SECURING THE UK'S SEMICONDUCTOR INDUSTRY

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23 September 2024

THE IMPORTANT ROLE OF SEMICONDUCTORS

In any issue, MPs tend to see the human angle first – that biotech feeds people or that pharma cures people. The impact of semiconductor technology, on the other hand, is more subtle.

This critical industry sector is often seen as impersonal, with microchips performing hidden technical, electrical functions buried below the surface of our lives.

Yet it is true that semiconductors are profoundly involved with people's lives, in every aspect, from healthcare to entertainment and from financial services to transport and logistics.

In healthcare, for example, there have been incredible developments in Artificial Intelligence diagnostics, remote surgical procedures, body scanning, prosthetic limbs and significant advances in the search for a cancer cure in recent years. The mapping of the genome, a huge breakthrough in disease analysis, was pioneered by Illumina machines and only made possible using novel semiconductor technology.

This sector will be pivotal to addressing the major challenges of the next several decades in climate change, productivity growth and healthcare.

Each year, more than a trillion semiconductors are shipped in our mobile phones, laptops, smart-home thermostats, virtual reality headsets, cars, space satellites, air traffic control systems, electricity power networks and industrial robots.

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THE ROLE OF SEMICONDUCTORS IN FUTURE TECHNOLOGY

Semiconductors are everywhere and are fundamental to civilisation. Without them, our modern world would shudder to a halt.

They are also the foundation of our future, of the world's emerging technologies in artificial intelligence, telecommunications, the metaverse and autonomous mobility. Quantum computing, the most transformative element of the digital revolution, only exists because of advances in semiconductors.

Although the global semiconductor industry is in 18th place by revenue as a percentage of the world economy today, it is the fastest growing sector and already ranked first by market cap globally. Semiconductors are also integral to the search for productivity growth – the enduring problem of the British economy.

Although the UK sector is small by comparison with the rest of the world, a domestic semiconductor industry delivers better:

- National security
- International credibility
- Geo-political Leverage
- Economic growth

Semiconductors are critical in defence, aerospace, FinTech, GreenTech and national communications.

KEY SEMICONDUCTOR STATISTICS

- In the last 12 months, the global semiconductor industry made sales of $600 billion and is projected to rise to $1 trillion by 2030. At around $10 billion in sales, the UK share of the global industry is just 1.7% – but with the potential to be much more.

- Of the world supply of semiconductors, 60% are manufactured in Taiwan, just off China's mainland and frequently threatened with invasion. Taiwan also manufactures 90% of the most advanced semiconductors – ones that are smaller than 10 nanometres (for comparison, a human hair is about 100,000 nanometres).

- The world's second largest company after Apple is the American semiconductor company NVIDIA valued at $3 trillion. Their chips are made by the largest semiconductor manufacturer, the Taiwanese company TSMC (Taiwanese Semiconductor Manufacturing Company), the 44th largest company in the world.

- For every new UK job in semiconductors, six jobs will be created in the supply chain – in raw materials, energy, building, metalwork, software, IT and systems infrastructure.

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- Substantial company sales have been made from the UK. Two domestic semiconductor start-ups sold to American multinationals for a billion dollars between them. However, a European Investment Bank report said that the UK only accounts for 2% of e-tech IPOs while the US accounts for 32%.

- The US created the CHIPS Act (Creating Helpful Incentives to Produce Semiconductors) to bolster their manufacturing and supply industry. The EU has created a similar initiative and provides start-ups with access to a cloud-based platform which gives free access to the design tools (up to 40% of the cost of designing a chip is in the tools).

THE FAB AND THE FABLESS

There are two stages involved in developing and supplying semiconductors, each with different requirements.

1. The invention and design of a semiconductor device needs expensive software 'design tools' and then a prototype manufacturing facility, to create a test device to validate its performance. In the UK, there are more than 160 organisations designing chips today.
2. Then the validated device needs to be manufactured in appropriate volumes for the market. This needs a chip factory, a foundry or 'fab' [fabrication plant]. Taiwan has dominated this sector over the last 30 years. In the UK, there are 27 such fabs, with some in universities. The UK has specific manufacturing expertise in materials other than silicon.

The incredible rise in the use of semiconductors has been accelerated by the so called 'fabless' model, where inventors and designers create a ready-to-manufacture product but outsource the manufacture to a 'foundry', usually abroad.

This is where TSMC in Taiwan excels. Two-thirds of the world's semiconductor sales are sold through a fabless model.

EQUIPMENT TO MAKE SEMICONDUCTORS

The supply of equipment used in semiconductor manufacturing is also a highly advanced and valuable sector globally, led by companies such as ASML in Holland. The UK has more than 30 companies which supply advanced equipment to the global semiconductor manufacturing industry.

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Design, manufacturing and equipment companies are spread across the UK. The North East, South, East and West of England, Scotland, Wales and Northern Ireland provide regional growth opportunities across our whole country.

> ***"The UK has got the raw engineering capability that can be used by the rest of the industry globally."***

Apple has three chip design centres in the UK. NVIDIA is opening one, and Qualcomm has had one for many years. They have been attracted by the links to universities and the access to talent. The centres are clustered mainly around Edinburgh, Cambridge and Bristol.

This pipeline of talent is essential to the future. An important part of that will be correcting our gender imbalance – which is 80:20 in the UK compared with 50:50 in India - and encouraging more children into STEM and then on to engineering apprenticeships and degrees.

