COGNIZANT

2ND QUARTER 2021

WHEN THE CHIPS ARE DOWN:
UNDERSTANDING THE SIGNIFICANCE OF THE GLOBAL SEMICONDUCTOR INDUSTRY

TSMC
A TALE OF PAST SUCCESS, CURRENT EXCELLENCE AND FUTURE RISK

NVIDIA
GAME, SET, MATCH

INTRODUCING OLD MUTUAL WEALTH ESG RATINGS

OLDMUTUAL WEALTH

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INTRODUCTION

CHRIS POTGIETER, MD: OLD MUTUAL WEALTH TRUST COMPANY (PRIVATE CLIENT SECURITIES | TREASURY AND ADVISORY SERVICES | FIDUCIARY SERVICES)

The global recovery continues to gather momentum and we believe that it is likely to play out over the next few years, fuelled by a number of key factors. Economic growth – particularly in developed markets – has been exceptionally strong and is accelerating, supported by widespread vaccination roll-out programmes, rising consumer spending and investments in essential infrastructure. Developing markets are set to follow. Although there are fears of rapidly rising and sustained inflation and the commensurate tightening of global monetary policy, we find these concerns to be overblown. While inflation is likely to increase from depressed levels, we do not expect double-digit or even high single-digit inflation figures to be sustained over the next few years. The base effect of low product and services prices in 2020-21 will distort inflation numbers. This means that reported inflation in the next year will be large because of price recovery from depressed levels. Given that the US Federal Reserve – and other major central banks – have signalled their intention to manage monetary supply for an extended period to ensure a sustained economic recovery, we believe that interest rates and liquidity conditions will remain accommodative for the foreseeable future. A further moderate rise in interest rates is to be expected and even welcomed.

Another key factor fuelling the global recovery is earnings growth. The US quarterly reporting season has just concluded and a large number of US companies across various sectors reported exceptionally strong earnings growth. Furthermore, many companies have revised their growth forecasts upwards for the next few years, clearly indicating a more positive outlook. This aligns with higher inflation expectations in the short to medium term. The other side of the argument is that rising inflation and interest rates could place pressure on company valuations (P/E multiples). Given how well markets performed over the last year, company valuations are indeed elevated. When economic growth is scarce, as it was in 2020, investors are more willing to pay higher multiples for fast-growing companies. With growth now broadening, we are seeing pressure on the valuation multiples of those companies, such as technology leaders that performed strongly last year. We have already witnessed this, and the trend may persist for some time. However, many of these companies have tailwinds that span into the next decade and we would expect them to remain highly valued in the medium to long term. Looking to the near term, it is worth noting that any setbacks in vaccine developments and new, more severe COVID variants could place a damper on the global recovery currently underway.

The bottom line is that the world is recovering from a traumatic event that impacted society and economies on many levels. The recovery is underway, but will not be smooth. Investors need to take a longer-term perspective so as not to make short-term missteps. Remain selectively invested and appropriately diversified.

On that note, I'm pleased to present our latest Cognizant, where we share our views on investments with you. The global semiconductor chip shortage has been highly topical over the last few months. These chips are effectively the "brain" within every electronic device and given our increasing dependence on technology, the chip shortage is having far reaching implications for many industries. Our feature article provides an overview of the semiconductor industry and the different dynamics at play. The industry as a whole is set to continue its robust growth, and as such, we believe it presents an exciting opportunity for investors.

We then look at one of the main players within the semiconductor industry, Taiwan Semiconductor Manufacturing Company (TSMC). The company is the world's top microchip manufacturer, boasting a global market share of over 50% of the highly competitive global electronics manufacturing industry. Our article unpacks how this exceptional feat was achieved and, more importantly, how it is being maintained.

We then turn our attention to another chip manufacturer, NVIDIA, whose chips provide considerable processing power to devices, allowing them to render crisp, smooth and more realistic graphics. The company is the leader in the field of visual computing and has conquered the global gaming market. Our article gives some insight into the next key areas of growth for the business, namely automotive, cloud computing, data centres and Artificial Intelligence.

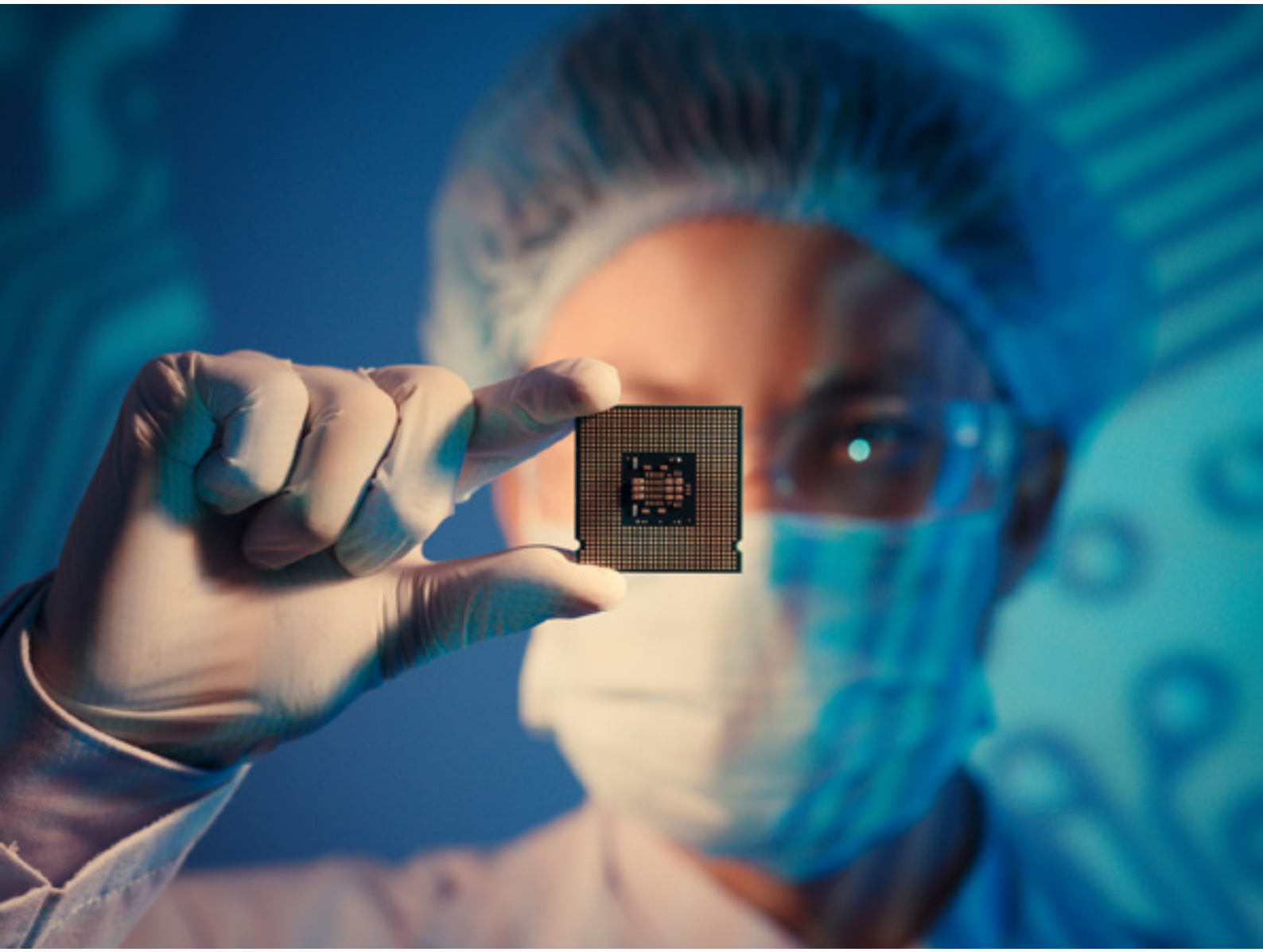
I trust that you will enjoy this issue.

All the best,
Chris

WHEN THE CHIPS ARE DOWN

UNDERSTANDING THE SIGNIFICANCE OF THE GLOBAL SEMICONDUCTOR INDUSTRY

ANDREW DITTBERNER, CHIEF INVESTMENT OFFICER AT PRIVATE CLIENT SECURITIES



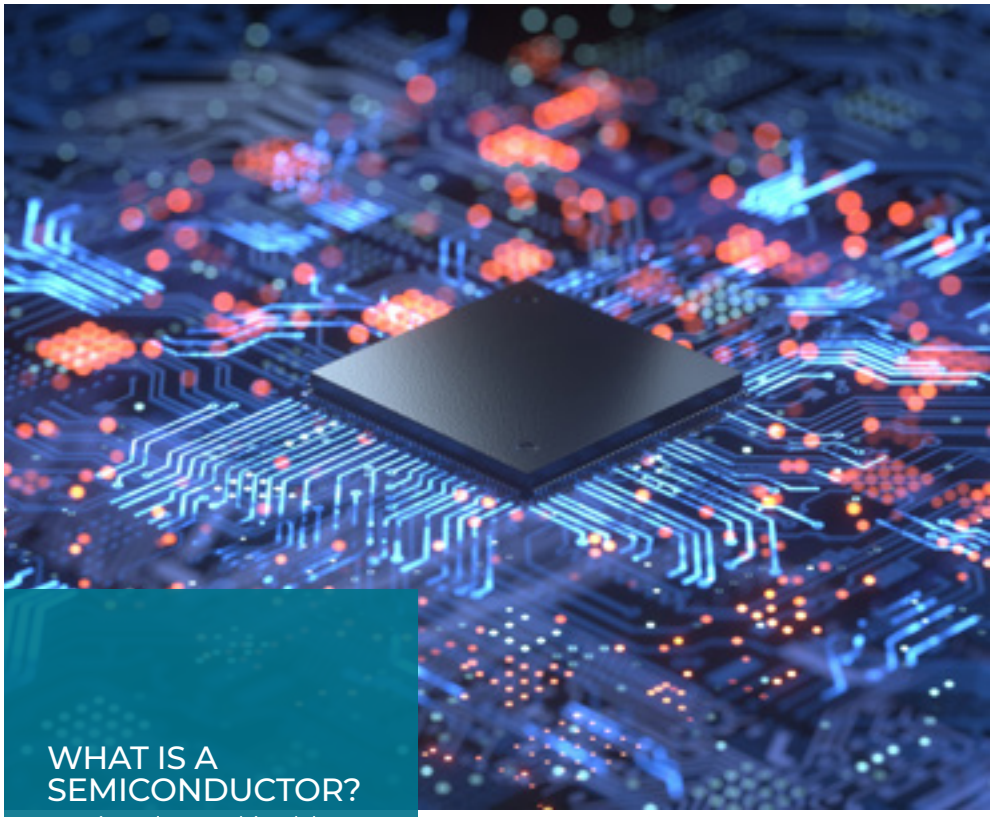
If 2021 has taught us anything thus far, then the fact that the fate of the world lies in the hands of a handful of companies should be near the top of the list. While most people were well aware of last year's highly publicised toilet paper shortage (dubbed The Great 2020 Toilet Paper Shortage), a shortage of an entirely different kind and magnitude has been brewing across the globe.

