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INVESTMENT MANAGEMENT

Small caps riding the AI wave

FOR PROFESSIONAL INVESTORS ONLY
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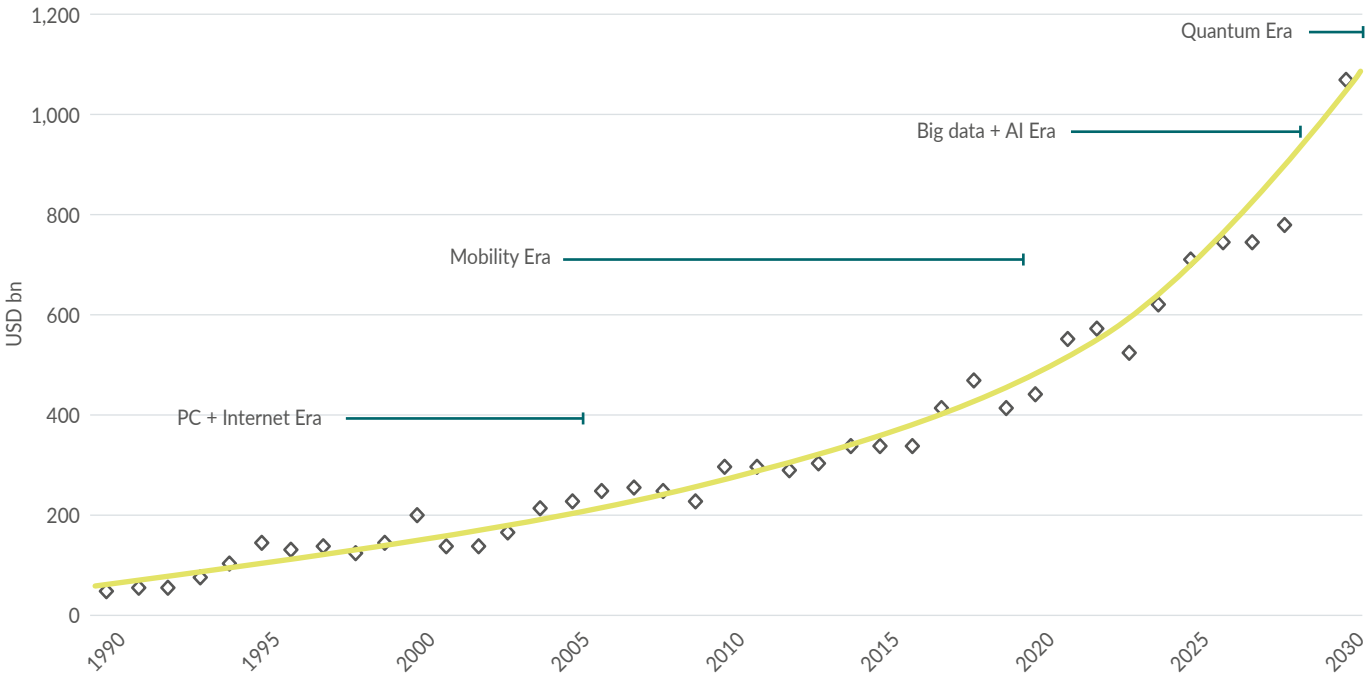
Looking at our personal lives, it is not hard to see that the integration of digital technologies into human life is fundamentally transforming how we communicate, travel, work, learn, and conduct business. Core to the ongoing and accelerating digitalisation are semiconductors, which are designed to compute, store and transmit large quantities of data. The rapidly spreading use of artificial intelligence is even further and more dramatically intensifying the demand for powerful semiconductor chips. This paper examines how the increased use of artificial intelligence impacts the semiconductor sector and what risks and opportunities it provides to small cap companies in particular.

An AI driven revenue revolution

While historical demand for semiconductors has been driven by personal and mobile computing, today, we see a new source of meaningful demand acceleration: Artificial Intelligence (AI), including Generative AI (GenAI). By 2030, the demand for more and increasingly powerful semiconductor chips could push the global semiconductor industry to USD 1 trillion in sales, from USD 500bn today[1]. It took the market over 50 years to reach this point[2].

