowed Intel to stay ahead of its main CPU competitor AMD.

This cycle began to crack in 2015-2016 with delays to the launch of Intel's 10nm node. These delays allowed TSMC and Samsung to catch up and reach process parity by 2018-2019. Intel's announcement of the delay in July 2020 means that they have undoubtedly lost process leadership; the most advanced microprocessors globally will now be produced by TSMC and Samsung. The virtuous cycle has broken.

Playing Catch-Up

Going forward there are 3 options for Intel – none of which will immediately resolve the process technology deficit:

1. Status Quo: this is the company's current strategy. They are aiming to fix the issues with 7nm and continue to operate as an IDM. Given the delays, they will still be at a process disadvantage relative to competitor AMD for at least 2-3 years;

2. Full Outsourcing: a radical change in strategy - with Intel exiting semiconductor manufacturing and becoming a Fabless player. This means they would operate on process parity with AMD because they would both be using the same foundries. A key question is what would happen to Intel's own manufacturing facilities. AMD executed a split from an IDM into a Fabless-Foundry model in 2009 but the Foundry (GlobalFoundries) has failed to keep up with TSMC and Samsung;

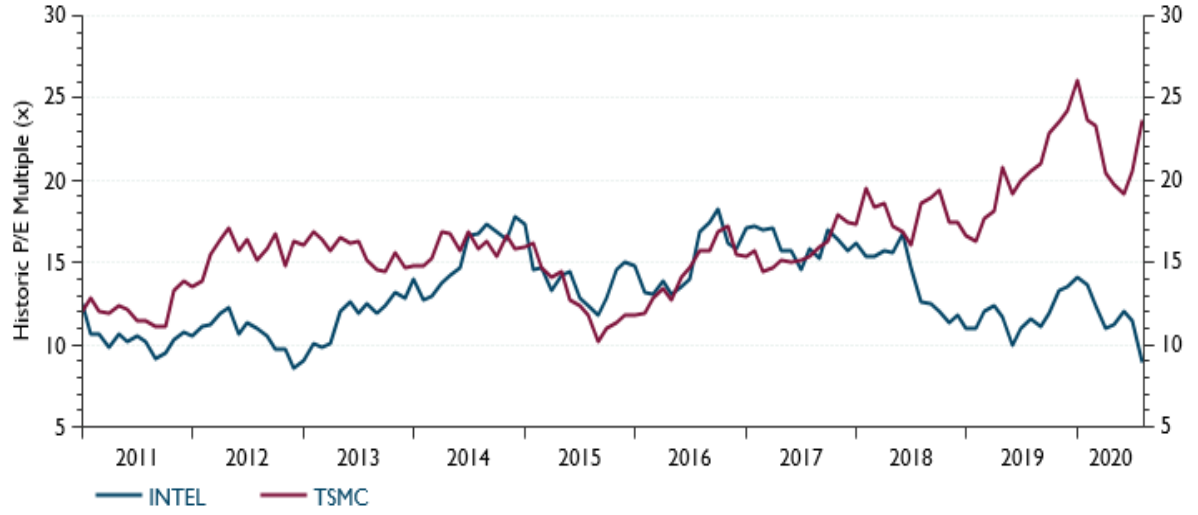
3. Hybrid: This is the fall-back option if Intel is unable to fix the 7nm issues. They would outsource their leading- edge semiconductors to TSMC and Samsung while keeping older nodes in-house. This would allow them to reach process parity with AMD but they would not regain leadership.

In every scenario Intel is likely to lose market share to AMD. As described earlier, Intel's dominant position in CPUs was built on node leadership; AMD has always struggled to compete because of its manufacturing disadvantage. Now the situation has flipped; AMD operates with a node advantage for the first time (through TSMC). Recent market share data suggests that AMD is already gaining significant traction in PCs. Server share may take longer but it is unlikely that Intel will maintain its current dominance.

Historic Earnings Multiples Mask Structural Shifts

Backward looking analysis does not capture emerging structural shifts. Chart 1 (showing historic earnings multiples) would suggest that Intel is *cheap* and TSMC is *expensive.* This ignores the stark differences between the earnings trajectories of the companies over the next 5 years.

