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Investment & Corporate Banking

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Digital Horizons: Technology, Media and Telecom

Redefining the Global Semiconductor Supply Chain

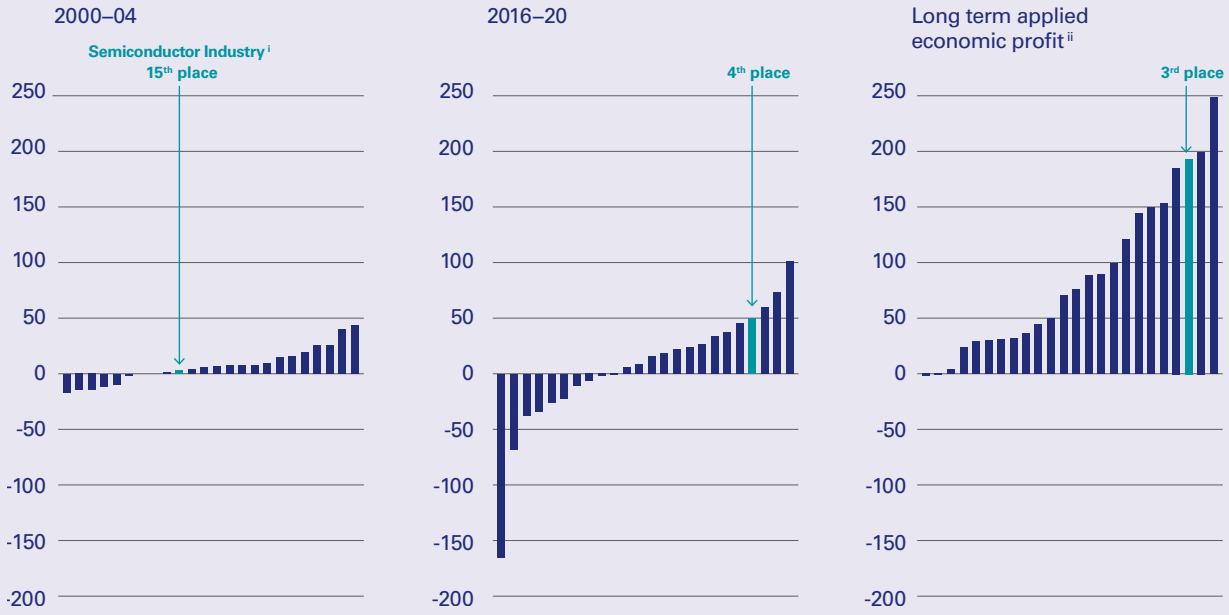
Spring 2022

Six Degrees of Separation

It's no longer "semiconductors inside"–the industry has evolved to the point that it has earned top billing in the products we use day to day. In fact, some are referring to it as the "New Oil," an essential commodity. And while semiconductors are one of the few items you can't "add to cart," they are fundamental in nearly every technology from cars to phones to robots.

When the COVID-19 pandemic struck and a semiconductor scarcity quickly followed, there was no backup plan for this tiny powerhouse. The shortage paralyzed industries across the globe leaving millions wondering: "why can't they just make more?" But semiconductor manufacturing and distribution is a multifaceted process encompassing expensive and precise creation with a limited number of suppliers, and geopolitical considerations.

In recent years, the semiconductor industry's economic profitability has improved relative to others, and this trend is expected to continue.[1]



Average economic profit (EP), by industry, $ billion (n=2,644 [iii] companies in 24 industries)

[i] Semiconductor industry's position versus other industries (based on top pure-play companies only).
[ii] Long-term-implied economic profit is based on Sept 13, 2021, market valuations.
[iii] Top publicly listed customers by revenue.

Semiconductors take center stage

Over the last 20 years, there has been a seismic shift in the semiconductor industry. Despite a slow start out of the gate with returns below the cost of capital, semiconductor profits soared in the 2010s. This was largely due to a surge in the technology sector and widespread implementation of cloud computing.