Chart 1 – Global Semiconductor Market Size (USDbn)



Source: The Semiconductor Industry Association (SIA), Gartner Group, McKinsey, Besi

1. McKinsey, The semiconductor decade: A trillion-dollar industry, April 1 2022. 2. Besi Investors Presentation 2024

AI potential

Let's consider the revenue growth mentioned above. GenAI is a form of machine learning that uses patterns in training data to generate new text, video, images, code, or music that can potentially be indistinguishable from what humans can create. Moreover, its appeal is that over time, the creation can be performed faster, cheaper, and with fewer errors than humans would ever make. Within the broad spectrum of GenAI, Large Language Models (LLMs) are a subset that have recently surged in popularity. LLMs are specifically trained to generate human language, with ChatGPT as a popular example.

Chart 2 – The evolution of artificial intelligence

Artificial intelligence
The science and engineering of making intelligent machines

AI is the broad field of developing machines that can replicate human behavior, including tasks related to perceiving, reasoning, learning, and problem-solving.

Machine learning
A major breakthrough in achieving AI

Machine learning algorithms detect patterns in large data sets and learn to make predictions by processing data, rather than by receiving explicit programming instructions.

Deep learning
An advanced branch of machine learning

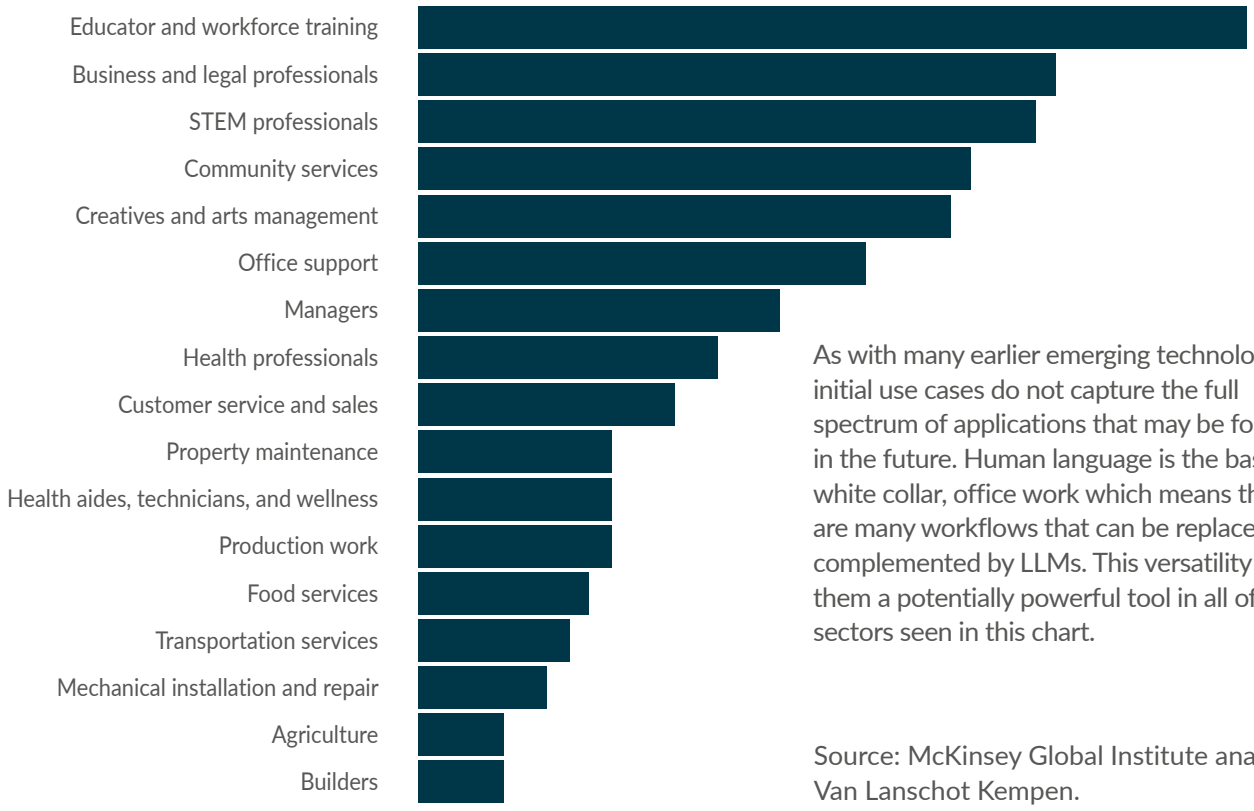
Deep learning uses neural networks, inspired by the way neurons interact in the human brain, to ingest data and process it through multiple iterations that learn increasingly complex features of the data and make increasingly sophisticated predictions.