Over the past few months, the world has experienced a severe shortage of semiconductor chips. These chips are effectively the "brain" within every electronic device and given our increasing dependence on technology, the chip shortage is having far-reaching implications for many industries. So who and what has caused the current situation?

Initially, the supply shortage appeared to be temporary, as factories were forced to shut down during the mandatory COVID-19 lockdowns in 2020. However, with demand quickly recovering (driven by changing habits fuelled by the pandemic), semiconductor manufacturers have not been able to keep pace. Nevertheless, to fully understand the cause of the shortage, one needs a firm grasp of the complexity and fundamentals of the semiconductor industry.

PUTTING THE SILICON INTO SILICON VALLEY

In the late 1950s, a new industry was making its presence felt in the southern region of San Francisco. Following a short stint at Shockley Semiconductor Laboratory, Gordon Moore and Robert Noyce went on to found Fairchild Semiconductor in 1957, a division of Fairchild Camera and Instrument. Noyce expressed his belief that silicon should replace germanium as the common material used in semiconductor manufacturing. Having designed and built the first silicon integrated circuit, Fairchild Semiconductor quickly grew from 12 to 12 000 employees, and thus, the birth of the silicon wafer semiconductor chip began.



WHAT IS A SEMICONDUCTOR?

Semiconductor chips (also called semiconductors, microchips or integrated circuits) are at the heart of electrical and electronic devices and are a series of electronic circuits printed onto a conducting material, usually silicon. They form the physical building blocks used to make computers and run software. Semiconductor size (or node size) is indicated in nanometres, which refers to the size of the transistors within the chips. While chips with 14 and 10 nanometres are currently in mass production, the industry continues to aim for smaller chips, which can be placed almost anywhere. Over the years, chip designers have managed to squeeze more and more transistor circuits into smaller spaces, making devices exponentially faster and cheaper.

However, growing restless on the back of their belief that Fairchild was not reinvesting enough of the proceeds from the highly profitable semiconductor business into research and development of new technologies, Noyce and Moore resigned in 1968 and later that year founded their new company, Intel. Unsurprisingly, continued innovation was a fundamental component of Intel's culture from the very beginning.

After just three years of existence, Intel had already contributed several of the most important inventions of the 20th century and, importantly, became profitable. Silicon semiconductor chips very quickly found their way into everything that was computerised. Around this time, journalist Don Hoefler wrote a series about the chip industry, with each piece carrying the title "Silicon Valley

USA". Unbeknownst to Hoefler at the time, it was a name that would not only stick, but would become synonymous with innovation, with the region attracting many of the world's brightest and most curious minds.

EXTREME IMPORTANCE

Today, the global semiconductor industry has grown into a US$500bn industry, enabling us to do pretty much everything – from driving vehicles, to ordering food for in-restaurant consumption or for home delivery, from flying to another country to hailing an uber to get us to the airport, and from diagnosing and treating disease in animals to boosting agricultural yields through precision farming.

Semiconductor chips are the engine driving the technological transformation of the world. As US entrepreneur Marc Andreessen famously pointed out, "software is eating the world", and evidence of this can be seen everywhere. However, without semiconductor chips, there would be no machines to drive the information age. Nevertheless, today we find ourselves in the very precarious position of relying on just a handful of companies to meet the world's insatiable appetite and desire for ever-faster, more powerful, and smaller semiconductor chips.

FROM FABRICATION TO FABLESS

Having held the position of vice president at Texas Instruments' semiconductor business, Morris Chang, a mechanical engineer, resigned in 1983 after he was overlooked for the top job. One of his key insights that came from over two decades' worth of experience in the business was that many chip designers wanted to start their own companies, but couldn't.

Too often, common sense and common practice get muddled up. In the case of the semiconductor industry, this is exactly what happened. Prior to Morris Chang resigning from Texas Instruments, common practice in the industry was to integrate chip design and manufacturing. Given the significant costs associated with building chip manufacturing capabilities, chip designers were never able to raise sufficient capital to start their own businesses. In Chang's mind, this did not make sense, as it was a clear impediment to innovation in the industry.

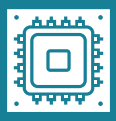
Upon leaving Texas Instruments, and after a short stint at General Instrument, Chang founded Taiwan Semiconductor Manufacturing Company (TSMC), a pure-play chip manufacturer based in Taiwan. The birth of the foundry enabled many independent chip designers to start their own businesses, leading to a burst of innovation in the industry, as a whole eco-system of companies focused solely on the design (and not fabrication) of various semiconductor chips – commonly referred to as fabless chip companies – came to life. This separation of chip design and manufacturing/fabrication effectively laid the architecture for the semiconductor industry's current structure. Understanding the difference between the various industry players (such as Intel, AMD and TSMC) and how they fit into the matrix brings clarity and understanding of the structure.

Intel has always been, and continues to be a vertically integrated business (i.e. taking control of the design, manufacturing and sales processes), which is known as an integrated device manufacturer (IDM) in the industry. While vertical integration does lead to efficiency gains due to the company

TYPES OF CHIPS

In understanding the semiconductor industry, it is important to understand the broad types of chips built from these semiconductors and their functionality.

MICROPROCESSORS



Microprocessors are referred to as central processing units (CPUs). They are the brains behind the computation happening when you run a complex programme, as opposed to one of repetition. They are ideal for powering your personal computer, server or mobile phone.

Example companies: Intel, AMD, Samsung

MEMORY (RAM)

Memory chips are those used to store data. Memory can come in the form of RAM, which is short-term memory that stores data provided the device is powered. Alternatively, there is longer-term memory, like flash storage.

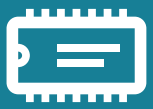
Example companies: Micron, Samsung, Intel

GRAPHIC PROCESSING UNITS (GPUS)

GPUs are responsible for the graphics that you see every time you turn a device on. GPUs power the computation required to populate each pixel on a screen. Today, GPUs are more multi-purpose than purely graphics. GPUs are efficient at powering repetitive programmes, thus making them very powerful in artificial intelligence and cryptocurrency mining.

Example companies: NVIDIA, AMD, Intel

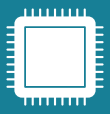
STANDARD & COMMODITY INTEGRATED CIRCUITS



- Application Specific Integrated Circuits (ASICs) are chips developed and produced for a specific application requirement. They are tailor-made to exact product requirements, reducing the need for additional components. They are costly to design.
- System on a Chip (SoC): SoCs are chips that integrate the majority of components of a computer onto a single chip. These components typically include CPUs, GPUs, primary and secondary memory, and input/output ports.

Example companies: AMD, Xilinx, NVIDIA

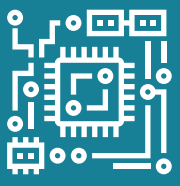
ANALOGUE CHIPS



Analogue chips connect the physical world to the computer world. Unlike digital chips that register 1 or 0, analogue chips can process gradations. Analogue chips can detect temperature, and report the health of a battery through the use of sensors.

Example companies: Texas Instruments, Analog Devices, Infineon

MIXED CIRCUIT



Augmenting analogue and standard chips, mixed circuits connect the analogue world to the digital world by converting analogue signals to digital circuits, and vice versa.

Example companies: Texas Instruments, Analog Devices, Infineon

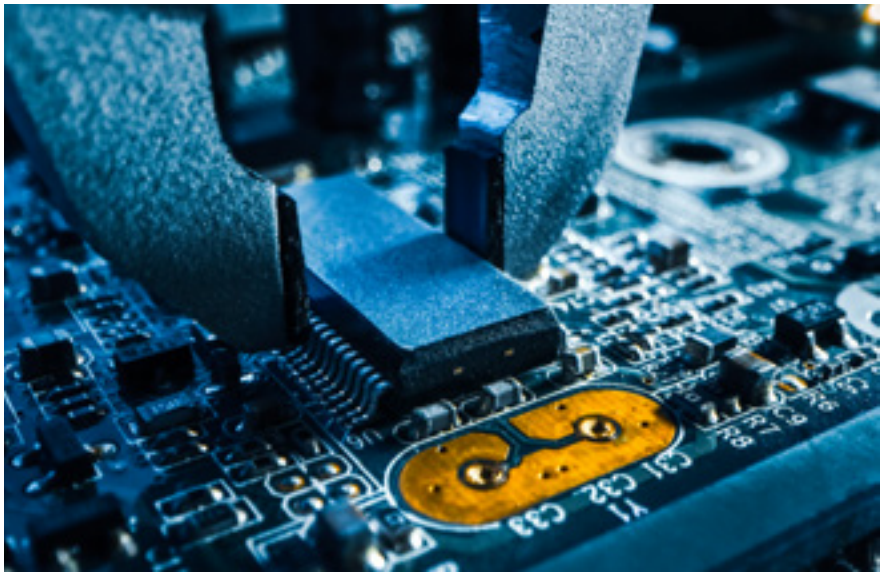
controlling the whole supply chain, from design to sales, it also leads to significantly higher costs due to the upfront and maintenance costs of a fabrication plant, as alluded to above. Conversely, AMD is an example of a business that is horizontally integrated, meaning that it relies on other fabrication companies (referred to as foundries) such as TSMC to take care of the manufacturing process.