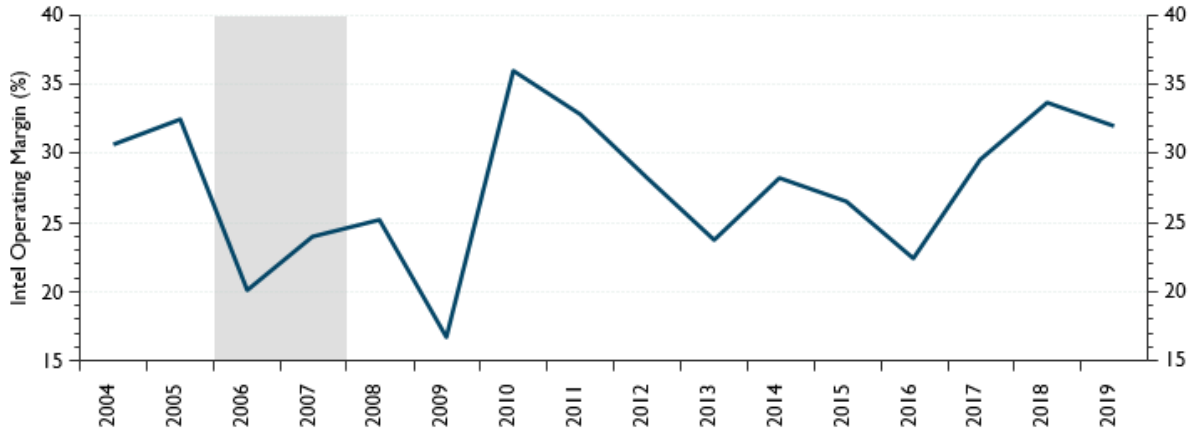
Chart 1: Historic P/E Multiples



Source: Refinitiv Datastream

Intel profitability will come under pressure as the company will be forced to compete on price as they have lost technological leadership. AMD products are currently priced at a significant discount to Intel and history provides some indication of the potential impact. The shaded area in Chart 2 highlights the last period when AMD had a strong offering and reached 25% market share. Intel operating margins fell significantly.

Chart 2: Intel Historic Operating Margin



Source: Refinitiv Datastream

Foundry players will gain market share in the CPU market either through AMD taking share from Intel or because Intel outsources some, or all, of their manufacturing. In the Full Outsourcing and Hybrid scenarios the foundry market will expand significantly because Intel accounts for most of the PC and Server CPU market. The companies that will capture this revenue opportunity are TSMC and Samsung Electronics because they are the only players operating at the leading-edge node. Revenues lost by Intel will be gained by TSMC and Samsung Electronics.

Intel's delays mean that the leading-edge processor market has become a duopoly and medium-term industry margins are likely to rise due to the increase in consolidation.

TSMC dominates the foundry market and benefits from the same virtuous cycle that Intel demonstrated historically: node leadership generating profits that are re-invested in winning the race to the next node. The company will gain revenues from Intel and likely see rising margins driven by industry consolidation.

Summary

This case study highlights the importance of assessing the long-term prospects of an industry and the players involved. Intel is currently the dominant player in CPUs but faces significant challenges. These challenges present a significant opportunity for TSMC and Samsung Electronics.

Backward looking valuation measures do not capture structural changes. It is crucial to look at long-term valuation multiples in order to invest successfully in the semiconductor industry.

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About the Author

Richard joined Edinburgh Partners in October 2016 with eight years investment experience. He is responsible for researching the global Technology sector.

Prior to joining Edinburgh Partners, Richard worked at Moneda Asset Management in Chile, where he was a Senior Investment Analyst covering LATAM TMT, Cement, Construction and Utilities.

He began his career at Fidelity Worldwide Investment as an Equity Research Analyst, where he spent almost five years covering European Small Cap Consumer stocks and then EMEA Financials.

Richard graduated from The University of Cambridge in 2008, with a first class Honours degree in Economics. Richard is a CFA charterholder.

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