Generative AI
An advanced branch of deep learning

Generative AI is a branch of deep learning that uses exceptionally large neural networks called large language models (with hundreds of billions of neurons) that can learn especially abstract patterns. Language models applied to interpret and create text, video, images, and data are known as generative AI.

Source: McKinsey, What is AI (artificial intelligence)?, April 3 2024

Chart 3 – LLMs automation potential by occupation



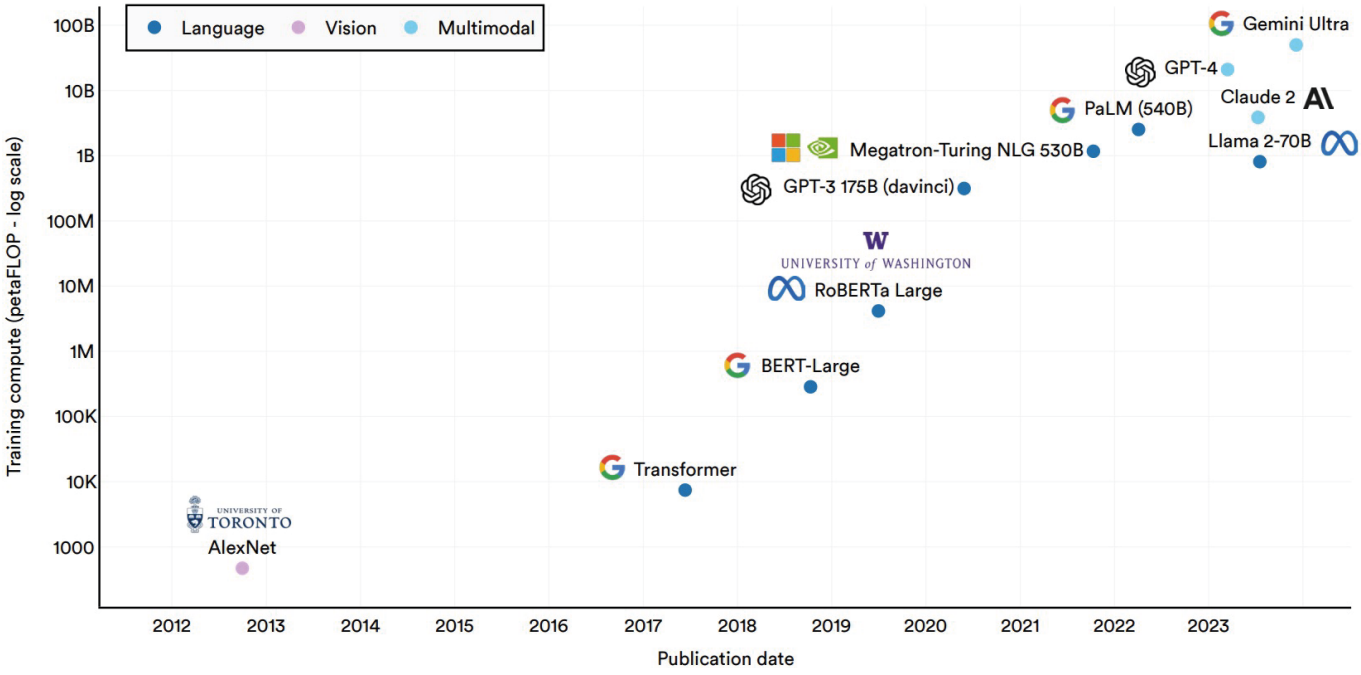
As with many earlier emerging technologies, initial use cases do not capture the full spectrum of applications that may be found in the future. Human language is the basis of white collar, office work which means there are many workflows that can be replaced or complemented by LLMs. This versatility makes them a potentially powerful tool in all of the sectors seen in this chart.