To put the cost of manufacturing semiconductor chips versus only designing them into perspective, consider that it costs around US$5.5bn to build and equip a foundry with 5 nanometres[1] (nm) production lines. This is over three times the cost of building a foundry that runs 10nm production lines. The steep increase in cost is due to the need for greater precision in manufacturing smaller and more complex structures. In addition to upfront costs, return on investment also needs to be considered. In the case of foundries, McKinsey[2] estimates that a best case scenario, which requires a very high utilisation rate, is likely to result in positive cash flows after five years. In this way, the stakes are exceptionally high, explaining why so few companies enter the foundry market. It also then becomes clear why 53% of all third-party fabricated chips pass through TSMC.

Fabless companies, on the other hand, face far lower costs given that their expenses are predominantly related to research and development (R&D). Although costs do increase as chips get smaller, they remain far more affordable. To illustrate the point, the entire process of designing a 5nm chip costs around US$540m. Similar to the fabrication production line costs, this is about three times the cost of designing a 10nm chip.

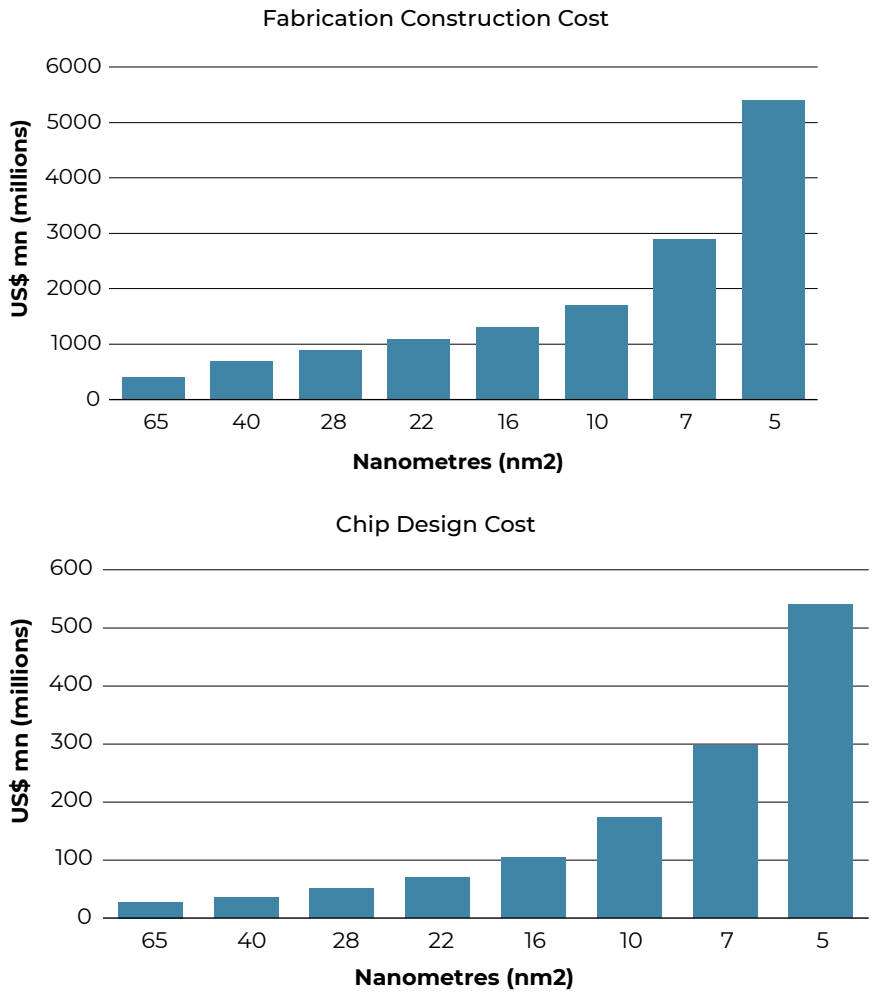
As the global demand for faster, more powerful and more energy-efficient semiconductor chips grows, both the R&D costs and the upfront fabrication costs are expected to increase exponentially. Graph 1 shows the increase in the upfront cost of design and fabrication of various semiconductor chips.

Outside of fabless and foundry businesses, there are also periphery businesses that supply equipment and materials to the industry, as well as those who test the chips and assemble the final products.



[1] Nanometres refer to the length of a transistor gate. Today the reference no longer refers to size but rather to the operational ability.
[2] McKinsey & Co, Aug 2020, Semiconductor design and manufacturing: Achieving leading-edge capabilities

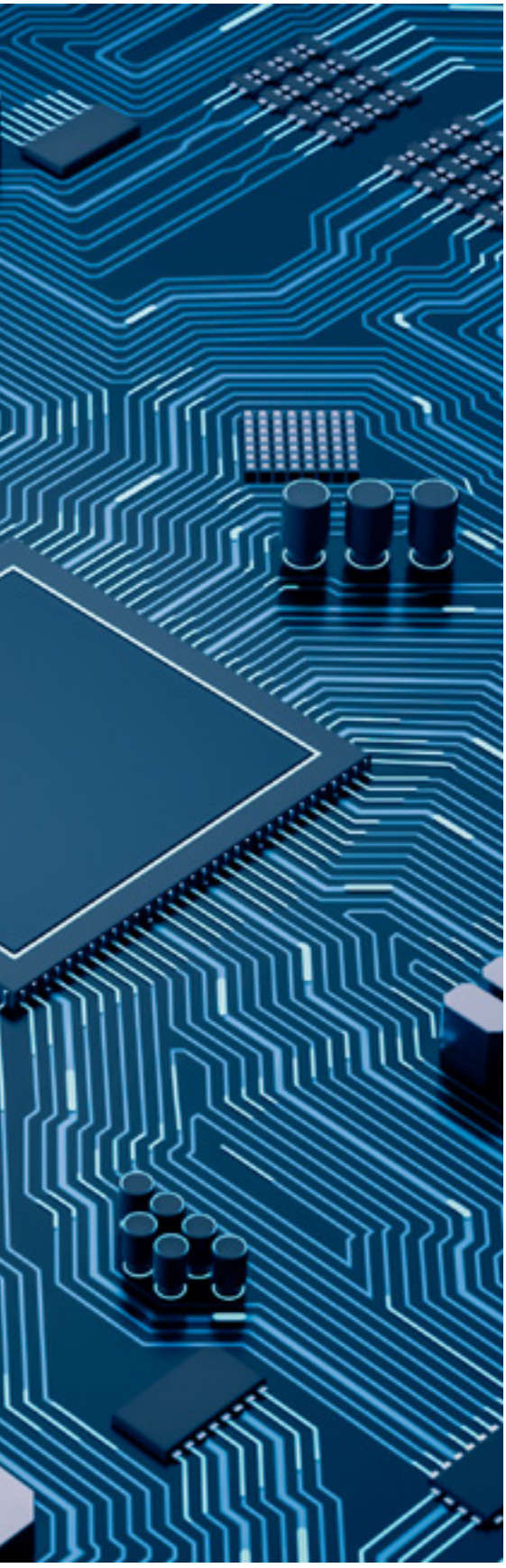
Graph 1: Semiconductor R&D and fabrication upfront costs



INDUSTRY CONSOLIDATION

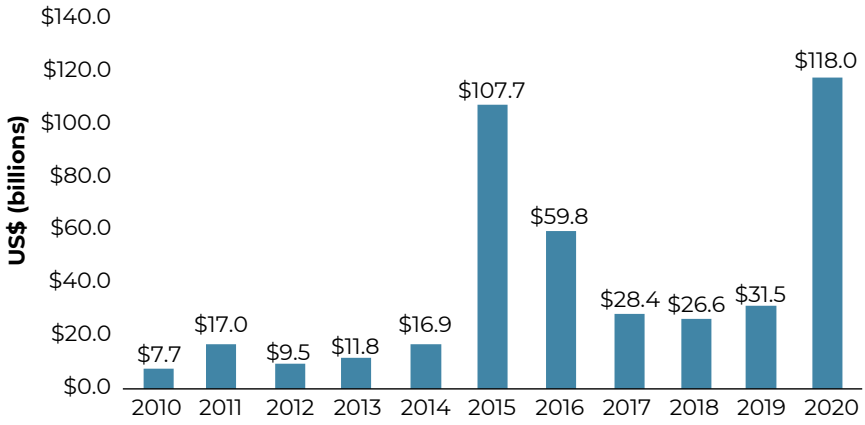
Increasing complexity around the design and fabrication of semiconductor chips has led to the number of key players within the industry reducing. This trend gained significant momentum after the 2008/2009 Global Financial Crisis (GFC). Hock Tan, long-time CEO of Avago (now Broadcom), saw an opportunity to purchase under-appreciated assets at bargain prices. Not only did Tan see the opportunity in buying the assets, but he also noticed that many businesses were poorly managed. Therefore, upon purchasing businesses, he quickly sold off underperforming divisions while investing in highly profitable franchises. In 2008, Avago acquired German-based semiconductor manufacturer Infineon Technologies, a spinoff from Siemens AG. Avago's penultimate acquisition transpired in 2015 with the purchase of Broadcom for US$37bn. At the time, this represented the largest semiconductor deal and the combined entity began to operate under the Broadcom name. Having spent over US$50bn on acquisitions, Tan took Avago from being a niche supplier of wireless technology to being the industry leader in wireless, networking and data centre solutions.

