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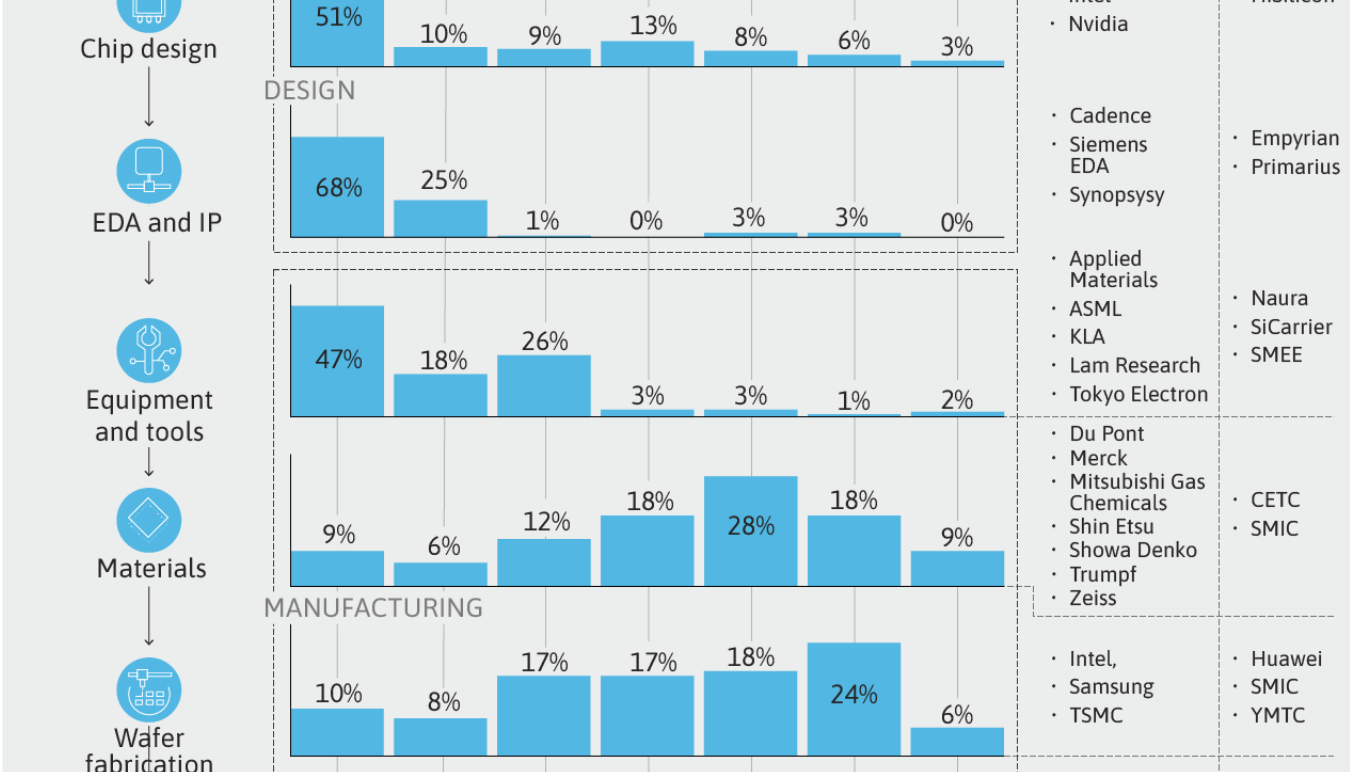
The Semiconductor Ecosystem and Export Controls