Source: McKinsey Global Institute analysis, Van Lanschot Kempen.

In need of compute power

Key to the quality of these AI models is the fact that they use vast amounts of data for training. The more data that can be absorbed, the higher the likelihood of getting useful outputs. However, analysing the data fast enough for it to be useful requires a large, and increasing, amount of compute power, especially as the AI models themselves are becoming more complex. The chart below shows that the compute resources used to train AI models are scaling exponentially. Since the publication of Alphabet's Transformer deep learning model in 2017[3], the volume of compute resources used in training has grown by a factor of over 1 million times for today's leading models, such as GPT-4.

Chart 4 – Compute power needed to train AI models



Source: Stanford, Artificial Intelligence Index Report 2024. Data from: Epoch, 2023

Applications such as ChatGPT, Gemini, Dall-E and Copilot have one thing in common: they all require increased compute power from more powerful microprocessors, more memory with high bandwidth, and more storage capacity. This requires the semiconductor value chain to invest heavily in order to add capacity and to develop more powerful next-generation technologies.

Compute resources used to train AI models are scaling exponentially.

3. Vaswani, Ashish, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Łukasz Kaiser, and Illia Polosukhin. "Attention is all you need." Advances in neural information processing systems 30 (2017). https://proceedings.neurips.cc/paper/2017/file/3f5ee243547dee91fbd053c1c4a845aa-Paper.pdf

Investing for more power

Compute power, measured by the number of operations performed per second, was historically determined by the number of transistors[4] that could be fitted on one microprocessor. As a reference, the chipset in the latest iPhone 15 pro can perform 35 trillion operations per second, driven by a chip that has ~19bn transistors on the size of a fingernail, vs a few thousand transistors in the 1969 moon lander Apollo guidance computer.[5] This development is characterised as Moore's Law, the doubling of transistors in an integrated circuit every two years which was historically made possible by advances in lithography (including developments made by ASML).[6]

However, the industry is nearing its limits in terms of numbers of transistor it can fit on a single microchip. As a consequence, the semiconductor industry is investing heavily in new technologies, in all steps of the semiconductor supply chain, to continue the cadence of increasing compute power, while at the same time increasing total production capacity to keep up with demand and to bring down production costs. This is pushing the industry to make over USD 200bn of annual investments in the coming decade (see Table 1), which could be a major revenue driver for small cap semiconductor equipment suppliers.

Table 1 – Announced Global Investment plans by Leading players

TechInsights	USDbn		Timing		USDbn p.a.	Purpose
Direct Investments						
TSMC	40.0	5	years	(2027)	8.0	New 4nm fab & 3nm fab
TSMC	50.0	4	years	(2026)	12.5	New fabs in Taiwan
Micron	100.0	~20	years	(2042)	5.0	New DRAM megafab
Micron	15.0	3	years	(2025)	5.0	New leading edge fab
Intel	20.0	6	years	(2027)	3.3	2 new fabs <7nm
Intel	20.0	5	years	(2027)	4.0	2 new fabs leading edge
Global Foundries	8.0	3	years	(2025)	2.7	Expansion/adding capacity
Texas Industries	30.0	8	years	(2030)	3.8	4 new fabs
Texas Industries	11.0	3	years	(2026)	3.7	Second fab in Lehi, Utah
Samsung	192.0	20	years	(2042)	9.6	11 new fabs in the US
Samsung	230.0	20	years	(2042)	11.5	5 new fabs in S. Korea
SK Hynix	106.5	10	years	(2032)	10.7	Adv. Memory and capacity expansion
Indirect Investments						
Apple	430.0	5	years	(2026)	86.0	Next-gen Silison, 5G innovation, data centres
Intel	80.0	10	years	(2032)	8.0	EU semi capacity
USA	52.0	5	years	(2026)	10.4	Semi capacity and R&D
EU	47.0	8	years	(2030)	5.9	European Chips Act
Korea	450.0	10	years	(2032)	45.0	Semi manufacturing incentives
Japan	8.6	3	years	(2024)	2.9	<20nm fab
Total	**1,890.1**				**237.8**	

Source: TechInsights, May 2023

4. The building blocks of a chip. 5. A computer built from NOR gates: inside the Apollo Guidance Computer (righto.com). 6. Moore's law is the observation that the number of transistors in an integrated circuit (here meaning a microchip) doubles about every two years thanks to improvements in production. First described by Gordon Moore in 1965.