Merger and acquisition (M&A)



activity within the semiconductor industry rapidly gained momentum from 2010 and peaked in 2015 as companies saw the need to increase scale and returns in order to survive. As shown in graph 2, M&A activity in the industry appears to be gaining traction once more. At present, NVIDIA is in the process of acquiring Arm Holdings for US$40bn; Maxim Integrated Products is being acquired by Analog Devices for US$21bn; AMD is acquiring Xilinx for US$35bn; and Intel's NAND memory chip business is being acquired by SK Hynix for US$9bn. Adding a number of smaller acquisitions to the tally, 2020 has exceeded the 2015 record-breaking year in terms of semiconductor M&A agreements[3] concluded in a single year.

Graph 2: The value of semiconductor M&A agreements



Source: IC Insights

THE WINNER TAKES IT ALL

In addition to being able to purchase undervalued businesses at record-low interest rates, one of the major drivers that led to Tan embarking on his M&A activity was the reduction of the industry's traditional cyclicality. Historically, demand cycles were largely dependent on new releases of Windows operating systems and mobile phone releases. However, Tan identified many other uses for chips with the early onset of Artificial Intelligence, cloud computing, the Internet of Things and the imminent explosion of mobile devices and smart phones. This insight allowed him to be ahead of the pack as the cyclicality all but disappeared over the years.

Over the past decade, technological advances have led to ever-increasing demand in complexity when it comes to the design and manufacturing of semiconductor chips. On the back of Morris Chang's (CEO of TSMC) insights, companies started to focus on specific chip design, or a specific part of the supply chain. And as complexity continues to soar, so too has specialisation. This has resulted in just a handful of companies being able to produce the most advanced chips that have node sizes of 14nm and below. Consequently, these companies have captured a large portion of the market, leading to a winner-takes-it-all dynamic in the industry.

[3] While all the agreements have not been concluded, they are expected to close this year.

According to a McKinsey & Co study[4] from 2015 to 2019, the five companies with the largest average annual profit (Samsung, Intel, TSMC, Qualcomm and Apple) had a larger combined annual profit than the other 249 semiconductor companies included in the study. Apple may skew the study somewhat, given that it is not a pure-play semiconductor business. Apple has a diversified revenue stream; however, they are included in the semiconductor industry given that they design their own chips.

COUNTRIES START TO BUILD SCALE

Competitive advantages are built on the back of specialisation, but simultaneously, supply chain interdependence and complexity also becomes increasingly entrenched. Today, no company nor region has the ability to offer end-to-end semiconductor design and manufacturing. As a result, supply chain disruptions are a serious cause for concern. For this reason, countries and regions are planning substantial capital outlays to bulk up their semiconductor design and manufacturing capabilities. In addition to avoiding production bottlenecks, this will also ensure that the valuable intellectual property – and, consequently, national security – does not leave a country or region as the product goes to the next port of call in the supply chain.

Graph 3, which provides a breakdown of the semiconductor value chain and the various regions' share thereof, clearly shows how certain countries dominate in different areas of the supply chain. Taiwan is the market leader in the pure-play foundry and assembly, testing and servicing markets, while the US is the leader in design and IDMs.

WHAT'S DRIVING DEMAND?

Looking ahead, the insatiable demand for semiconductor chips is being fuelled by three clear factors:

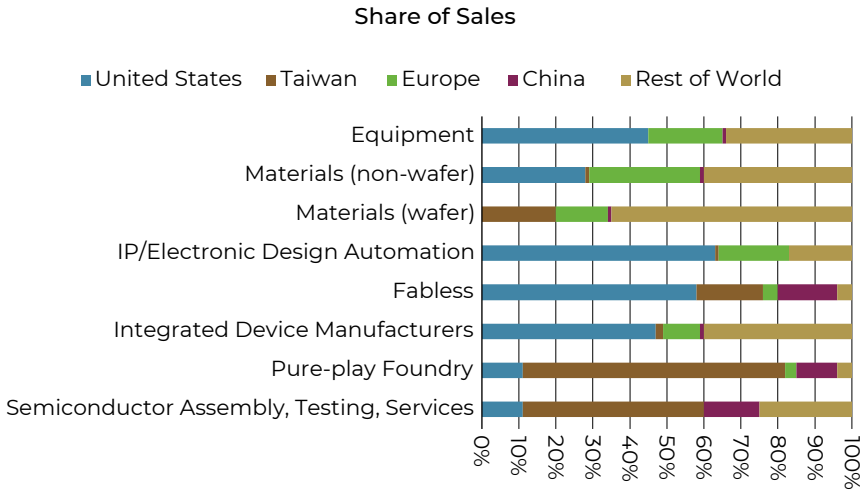
- **The need for cloud datacentre processing power.** As computers, programmes and applications move to the cloud and require more processing power, the demand for not just more, but also more powerful chips, accelerates.
- **The move to mobile.** As we become more mobile, the demand for smaller, more powerful and more energy-efficient chips increases. This will be further augmented by the onset of 5G, which leads to the third driver.
- **The Internet of Things (IoT).** The IoT enables Machine Learning and Artificial Intelligence fuelling a host of industries. With the need to have everything connected and smart, from your TV to your fridge to the family motor vehicle, all these objects require ever more powerful chips.

ADDRESSING THE CHIP SHORTAGE

Given that demand for semiconductor chips is set to accelerate in the years ahead, it is key to understand the cause of the current shortage to ensure that similar issues do not recur. Fortunately, a step in the right direction has already been taken and significant capital expenditure plans have been put on the table by a number of companies. Importantly though, these capital expenditure plans expand geographies, ensuring a less concentrated supply chain, which should lower the probability of future shortages. Examples of these projects include TSMC's US$12bn plan to build a 5nm foundry in Arizona, and Samsung's US$10bn plan to build a similar facility in Austin, Texas.

Given that around 60% of the world's semiconductors are currently manufactured in the Asia Pacific region, significant geopolitical risk resides within the supply chain and this would have been amplified by US-China trade tensions. Compounding

Graph 3: Regional Exposure to the Value Chain



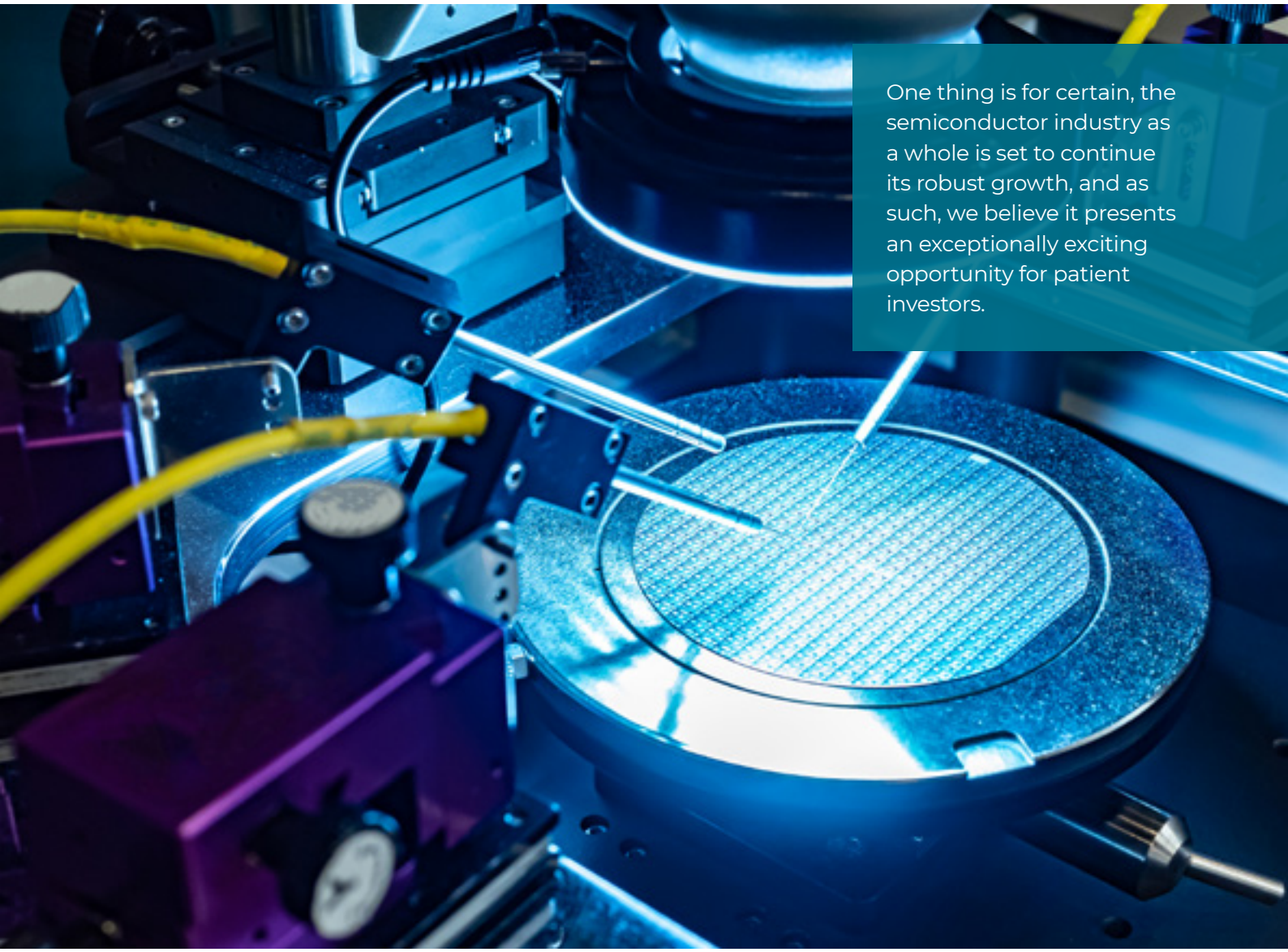
Sources: Gartner; IHS; Strategy Analytics; McKinsey

[4] McKinsey & Co, Aug 2020, Semiconductor design and manufacturing: Achieving leading-edge capabilities

this is the fact that over the past year, many manufacturers curbed supply to certain industries in order to keep pace with demand from other industries. As an example, smartphones, tablets and gaming devices were prioritised through 2020 as demand surged, at the expense of automakers. Further supply issues were prevalent last year, with many plants being shut down due to COVID-19. And while the supply constraints persisted through the year, demand increased sharply as people worked from home, children were home-schooled and demand for everything digital spiked.