However, in 2020, COVID-19 brought sweeping changes to the semiconductor industry, creating a massive shortage and highlighting a persistent need for this technology, impacting many industries throughout the world but also spotlighting our reliance on China to provide it. Although solutions are coming online to address the shortage and the supply chain issues–such as build out of manufacturing capabilities in the U.S., resurgence of aging production, and in-house design of custom chips–implementation will take time and have financial and political ramifications.

Adding to the complexity, the ecosystem of design, fabrication, production and distribution is a web of dependencies and interdependencies that span geographic and industry lines, making companies wonder how to manage supply of this critical component. The industry is largely shifting from "just-in-time" to "just-in-case," as companies gear up to increase their orders of semiconductors to rebuild their inventory levels and buffer against future shocks and lost revenues.

[1] Source: Mckinsey Strategy Practise and Corporate Performance Analysis

Technology chokepoint: supply chain issues and shortages

Prior to the COVID-19 pandemic, many have not been aware of the semiconductor "supply chain" and the increasing role semiconductors play in the technology and automotive sectors. During the pandemic, semiconductor sales surged,[2] growing 30% between August 2020 and August 2021. Some of the growth was destined to happen, with semiconductors becoming ubiquitous in many essential products. But the industry did not predict the demand for work from home technology, solutions for lockdown boredom (like the Nintendo Switch) and the quick shift to e-commerce.

For years, users of semiconductors relied on a small amount of "top of the pyramid" suppliers, including Intel, Samsung and Taiwan Semiconductor. But the pandemic alerted consumers and the government alike, to how sensitive semiconductor technology actually is. Many products cannot be made without semiconductors, including mobile phones, digital notebooks, servers, automotive components, smart home appliances, games, wearables, and Wi-Fi access points. This affects dozens of industries, and in addition, geopolitical concerns with countries like China puts supply reliance on shaky grounds. The U.S. imposed sanctions on Chinese companies further jeopardizing the supply chain, with the U.S. unable to fill the manufacturing need. Additionally, it became clear that one chokepoint could halt the full production process, as evidenced through several instances over the last couple of years where entire categories became scarce due to a single sell-out.

Which technologies rely on semiconductors?

Wireless Devices

Automotive Products

Artificial Intelligence

Consumer Electronics

Robotics

Cloud Computing

Durable Appliances

And many others

> During the pandemic, semiconductor sales surged,[2] growing 30% between August 2020 and August 2021."

[2] Source: https://www.semiconductors.org/global-semiconductor-sales-increase-29-7-year-to-year-3-3-month-to-month-in-august/

Buy local: regionalized and nationalized manufacturing buildout

2021 has brought legislation with $50 billion allocated to build out semiconductor manufacturing in the U.S. This may seem like a drop in the bucket when the average facility buildout costs $10 billion. However, the goal was to secure multi-year investments from manufacturers. The U.S. will be chasing countries like China and South Korea, who have pledged $1.4 trillion and $450 billion respectively, to continue development and growth. Globally, 68 new fabrication shells are currently in the works, totaling up to $385 billion worth of equipment.[3]

Semiconductor manufacturing build out in the U.S. hopes to entice technology and auto businesses to "buy local" and decrease the reliance on foreign suppliers of semiconductors. This includes intentions to diversify leading-edge capacity in order to reduce risk, which has compelled manufacturers such as Intel and Taiwan Semiconductor to build facilities in Texas and Arizona, with staunch U.S. government support. This plan also calls for export controls that would "protect U.S. national security interests by limiting advanced semiconductor capabilities in countries of concern."[4] In the U.S., aging factories that have slowed production are ramping up again. This has placed them in positions of power where they may hold a key to filling in some of the shortage gaps while new factories are being built.

Additionally, some companies that require semiconductors for their own products, like Microsoft and Apple, are trying their hand at designing a proprietary blueprint for which they would outsource manufacturing. They're not aiming to replicate the standard design – instead designing custom chips that fit into their applications specific requirement, creating a uniqueness that could give them a leg up on the competition.

What has this meant for deal-making?