Investment opportunities in Small caps

As this article has shown, there are strong growth drivers for the semiconductor industry. Additionally, the industry has high entry barriers driven by R&D-related intellectual property and strong customer relationships. High gross margins are due to added value and healthy supply chain dynamics, which allow companies to invest heavily in R&D and enables the leaders to strengthen their positions. As a result the industry is characterised by companies with high market shares in niche segments as demand concentrates to the leading players. We frequently observe monopoly or duopoly positions for critical parts of the semiconductor value chain. The small-cap universe offers a broad opportunity set for investing in these world-leading companies.

We should note that it is and will remain difficult to forecast the future direction of new technologies; companies identified as GenAI global leaders (e.g. the 'Magnificent 7' and the companies mentioned below) may be pricing in GenAI potential that could fail to materialise. Additionally, the semiconductor industry is characterized by a high degree of cyclicality, meaning we cannot extrapolate short term revenue trends.

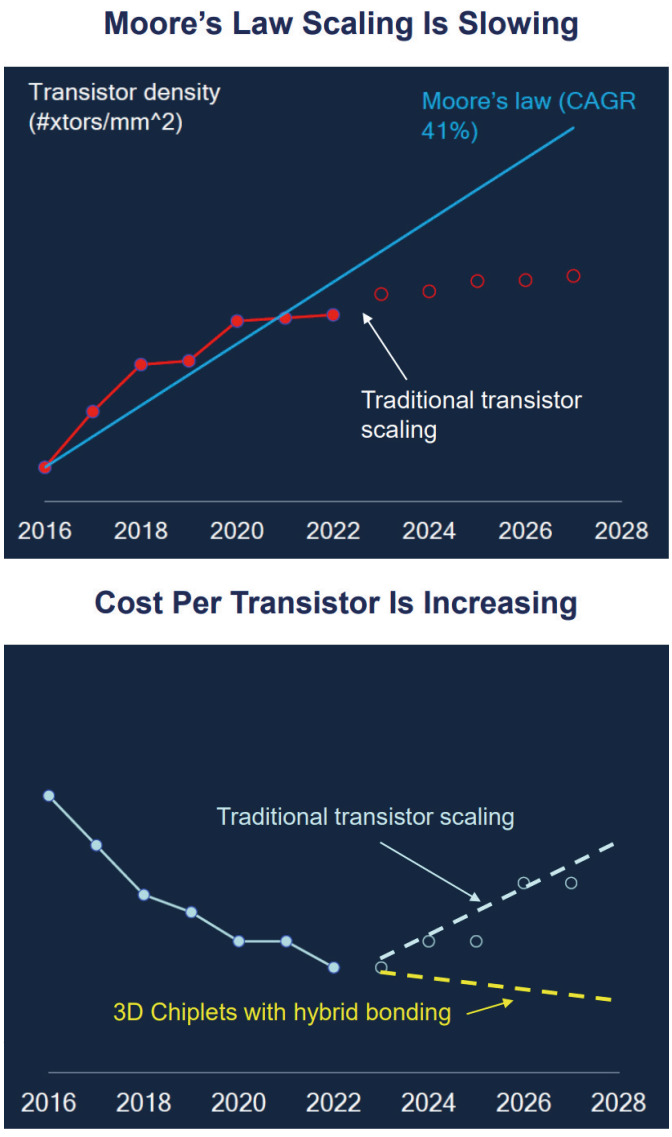
A few illustrations of companies in the AI value chain

Besi (BE Semiconductor) is the global leader in packaging and assembly equipment for semiconductors and is a key supplier to companies such as TSMC, Intel, Samsung, and Apple. As Moore's law is slowing, and the industry is approaching the physical limitations to increasing transistor count, Besi's position in the value chain has become increasingly more important. This is evidenced by its gross margin development from 35% in 2007 to an industry-leading 65% in 2023.[7]

In addition, Besi is the dominant world market leader in the key AI-enabling technology 'hybrid bonding'. As the industry is moving to chiplets - a new chip design that allows for smaller modular components which can be packaged together to form a larger complex chip - advanced packaging technologies such as hybrid bonding could be crucial. As a consequence, Besi itself expects to generate well over EUR 1 billion in revenues in the next upcycle, up from EUR 579 million in 2023.