ROBUST GROWTH EXPECTED

The semiconductor industry is complex to navigate and from an investment perspective, there are many different dynamics that need to be taken into consideration. These include which part of the supply chain and then which companies within that sector to invest in. Each company is differentiated by its products, with no two companies producing the same products for the same use case. Within the PCS Global Equity Model Portfolio, we are invested in the iShares PHLX Semiconductor Exchange Traded Fund (ETF). Given the above backdrop, which includes a complex industry with significant corporate action taking place, identifying a single company that will be a major beneficiary over the long term is incredibly difficult. However, through the ETF, the portfolio has exposure across the value chain and across all types of companies and chips.



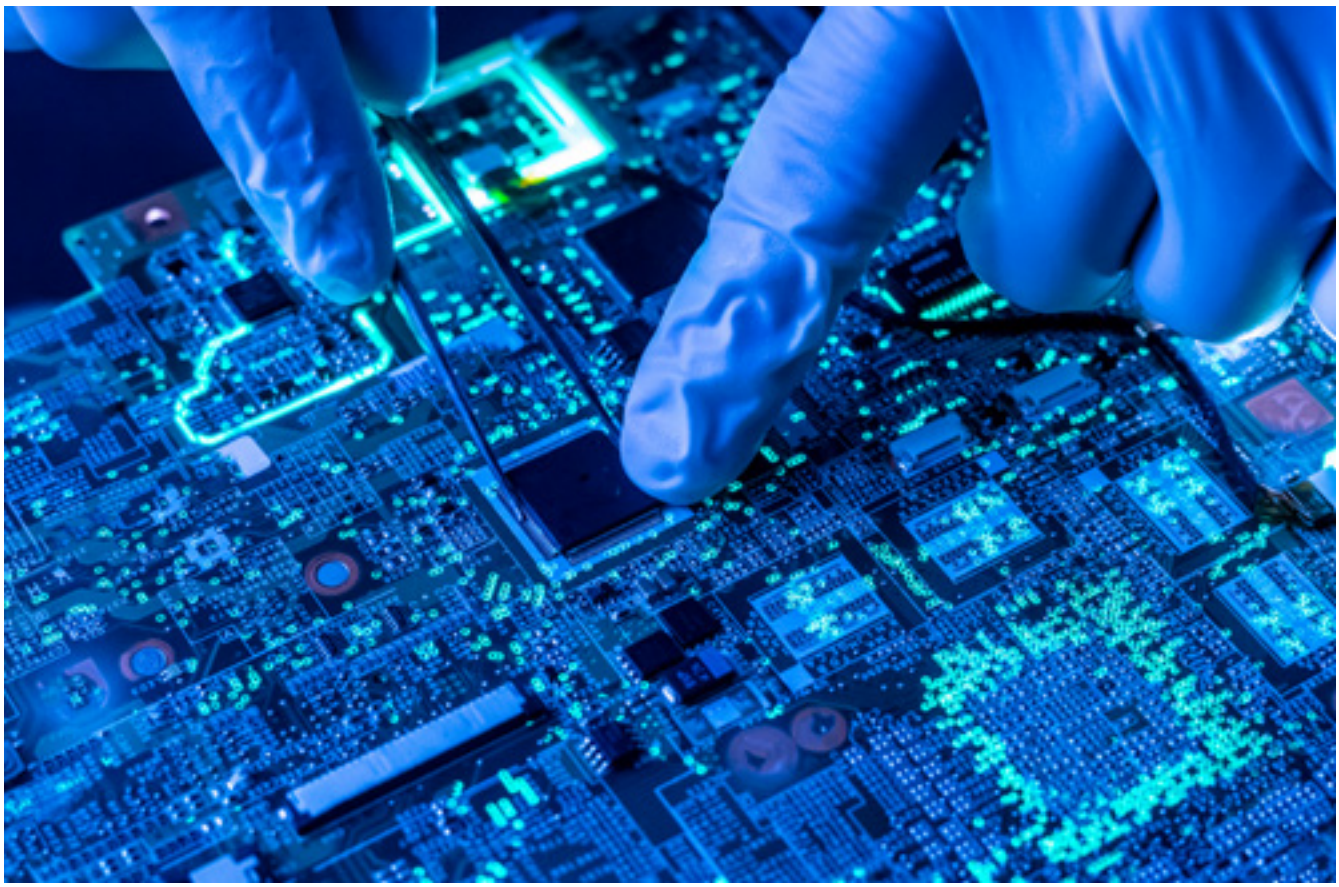
One thing is for certain, the semiconductor industry as a whole is set to continue its robust growth, and as such, we believe it presents an exceptionally exciting opportunity for patient investors.

TSMC

A TALE OF PAST SUCCESS, CURRENT EXCELLENCE AND FUTURE RISK

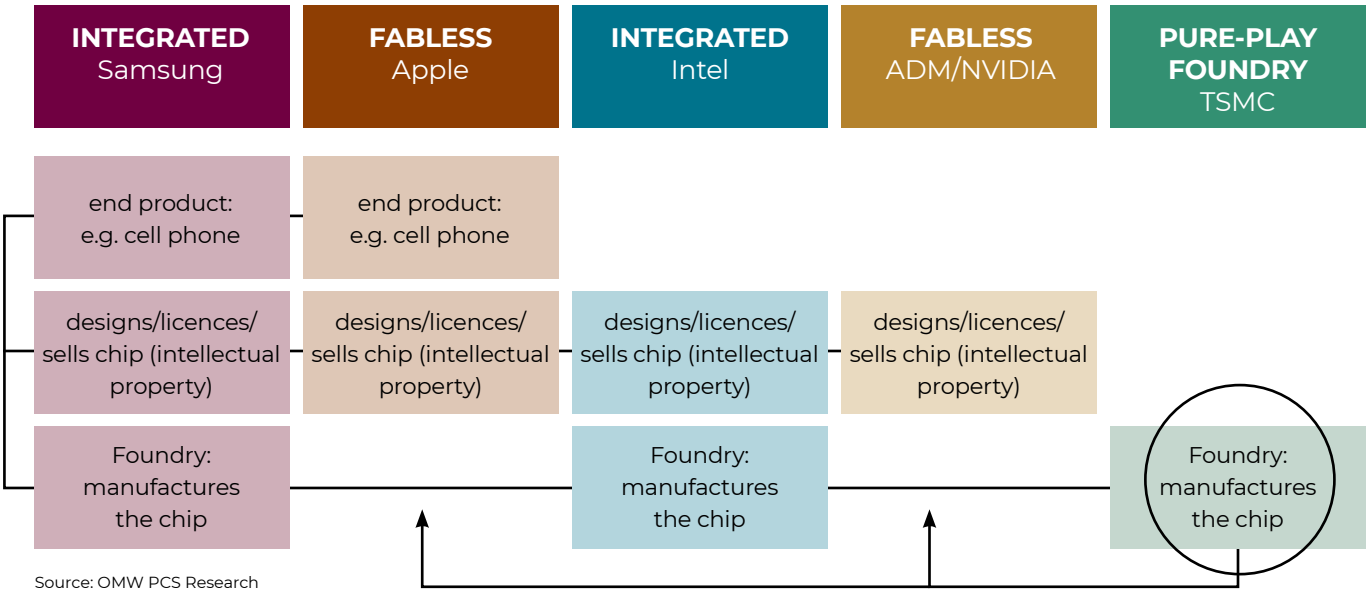
VICTOR MUPUNGA, RESEARCH ANALYST AT PRIVATE CLIENT SECURITIES

In any industry, it is rare to come across a company that boasts a global market share of over 50%. Whenever one encounters such an anomaly, particularly within a competitive industry such as electronics manufacturing, it is worth exploring how this exceptional feat was achieved and is being maintained.



For Taiwan Semiconductor Manufacturing Company (TSMC), it all started by "walking the path least travelled" when the business pioneered its own operating model in the early 1990s. At a time when microchips were produced in-house by giant integrated device manufacturers like Intel Corporation, TSMC's novel concept was to operate a dedicated foundry that produced chips for all semiconductor companies. By separating the manufacturing step from the rest of the chip-making processes (design, marketing and the building of end products, e.g. cell phones), TSMC not only created a niche for itself, but sparked a boom of microchip companies that participate in every step of the chip-making process, except manufacturing , which they outsource to TSMC.

The Microchip Product Life Cycle



Source: OMW PCS Research

IT TAKES AN ISLAND

A number of factors were critical to the early success of TSMC, with the catalytic role played by the Taiwanese government in establishing the industry in the late 1970s being key. The government set up self-funding research centres, invested in microchip start-ups and persuaded banks to also put up money at a time when private investors were reluctant to back the nascent industry. This supportive role effectively laid the foundation for Taiwan's current status as being home to many of the world's most technologically advanced microchip companies. Indeed, two of the three largest manufacturers (TSMC and UMC) and the fourth largest chip designer (MediaTek) all originate from the island.