CUTTING EDGE DEVELOPMENTS IN THE UK

- Plessey is designing and manufacturing microLED displays recreating the performance of a widescreen HDTV in a 15mm display. In a few years' time, ordinary spectacles will use such displays to provide Augmented Reality functions in them.
- The UK can produce world-first products, such as the discovery or invention of graphene as an industrial material. With its proprietary process, Paragraf is the only company in the world manufacturing with graphene, and China is currently spending $80 billion to try to replicate their process.
- Pragmatic's flexible FlexIC chips employ a simplified fabrication process using less water, energy and harmful chemicals. The lower costs of chips open the door to countless new applications.
- Arm continues to employ thousands of skilled engineers in the UK, working on microprocessor architecture and design. Some of these have themselves gone on to found cutting edge processor start up companies.

THE SCALE-UP PROBLEM

The UK has a large range of start-ups but few that scale up to be globally successful.

> ***"There is this black hole of gravitational attraction where all our best companies and ideas get sucked into the US. And it's got worse over the last 10 years."***

All too often, our university research, early-stage innovation or start-ups are licensed or sold overseas, and we lose the downstream economic value. In 2024, NVIDIA's US revenue will be around $90 billion (up from $10 billion in 2019) because of its pivot towards AI chips.

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However, if we get it right, the next NVIDIA is just as likely to be in the UK as anywhere else.

The question is how the UK semiconductor industry can continue to work with foreign multinationals without the larger partner licensing, buying their achievements for development, production and/or sales out of Taiwan or America.

> ***"There's plenty of private money out there but if you are growing organically, you can't fund capex through innovate funding."***

Compared with foreign investors, their UK counterparts typically prefer shorter returns at less risk than the semiconductor sector delivers and do not understand the sector sufficiently. Inevitably, early-stage businesses struggle to raise growth finance starting at early Series A stage, unless they can secure a lead investor from outside the UK.

The availability of capex funding to support equipment-hungry businesses (fabs or companies working on new materials) is extremely difficult to secure in the private sector. Government initiatives via UKRI are limited due to subsidy control regulations, even though many countries have put in place incentives to fund their own domestic semiconductor sectors.

A high-end ultra-high volume semiconductor factory in Taiwan costs between $20 and $40 billion.

With novel developments in the British industry, an equivalent facility for prototype production might come in at under $1 billion, or a 2D graphene foundry for under $100 million. For comparison, a single machine that TSMC buys for its front-end highest-performance chips costs $150 million.

The reason people go to the US is for capital. The British Business Bank (wholly-owned by Government but independently run) and the newly announced National Wealth Fund (formerly UKIB) do offer funding for semiconductors. But the amounts are often too low and by following investment rather than leading, they do not crowd-in significant domestic private finance. Ultimately, the sector needs a much deeper pool of investment to the tune of several billion pounds.

> ***"If capital were available in the UK that would be an option instead of going to the US."***

The Spanish government's PERPE chip programme is worth €12 billion, much of which is going into manufacturing (with €1.3 billion into design).

A company from the University of Edinburgh defied expectations by going out, getting the capital together and purchasing manufacturing in Massachusetts. Some UK companies have done likewise, and they deserve study as an example for the industry to learn from.

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WHAT CAN THE GOVERNMENT DO?

- Better access to deeper pots of patient capital will help the UK keep some of its inventions onshore as national assets and boost domestic productivity and GDP in what is a high value, high-growth sector globally.

- The curriculum in schools and universities will be crucial to developing talent in the workforce. But society needs to be better equipped to understand the importance and value of semiconductors and related deep technology.

- Addressing the gender balance will help the pipeline of talent. Cyber First, a £10 million government programme has helped here.

- Stimulating domestic supply chains will help to grow UK companies, providing early business opportunities and supporting scaled-up production. The rules around government procurement can be reviewed to find opportunities here.

- Several government initiatives have been brought forward, but not yet delivered. These should be prioritised to assist the sector. For example, up to £1 billion funding is needed to support the roll-out of the government semiconductor strategy and the creation of the National Semiconductor Institute to act as a joint Industry, Academia, Government convener for national strategy and coordination.

WHAT ARE THE PRIORITIES?

- Develop a national long-term plan for the UK to have more of a presence in the global chip industry, across innovation, design, scale-up and manufacturing, recognising the different needs and opportunities in each area and focussing on global opportunities versus UK strengths.

- Improve access to UK patient capital, increasing the number of investors with an appetite for, and understanding of, the semiconductor sector and incentivising private investment to scale companies over a meaningful period whilst staying rooted within the UK ecosystem.

- Scale-up support for semiconductor fabs when investing in strategic upgrades to UK facilities to lead in global markets or support domestic open access.

- In consideration of the international incentives and subsides applied to the sector, investigate mechanisms for the UK to appropriately support domestic players to compete on a more level playing field globally.

- Incentivise domestic demand to grow UK supply chains, increasing business collaboration and national resilience. Public procurement is one option here.

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- Develop a national skills pipeline, from school to industry, with initiatives to ensure children, parents and teachers are aware of the importance of semiconductors and the exciting and worthwhile careers available as designers, engineers and technicians. Encourage university graduates to pursue careers in semiconductors and support them in their professional development so they are equipped with work-ready skills and experience.

- A dynamic, responsive economy will always need skilled immigration, because the market moves more quickly than the education system can adapt, and so the visa system should also be reviewed.

- Monitor global regulations to ensure the UK remains competitive, such as in PFAS (synthetic chemicals heavily used in manufacturing) and increasingly challenging export controls and trade regulations. Exporting from the UK is often slower than elsewhere.

"We've got to create a sense of hair-on-fire in government right now, because they need to move quickly. The UK has diminishing assets, and unless it leverages them quickly, they will have gone. This world is becoming more competitive not less."