M&A actively has dominated the semiconductor industry, which topped $118 billion in 2020[5] and $59 billion in 2021.[6] This year, 2022 has already kicked off with big announcements including AMD's $35-billion-dollar acquisition of Xilinx, a company that produces programmable semiconductors, including FPGAs (field-programmable gate arrays) and ASICs (application-specific integrated circuit) as well as Intel's acquisition of Tower Semiconductor for $5.4 billion, pending regulatory approval.

But even with these unprecedented numbers, geopolitical concerns have had major implications on the ability to enact M&A transactions. As consolidation has accelerated and M&A volume has increased, supply chain struggles and regulatory uncertainty are pushing investment back into the U.S. and Europe.

Nvidia's proposed purchase of Arm in 2020 was poised to be the largest semiconductor deal in history. However, the Federal Trade Commission has voted unanimously to block the merger, claiming that the deal "would distort Arm's incentives in chip markets and allow the combined firm to unfairly undermine Nvidia's rivals."[7]

Nvidia is not the first semiconductor deal that has attracted government scrutiny. Several international semiconductor deals have been blocked by government entities, including the Broadcom acquisition of Qualcomm, the Qualcomm bid for NXP, and Wise Road's deal with Magnachip.

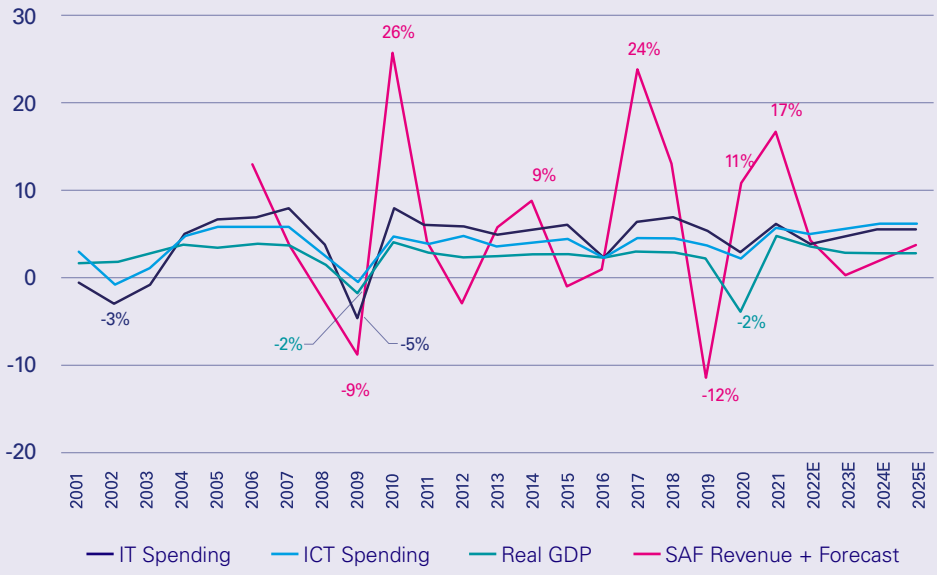
[3] Source: https://www.fool.com/earnings/call-transcripts/2022/02/16/applied-materials-amat-q1-2022-earnings-call-trans/
[4] Source: https://www.washingtonpost.com/business/on-small-business/biden-will-need-more-than-52-billion-for-chip-effort/2021/06/09/0f4ebffc-c91b-11eb-8708-64991f2acf28_story.html
[5] Source: IC Insights. Data as of 12/31/2021.
[6] Source: Dealogic. Data as of 12/31/2021.
[7] Source: https://www.ftc.gov/news-events/press-releases/2021/12/ftc-sues-block-40-billion-semiconductor-chip-merger

Growth in the semiconductor market

Current market

- Global economy on solid footing
- Increasing DRAM and NAND pricing
- 5G mobile phone replacement cycle
- Rebound high-performance computing and PCs
- Strong edge device demand
- Shortages in older nodes
- Shortages in automotive
- Manufacturing capacity additions limited

IDC Semiconductor Application Forecaster July 2021 • IDC Worldwide Black Book February 2021, growth in constant currency: "IT Spending" excludes telecom spending buisness services and emerging technologies (IoT sensors and connectivity, drones/robots, 3D printers, AR/VR viewers, next-gen security, OT software services)



Outlook for 2022 and 2023: Light at the end of the tunnel?