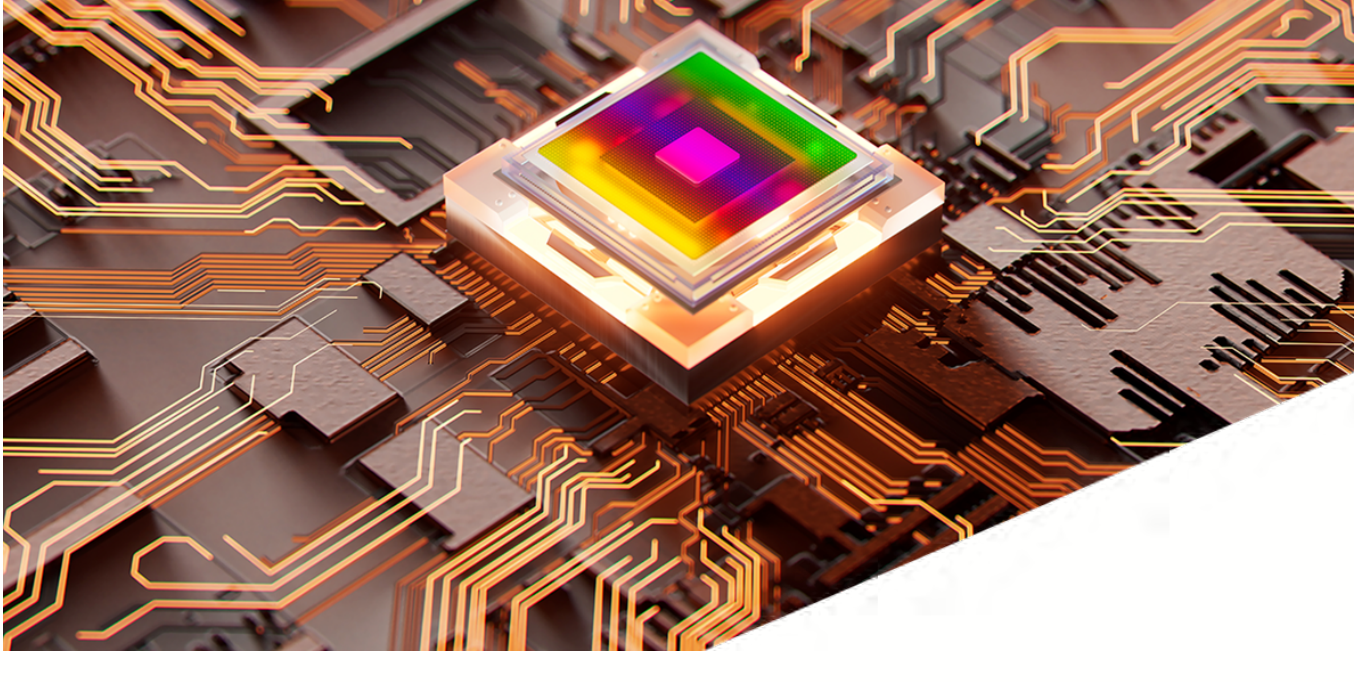
All artificial intelligence (AI) models are run on chips. Whoever dominates the semiconductor ecosystem will have a comparative advantage in the AI race. The United States' AI leadership depends on the ability to build and maintain global chip coalitions, but it could be negatively affected by spillover effects from other policy domains such as trade.

- **A globally interconnected industry:** The semiconductor supply chain spans over 50 countries and involves deeply specialised stages, making full national reshoring virtually impossible without massive investment, coordination and time.
- **A strategic shift in US export controls:** Under the Trump administration, export controls have become increasingly unilateral and transactional, marking a departure from prior multilateral, security-based approaches. The US seeks to maintain the largest AI ecosystem to set global AI standards.
- **China's bid for self-sufficiency:** Beijing is accelerating efforts to localise its semiconductor ecosystem through state-backed investment, but key chokepoints – such as electronic design automation (EDA) software and extreme ultraviolet lithography (EUV) – are still dominated by Western firms, limiting China's near-term autonomy objective.

The semiconductor supply chain and chokepoints



70x ONCE PRODUCED, A SEMICONDUCTOR CAN CROSS BORDERS MORE THAN 70 TIMES BEFORE REACHING ITS FINAL DESTINATION



Global industry

The race for domination in AI lies at the heart of the strategic competition between the US and China. With chips being the building blocks of AI development, the country that controls the semiconductor ecosystem will lead. Both the US and China are vying for greater control, but neither Washington nor Beijing dominates the semiconductor ecosystem entirely. However, notable changes have been driven by the United States' approach to export controls and China's advancements in its indigenous chip industry.