Shortly after its inception in the early 1990s, the backing of TSMC's largest shareholders (the government and Philips Electronics with a combined 49% shareholding) afforded the company the opportunity to build what was then already regarded as the world's best foundry. The group's early success in overcoming what remains one of the most prohibitive barriers to entry – high upfront capital requirements – enabled TSMC to quickly grow market share and dominate as the world's top microchip manufacturer. Decades later, TSMC has not relinquished this title, as its substantial capital and research and development (R&D) spend continues to drive innovation which attracts the best customers.

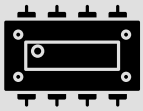
In this way, a virtuous cycle that fuels the group's profitability has been established.

A WIDENING MOAT

To fully appreciate TSMC's enduring dominance, it is important to understand the prohibitive upfront costs of building a foundry, which is a requirement for any advancement in microchip technology. The accompanying image depicting the microchip launch timeline shows some of the microchips that have been designed and manufactured since 1971. Each new chip brings an improvement in processing power, energy efficiency, performance (faster) and size (smaller), which benefit the devices they power.

MICROCHIP LAUNCH TIMELINE

SEMICONDUCTOR MANUFACTURING PROCESSES



- 10 µm – **1971**
- 6 µm – **1974**
- 3 µm – **1977**
- 1.5 µm – **1982**
- 1 µm – **1985**
- 800 nm – **1989**
- 600 nm – **1994**
- 350 nm – **1995**
- 250 nm – **1997**
- 180nm – **1997**
- 180nm – **1999**
- 130 nm – **2001**
- 90 nm – **2004**
- 65 nm – **2006**
- 45 nm – **2008**
- 32 nm – **2010**
- 22 nm – **2012**
- 14 nm – **2014**
- 10 nm – **2017**
- 7 nm – **2018**
- 5 nm – **2020**
- 3 nm – **2022**

Source: OMW PCS Research

In 2015, six firms were able to manufacture the 14nm[1] chip. Since then, the growing cost of chip innovation, coupled with technical hurdles, has seen most of these firms abandoning their plans to remain industry leaders. Today, only two firms – TSMC and Samsung Electronics – produce 5nm chips.

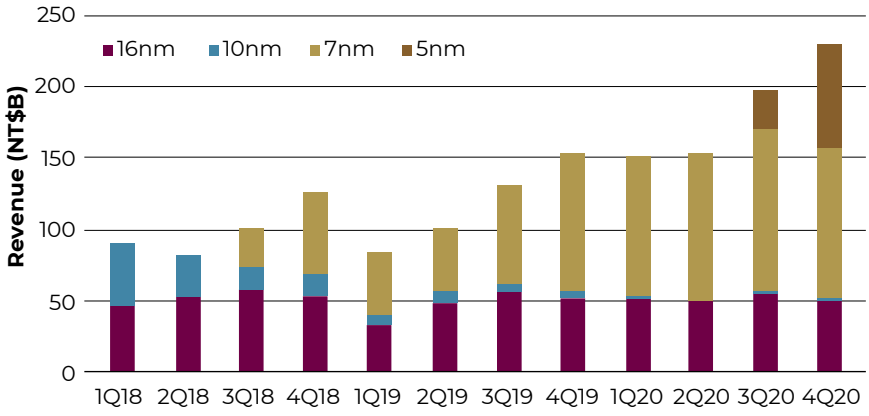
In a bid to expand its 5nm capacity, and to somewhat appease its US customers, TSMC plans to build a foundry in Arizona at a cost of US$12bn. This is part of the group's enormous US$28bn capital expenditure budget for 2021 – 80% of which will be spent on cutting-edge technology such as 5nm and 3nm chips. In our view, this clearly highlights the first two steps of the group's powerful virtuous cycle – significant investment spend that drives innovation. Graph 1 shows how TSMC's revenue mix continues to shift towards the latest microchip technology.

TAKING STRIDES TO DIVERSIFY

TSMC's leading technology and focus on high-end products have assisted the group in building a solid customer base in multiple subsectors, like Apple in mobile chips, NVIDIA in graphic processors and Xilinx in reprogrammable chips. Because of the critical role that TSMC plays in enabling product development within its customers' businesses, their customers are willing to share detailed roadmaps of their future plans, which enables TSMC to better serve them. In this way, the group is regarded as an independent partner rather than a supplier by its clients. This foundation of trust with a wide range of industry customers is valuable.

Although the group works closely with its clients to further their individual objectives, TSMC's R&D and capex efforts ultimately extend across various clients and industries. The latest 5nm chip that began mass production in 2020 is a great example of this. Largely due to manufacturing capacity constraints, Apple currently pays a premium for being the first to use the chip in its latest iPhones and iPads. As capacity ramps up and 5nm prices decline, TSMC's customers in other industries (i.e. automotive, data centres, servers and personal computing) will also use the technology. Graph 2 shows the revenue contribution and growth within each industry segment. The continuing

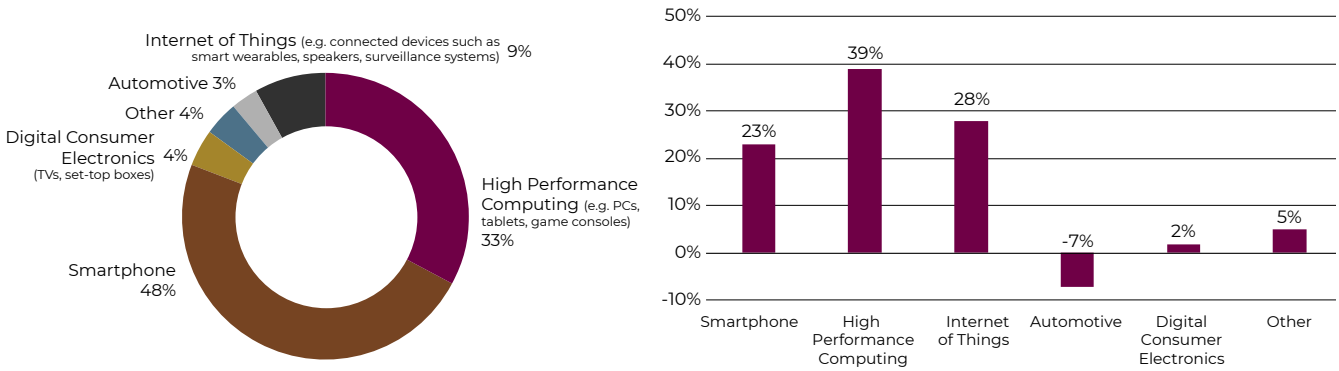
Graph 1: Revenue contribution from 16nm chips and below



Source: Company reports

[1] Nm (nanometre) refers to the size of the transistors inside the chips. The smaller the transistors, the more of them you can pack inside a chipset, which naturally improves performance per square inch. Smallness enables the design of ultra-tiny chips that can be placed almost anywhere.

Graph 2: Revenue contribution and growth per segment in 2020



Source: Company report

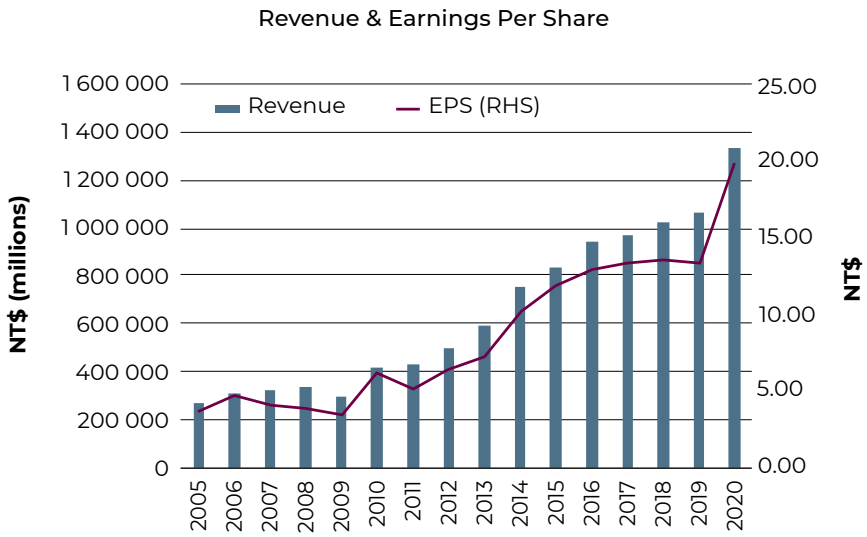
trend of both the Internet of Things and High Performance Computing outgrowing the smartphone segment is leading to diversification. Three years ago, smartphones contributed 62% to revenue compared to the current 48%.

FUNDAMENTAL EXCELLENCE

TSMC's impressive fundamentals validate the group's dominant market position. Revenue and earnings per share over the last fifteen years have grown at an average compound rate of 11.4% and 12.2% respectively. Over that period, operating margins have consistently ranged between 31% and 42% – at least double the level of its closest competitors.

Furthermore, the group has reported an average cash conversion ratio[2] of 172% over the last fifteen years. From a balance sheet perspective, TSMC consistently maintains a net cash positive position (more cash than debt) and, with one exception, has raised its dividend every year since instituting it in 2004. While these metrics are all notable, in our view, the most impressive of all is the group's return on invested capital[3], which has remained above 20% every year, with the exception of 2009 during the Global Financial Crisis, when it was 18%. To achieve such high and consistent returns in an unpredictable and asset-heavy sector is truly exceptional.