Data released by IDC[8] shows the semiconductor market poised to grow by 17% in 2021 versus 11% in 2020. Normalization and balance is expected by the middle of 2022, with a potential for overcapacity in 2023 as the expansions that kicked off in 2021 begin to come online towards the end of 2022.

With the current shortage, demand is at a high, and manufacturers are gearing up to fill that level of need. However, as the backlog is caught up and demand decreases, there is a possibility of surplus as the supply surpasses the need in late 2022 and 2023. By that time, other issues aside from the shortage may have been addressed. The U.S. conceivably will no longer have to rely as much on foreign manufactured supplies of semiconductors, and American manufacturing will be boosted by the new semiconductor facilities. This will also be a turning point in international politics, as countries begin to be self-reliant when it comes to the creation of semiconductors.

[8] Source: https://www.idc.com/getdoc.jsp?containerId=prAP48247621

> Innovation and production in the U.S. could not only reduce reliance on other countries but keep American companies from being absorbed by offshore entities."

Looking deeper: the expanse of the semiconductor supply chain

The complexity of the semiconductor supply chain is unlike any that have been seen before. The current shortage and bottlenecks have in part been created by the "fab-less" manufacturing, which disconnects the seller from the creation by several degrees. Manufacturing, assembly and brand are all separate, with many domestic companies having foreign supply chains, and vice versa.

U.S. Commerce Secretary Gina Raimondo has continually pressed on the issue of manufacturers providing more information, stating that more clarity "will give us more information about the supply chain, and the goal is to increase transparency so we can try to identify where the bottlenecks (are) and then predict challenges."

Historically, supply chains were merely a factor of domestic manufacturing. But now due to their complexity and degrees of separation, they have become geopolitical. As government and companies have realized the extent of the semiconductor supply chain and its geopolitical considerations, the desire to keep things "close to home" has increased. Companies headquartered in the U.S. have become motivated to secure their supply chain by establishing fabrication processes within the country. Innovation and production in the U.S. could not only reduce reliance on other countries but keep American companies from being absorbed by offshore entities.

Next steps: how can management teams move forward?

So how should companies de-risk their dependency on this critical technological component? The answer lies in carefully understanding the players in the supply chain and identifying problem areas to keep the operation running. While it might be ideal to take a page from the Microsoft or Apple playbook and try your hand at developing a solution in-house, many could untangle the supply web by working closely with manufacturing partners and not leaving the chain to manage itself.

Beyond the Obvious Takeaways

1. Alternate technologies: looking beyond silicon

With the chip shortage crushing industries across the world, alternative technologies are being explored. One option is quantum computers, which are already in the works at Google, IBM, Intel and several start ups. These computers will be driven by quantum physics, which will provide amazing processing power; however, development progress has been slow. Graphene and carbon nanotubes, which are strong and easy to fabricate, have promise, but they rely on the success of quantum computing in order to function. Nanomagnetics are the most encouraging as a replacement, as they work similarly to silicon-based semiconductors, just using switching of magnetization states instead of transistors.

2. Securing the supply chain

In order to even begin securing the supply chain, companies need to challenge their thinking on procurement: Who is designing? Who is creating? Who is branding? Until there is a full understanding of the depth of the supply chain, there is no chance of having control of it, and shortages and issues will continue to persist. If companies cannot identify, measure and manage the various pieces and players in their supply chain, they will be challenged to secure it. There is likely to be a major shift to long-term supply agreements, a co-investment strategy where semiconductor manufacturers agree to build new capacity if customers commit to buying.

3. Looking towards the problems of the future

When the semiconductor shortage came to light, the focus was on making the supply chain more stable and resilient in the future. But that goal was shifted as desperation for the technology grew and an immediate solution to the demand was needed. But now that a plan is laid out for solving the immediate shortage, government and the private sector need to jointly focus on the future. Even with solutions over the next year or two, the cross-border and politically-influenced issues will persist. Policymakers could offer incentives to businesses to map their supply chains and ensure reliability and strength. Continuing to boost investment in U.S. capabilities would provide stability to the chain.

Look Beyond the Obvious

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