The semiconductor industry is truly global. Each segment of its value chain relies on extensive international integration. On average, 25 countries are directly involved in the supply chain for a single chip, with an additional 23 supporting key market functions. Wafer fabrication – the most globally dispersed segment – engages 39 countries. Packaging and assembly span another 25 countries.

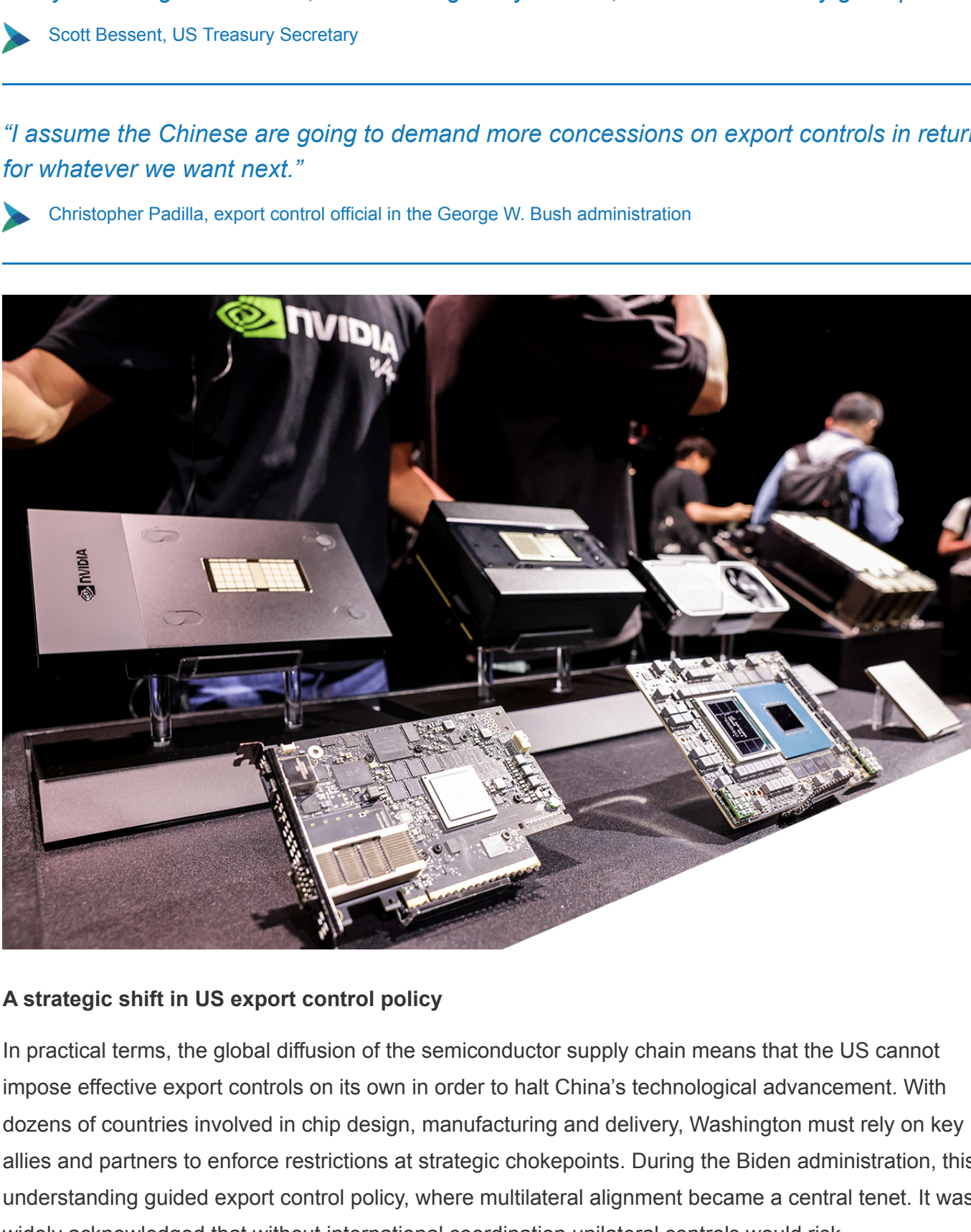
This complexity underscores the fact that no country has succeeded in reshoring the entire semiconductor supply chain. Doing so would require more than US$1 trillion in investment and at least a decade to complete. But the issue is not only financial. Each stage of the chain involves deeply specialised processes, tools and expertise. While the US leads in chip design, manufacturing equipment, and some advanced materials, the fabrication, packaging and assembly of chips are overwhelmingly concentrated in Asia.