Meanwhile Besi has been highly cash generative as a result of its high margins (~40% EBIT) and limited capital requirements (Capex/Sales ~5%). However, timing of the hybrid adoption remains uncertain, just like Basi's ability to maintain its market leading position going forward.

Chart 6 - New Wafer Level Assembly Technologies Extend Moore's Law



7. Besi target. Besi Capital Markets Day, June 2023

Suess Microtec is the global market leader in several important steps of the semiconductor value chain, supplying companies such as TSMC and Samsung. With its temporary bonding solution, Suess helps memory manufacturers to produce high-performance memory necessary for AI applications, known as high-bandwidth memory (HBM).

Driven by AI adoption, Suess has seen strong revenue growth and a high order intake. In its Presentation on the 2023 Annual Results, the German company said it expects to improve revenues to over EUR 400m (compared to EUR 304m in 2023) and EBIT margins to 15% in 2025 (compared to 9.1% in 2023)[8], due to the favorable industry tailwinds and increased operational focus.

Despite these expectations, Suess valuation is still at a steep discount to other equipment manufacturers. However, risks of operational execution and more general technological uncertainties remain.

Lumentum produces photonics used in fibre-optic communications, including lasers, transceivers, and optical switches. Fiber-optics uses lasers to transmit data as light signals down a glass fibre and the technology has historically been used in telecommunications infrastructure.

With the advent of AI, new datacentre architectures are running large numbers of graphics processing units (GPUs) to solve problems in parallel, which requires 5-10x the communication bandwidth of conventional servers[9]. Fiber-optics have advantages over electrical interconnects, including higher bandwidth, lower signal degradation, and less interference, which is leading to more optical communications in datacenters.

Lumentum sells both the chip-level components used in the datacenter, where it is a global leader in edge-emitting lasers, and also complete transceivers, which combine the send/receive components in a single package. The company projects the datacentre photonics market to expand from USD 4.5bn in 2023, to USD 16bn by 2028, a 30% CAGR[10]. While the total potential opportunity for Lumentum is large, the transceiver market is characterised by a small number of potential customers (the cloud hyperscalers: Alphabet, Meta, Microsoft, and Amazon) and there is intense competition to win these contracts.

Jabil is a provider of outsourced manufacturing services, using its own facilities and expertise to help engineer and manufacture products for its customers in diverse end markets. Jabil is focusing on higher value-added opportunities such as EV powertrains, medical implants, and semiconductor production equipment.

With the emergence of AI, cloud hyperscalers are investing heavily in new datacentres and Jabil could enable these projects as a manufacturing partner. Jabil has contracts to outfit new datacentres, including responsibilities for power supply, server racks, and cooling .The company expects these AI-related projects to contribute USD 6bn in revenue by fiscal year 2025.[11] However, the exact revenue recognised by Jabil will depend on the size and timing of their customers' projects, and as they have some customer concentration, this is uncertain.

The small-cap universe offers a broad opportunity set for investing in world-leading semiconductor companies.

8. Suess Microtec Investor Presentation Annual Results 2023. 9. Meta: Optical Interconnects in Data Centers with Rob Stone (youtube.com).
10. Lumentum, OFC Conference presentation, 2024. 11. Jabil 2024 Q2 earnings call

Summarising

The AI revolution is having a fundamental impact on the semiconductor supply chain as the need for more compute power, more memory capacity and lower cost drives unprecedented levels of investments. The small cap universe offers access to companies that are world market leaders in important niches of the semiconductor supply chain and can benefit from the strong industry trends. While the industry has attractive characteristics and the market opportunity is significant, it is also important to keep in mind that the future direction of new technologies remain uncertain and valuations may be reflecting GenAI potential that may never or only partly materialise.

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