Graph 3: Strong revenue and earnings growth



NOT WITHOUT RISKS

One criticism that has constantly been levelled at TSMC is that of customer concentration. Given the sheer size and calibre of the group's top customers, they tend to contribute significantly to TSMC's profits. Apple, for example, is the group's largest customer and accounts for 23% of revenue while the largest ten customers make up about 65%. Although this has

[2] A ratio that measures what percentage of net income a company converts into cash
[3] A metric that measures the level of profitability of a company versus the investments it has made

reduced over time, to some extent, TSMC's fortunes remain tied to a handful of customers.

Despite the strong tailwinds that currently support TSMC's future growth, it still remains important to remember that the semiconductor industry can be highly cyclical due to end user demand for the products that use microchips, such as mobile phones, cars, TVs and computers. The combination of cyclicality and high capital requirements means that any capital allocation errors are amplified.

From a geopolitical perspective, there are some valid risks worth noting. The Chinese government has committed to technological independence by 2025, and what this ultimately means for TSMC remains unclear. Mainland China's largest foundry, SMIC, would appear to be the natural beneficiary in the event that TSMC loses market share within China. Across developed markets, increased protectionism, particularly within the tech industry, is a development that raises concerns. Apprehension regarding foreign companies making semiconductor (and telecommunications) parts for US and European companies is unlikely to abate given the privacy and security concerns. The ongoing global shortage of semiconductor chips only heightens this risk as countries seek to guarantee future supply.

JUSTIFIES A PREMIUM

Despite these risks, over the last decade, investors have increasingly taken note of TSMC's unique market position, and granted the company a premium valuation relative to its peers. In our view, this premium is largely justified by TSMC's market dominance and strong fundamentals. TSMC is the sixth largest holding within the iShares Semiconductor ETF, which we hold within our Global Equity Model Portfolio.

NVIDIA

GAME, SET, MATCH

MOOSA HASSIM, PCS INVESTMENT ANALYST

While not a household name, most people have had a device powered by NVIDIA (pronounced: en-vid-eeyah) at some point. Be it a laptop, desktop PC or even a gaming console like the original Xbox or the newer Nintendo Switch, NVIDIA's chips provide considerable processing power to devices, allowing them to render crisp, smooth and more realistic graphics.

Founded in Delaware in 1993 by computer scientists Jensen Huang (current CEO), Chris Malachowsky and Curtis Priem, NVIDIA was established to transform computer graphics. At the time, gaming and visuals were among the most computationally challenging problems and these founders believed that the PC would ultimately become a consumer device for enjoying games and multimedia. This led them to develop the very first GPU (Graphics Processing Unit), the GeForce 256, which at the time far outperformed existing products and set the company's course to become the leader in the field of visual computing. Fuelled by the massive growth of the gaming market and its insatiable demand for better 3D graphics over the ensuing years, NVIDIA has evolved the GPU into a powerful computer "brain" at the intersection of virtual reality, high performance computing and Artificial Intelligence.

THE TECHNOLOGY BEHIND IT ALL

In order to understand NVIDIA's vision for the future, it is important to have a firm grasp of the technology behind their products.

Central Processing Units (CPUs) and Graphics Processing Units (GPUs) are fundamental computing chips that are primarily designed to work together. Both are silicon-based and process data via cores, but they each have a different architecture and are built for different purposes.

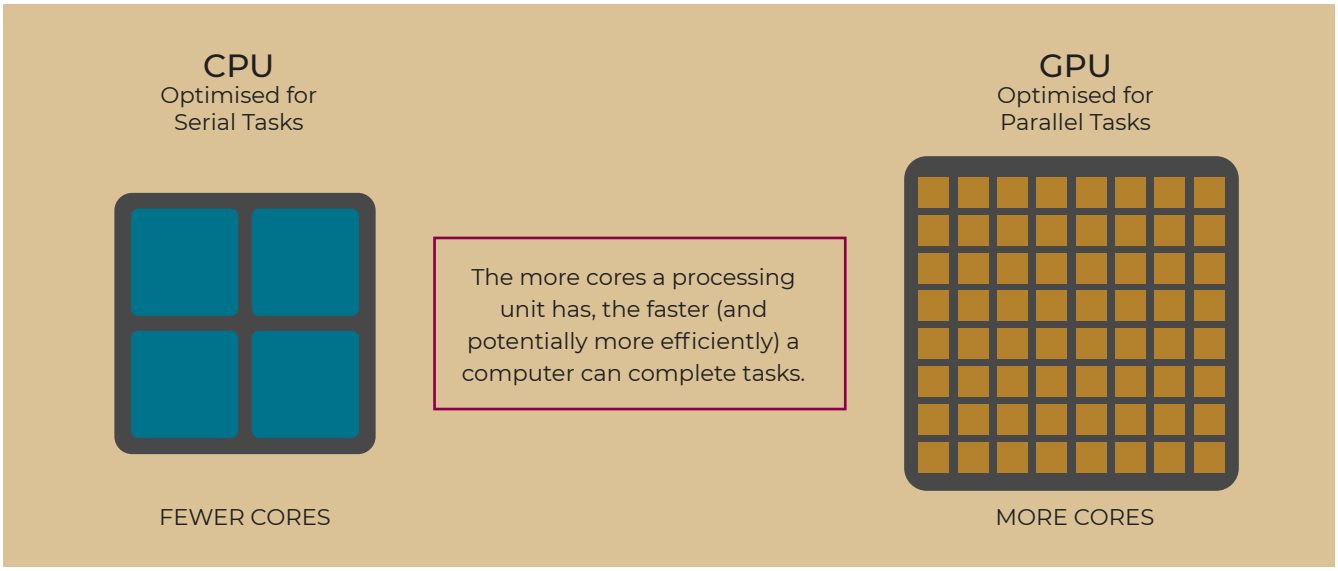
A CPU focuses its smaller number of cores to quickly process individual tasks sequentially. This makes it well equipped for more basic tasks ranging from serial computing to running databases. A GPU, on the other hand, has many more specialised cores and can process tasks in parallel faster and more efficiently. And while a GPU may have more computational power than a CPU, it cannot fully replace a CPU. In this way, a CPU can be considered to be the taskmaster of the entire system, coordinating a wide range of general-purpose computing tasks, with the GPU performing a narrower range of more specialised tasks.

THE POTENTIAL IN GPUS

Two decades ago, GPUs were used primarily to accelerate real-time 3D graphics applications such as games. However, at the turn of the 21st century, computer scientists realised that GPUs have the potential to solve some of the world's most challenging computing problems. This realisation gave rise to the general-purpose GPU era and today, graphics technology is applied more extensively to an increasing range of problems. Today's GPUs are more programmable than ever, affording them the flexibility to accelerate a broad range of applications that go well beyond traditional graphics rendering.

A *(GE)*FORCE TO BE RECKONED WITH

Arriving on the scene in the late 1990s with two graphics cards – the RIVA TNT 2 and the NVIDIA GeForce 256 (the world's first GPU) – NVIDIA has never looked back. At the time, their GPUs were leaps and bounds ahead of anything anyone had seen in terms of graphical processing power, and this competitive advantage was the driving force behind the company's massive growth.



Since then, video games have become a lot more computationally intensive, with hyper-realistic graphics and vast, complex in-game worlds. With advanced display technologies, along with the rise of virtual reality gaming, demands on GPUs are accelerating. The accompanying image depicting the visual evolution of Lara Croft from the Tomb Raider series clearly demonstrates the evolution of graphic technology over time.

STAYING AHEAD OF THE GAME

The gaming market has grown phenomenally over the past two decades and by pioneering the technology involved in rendering games, NVIDIA has benefited significantly. The overall gaming market has ballooned from a US$70bn industry in 2012 to an estimated US$166bn in 2020.

In fact, Grand Theft Auto V – a video game that involves robbing banks and running from the police – holds the title of being of the biggest hit in entertainment history, having achieved over US$6bn in sales since its release in 2013. To put this into perspective, this far exceeds the sales achieved by Michael Jackson's iconic album Thriller (US$500m since 1982); the first Harry Potter novel (US$1bn since 1997); and the highest-grossing movie ever, Avengers: Endgame (US$2.8bn at the box office in 2019).

Clearly, the gaming market is substantial and, importantly, is still growing. According to DFC Intelligence, the global video game consumer population surpassed three billion in 2020 (about 40% of the total global population) and almost half of those game on PCs. Considering that NVIDIA boasts an 80% share of the global discrete[1]

[1] Discrete graphics refer to a separate GPU as opposed to an on-board GPU. NVIDIA does not manufacture on-board GPUs.

The changing face of Lara Croft: 1996 - 2014

graphics card market, the company serves a substantial amount of gamers globally.

Furthermore, with the launch of its next-generation GPUs (the GeForce RTX 30 series), NVIDIA has ensured its dominance in this category. The processing power in the company's latest GPUs has improved significantly and offers double the performance and power efficiency of the prior generation at a relatively affordable price. These next-gen GPUs have proven to be immensely popular and are often sold out within minutes of stock being made available. In this way, NVIDIA's continuous innovation and drive to improve computational efficiency should ensure their growth and competitive advantage in this category well into the future.

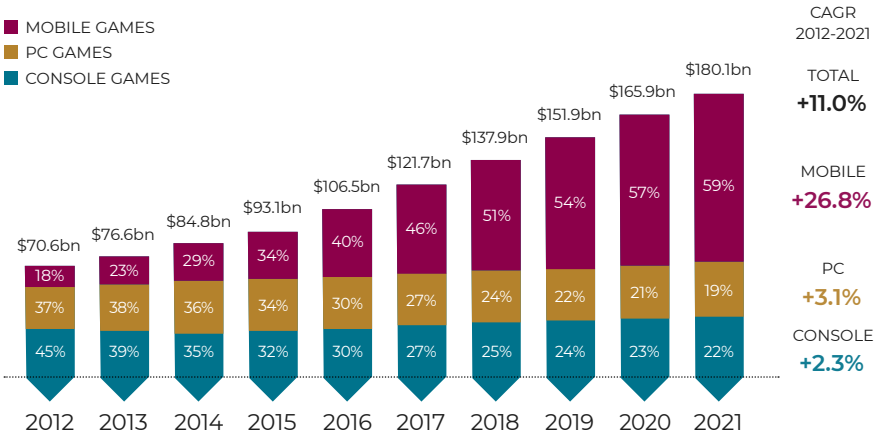
THE NEXT WAVE OF GROWTH

Having conquered the GPU gaming market, NVIDIA has taken steps to leverage its GPU prowess into other growth markets such as automotive, cloud computing, data centres and Artificial Intelligence.

Internet behemoths such as Google, Facebook, Amazon and Microsoft have found GPUs to be very useful at accelerating cloud workloads

Graph 1: 2012 – 2021 Global games market

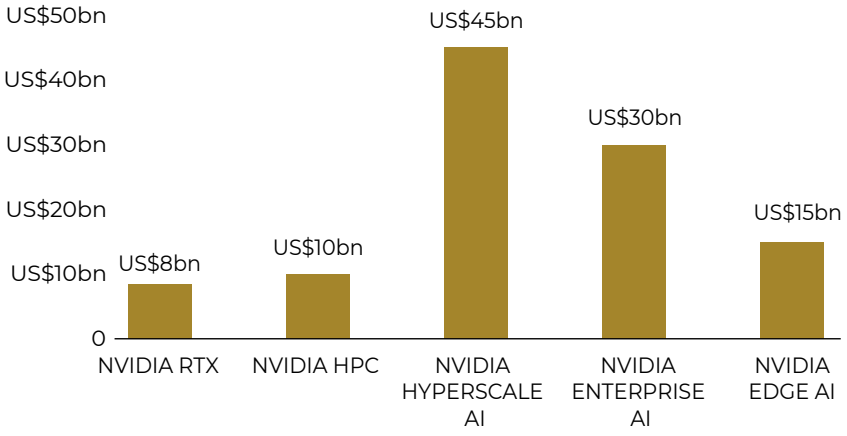
Revenues per segment 2012 – 2021 with compound annual growth rates



that use deep learning techniques to achieve speech recognition (Siri, Google Now, Alexa, Cortana), photo recognition (identifying faces in pictures on Facebook, videos of cats on YouTube), and recommendation engines (Netflix and Amazon).
To train a computer to recognise spoken words or images, it must be exposed to massive amounts of data with the goal of educating itself. Traditional data centres were built using CPU servers, supplied predominantly by Intel. However, CPU processing power is slowly hitting a ceiling as they are unable to compute the massive amounts of data required to train and run AI applications. Enter NVIDIA's GPUs, which can speed up high performance computing (HPC) workloads by 25 times and AI training workloads by 100 times relative to CPUs. Moreover, NVIDIA's GPUs deliver this performance while reducing the physical server count from 5 000 to just 200, and in some cases, even less than 50. This has led to significant uptake of NVIDIA's technology in data centres, with a study in May 2019 revealing that the top four infrastructure-as-a-service (IaaS) computing providers (i.e. Amazon Web Services, Microsoft Azure, Google Cloud Platform and Alibaba Cloud) use NVIDIA GPUs in 97.4% of their instance types.

The cloud HPC market is a fast-growing space and has achieved a compound annual growth rate of 21% since 2015. Similarly, Mordor Intelligence expects the cloud AI market to grow by more than 20% annually until 2025. As a result, demand for workload accelerators such as graphics cards is expected to grow by leaps and bounds in the future, which should stand NVIDIA in good stead. Despite all the hype, AI is still in its infancy and the opportunity set for NVIDIA in this market is massive. To put this into perspective, consider that in 2020 NVIDIA's gaming revenue was around US$8bn, while the total

Graph 2: Data centre and AI total addressable market by 2024



Source: NVIDIA estimates, incorporating data from Counterpoint, Dell'Oro, Gartner, IDC, IHS, Hyperion and Strategy Analytics

addressable market for the data centre and AI segment is estimated to be US$100bn by 2024.

ACQUISITION OF ARM

While NVIDIA by itself is not short of growth drivers, the yet-to-be-concluded acquisition of British semiconductor and software design company Arm could place their growth path onto another trajectory. Arm designs CPU chips and licenses out its intellectual property, providing a steady stream of high-margin royalty revenue. Its technology is used by 70% of the world's population – in everything from smartphones to cars – and its customers include the likes of Amazon, Intel, Samsung, Apple, and Qualcomm.

Through this acquisition, NVIDIA would be able to leverage Arm's client base to cross-sell its GPUs and to also use its own technology to expand Arm's IP portfolio. NVIDIA is looking to create "the premier computing company for the age of AI" by combining its GPU and Arm's CPU capabilities. It estimates that the combined business would have an addressable market worth US$250bn by 2023.

Despite the positive outlook for the companies, it's worth noting that this deal will face significant regulatory scrutiny. Rivals of the companies are opposed to the deal as they fear NVIDIA could push many smaller players out of the market should they decide to halt Arm's open-licensing business model. And while NVIDIA has stated that it will not change this model, the regulators will have the final say.

PLAYING THE LONG GAME

Given that we are only at the beginning of the journey towards harnessing the full potential of the Internet of Things and AI, we are confident that NVIDIA has a long and diverse runway for growth. Our Global Equity Model Portfolio has exposure to NVIDIA through our holding in the iShares Semiconductor ETF (NVIDIA is one of the top holdings within the ETF).

With or without the addition of Arm, the business is set to play a pivotal role in the future of technology. According to CEO Jensen Huang, NVIDIA is "firing on all cylinders" and we believe that the business still has plenty of fuel left in its tank.

NVIDIA recently launched the Ampere chip architecture and the A100 system, which reduces a whole room of servers to just one rack. Using NVIDIAs DGX A100 Systems, data centres will go from this:

To this:

Source: NVIDIA

INTRODUCING OLD MUTUAL WEALTH ESG RATINGS

At Old Mutual Wealth, we are now the first Linked Investment Service Provider (LISP) in South Africa to provide and publish an ESG rating for all the Old Mutual Unit Trust Funds listed on our platform.

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OLD MUTUAL WEALTH ESG FUND RATINGS

MSCI ESG Research provides ESG Fund Ratings on a scale of AAA (leader) to CCC (laggard), according to exposure of the underlying assets held to industry-specific ESG risks and the ability to manage those risks relative to peers.

RESPONSIBLE INVESTING AND ESG

Responsible investing is an investment approach that considers Environmental, Social and Governance (ESG) factors together with financial returns to achieve sustainable long-term returns.

THE BENEFITS OF ESG INVESTING

Historically, companies with high ESG scores showed resilience and delivered superior growth and investment returns when compared to those with lower scores.

WHY WE PRIORITISE RESPONSIBLE INVESTING

Old Mutual is a signatory of the United Nations-backed Principles for Responsible Investing (PRI).

ESG INVESTING AT OLD MUTUAL WEALTH

Various investment managers and capabilities at Old Mutual Wealth integrate ESG into their investment solutions:

Old Mutual Multi-Managers – applies ESG considerations in its manager selection and in its stewardship of underlying assets.

Old Mutual Wealth – offers index funds with ESG overlays for planners through Tailored Fund Portfolios, and curates bespoke ESG portfolios for clients through Private Client Securities.

Old Mutual Unit Trusts – currently offers funds managed by investment managers Old Mutual Investment Group (OMIG), Old Mutual Multi-Managers, Futuregrowth Asset Managers and Jupiter Asset Managers. All investment managers integrate ESG considerations into their investment processes. OMIG also offers three specialist ESG funds – Old Mutual MSCI World ESG Index Feeder Fund, Old Mutual MSCI Emerging Markets ESG Index Feeder Fund and Old Mutual ESG Equity Fund. In addition, OMIG offers three ethical investment funds – Old Mutual Albaraka Equity Fund, Old Mutual Albaraka Balanced Fund and the Old Mutual Albaraka Income Fund.

THE PURPOSE

Our objective is to collaborate with other players across the financial services industry and to motivate the broader industry to adopt ESG fund ratings and to build trust through full transparency.

THE AUTHORS

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Chief Investment Officer at Private Client Securities

Andrew joined PCS in 2017 and was previously employed at Cannon Asset Managers. He joined Cannon in 2007 as a research analyst and during his tenure, he rose through the ranks to become a portfolio manager in 2011 and was then appointed CIO in 2014. Andrew has extensive knowledge and insight into valuing businesses across multiple industries and identifying suitable investment opportunities. He holds a master's degree in Economic Science from the University of the Witwatersrand, where he lectured for a while. Last year, Andrew obtained a PhD in Investments and Securities from the University of Pretoria upon completing his thesis titled "Fundamental Momentum: A New Approach to Investment Analysis".

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Research Analyst Private Client Securities

Victor joined PCS in 2016 and was previously employed as an investment analyst at Maestro Investment Management, where in addition to equity research, he was responsible for managing a number of private client equity portfolios on a discretionary basis and managing the client relationships. Prior to that, he was a fund accountant at Investment Data Services where he prepared and reviewed valuations and accounting records of hedge funds. Victor graduated from the University of Cape Town with a Bachelor of Business Science (Hons) in Finance in 2007. He is also a CFA Charterholder.

Moosa Hassim

Investment Analyst Private Client Securities

Moosa joined PCS in 2014 and was previously employed as an institutional client accountant at Maitland, where he provided accounting support for hedge funds. Prior to that, he was a client portfolio analyst at First National Bank, where he fulfilled the role of both service and credit analyst. Moosa holds a bachelor's degree in Accounting and a postgraduate qualification in Islamic Finance – CIFP (Chartered Islamic Finance Professional) from INCEIF.

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WEALTH

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