Between 1990 and 2020, the US share of global semiconductor manufacturing declined from 37% to 12%. Meanwhile, China is expected to account for 40% of global capacity expansion in the coming decade, positioning it as the largest chip manufacturing hub globally. Other countries like Japan, the Netherlands, South Korea and Taiwan possess critical shares in the supply chain.

This shift in geography has made semiconductors a central front in the strategic rivalry between the US and China – one increasingly shaped by export controls, industrial policy and efforts to dominate critical chokepoints in the supply chain.

"They had things we wanted, we had things they wanted, and we're in a very good place."
Scott Bessent, US Treasury Secretary

"I assume the Chinese are going to demand more concessions on export controls in return for whatever we want next."
Christopher Padilla, export control official in the George W. Bush administration



A strategic shift in US export control policy

In practical terms, the global diffusion of the semiconductor supply chain means that the US cannot impose effective export controls on its own in order to halt China's technological advancement. With dozens of countries involved in chip design, manufacturing and delivery, Washington must rely on key allies and partners to enforce restrictions at strategic chokepoints. During the Biden administration, this understanding guided export control policy, where multilateral alignment became a central tenet. It was widely acknowledged that without international coordination unilateral controls would risk circumvention, invite backfilling and undermine strategic goals.

The second Trump administration has taken a very different approach to export controls. While technology restrictions remain at the heart of the US's strategy towards China, there have been notable changes. Firstly, the administration is much more willing to use export controls unilaterally and extraterritorially. The Bureau of Industry and Security (BIS) plans to put pressure on allies such as Japan and the Netherlands to bring them into closer alignment with US export controls. Malaysia, Singapore and Taiwan have already tightened their national export controls under pressure from Washington in order to prevent the re-routing of US chips to China. The agency has also informed South Korean and Taiwanese chip manufacturers that it may revoke the current waivers allowing them to import certain US technologies into their China-based facilities.

Secondly, the Trump administration has started using export controls as explicit bargaining chips. This was exemplified by major AI deals with the Gulf states and the lifting of restrictions on chip design software as well as resuming the sale of Nvidia's H20 AI chips to China. Under pressure from Beijing's rare earth controls, this marked a dramatic reversal of the Trump administration's previous hawkish stance on China.

This policy shift marks a departure from previous administrations, which viewed export controls as non-negotiable instruments of national security. Under Trump, the distinction between strategic and transactional export controls is becoming increasingly blurred. This may embolden Beijing to demand further concessions from Washington and European countries who hold chokepoints in the semiconductor supply chain.

Finally, the return of Nvidia's chips to the Chinese market indicates a broader paradigm change. As set out in the White House's AI Action Plan, the administration is set to prioritise the diffusion and commercial scale of technology over long-term strategic denial. In this new context, export controls are no longer considered the default method of constraining Chinese technological advancement. Instead, the administration has echoed industry arguments that maintaining global market access for US firms such as Nvidia is crucial for preserving American leadership and AI standards.

While the administration seeks to ensure that its allies are building AI on American technology, its transactional approach to export controls, a penchant for extraterritoriality and an inconsistent trade policy could complicate coalition-building.

"The American tech stack should be the global standard, just as the American dollar is the standard by which every country builds on."
Jensen Huang, CEO of Nvidia

US$47.5 BILLION CHINA'S BIG FUND III WILL INVEST US$47.5 BILLION TO BOOST INDIGENOUS CHIP CAPABILITIES.

China's self-sufficiency drive

The effectiveness of US export controls depends not only on multilateral coordination but also on the trajectory of China's technological self-sufficiency. If Beijing succeeds in developing viable homegrown alternatives, US chokepoints may lose their strategic relevance. Such a shift would profoundly reshape the global semiconductor ecosystem.

China considers AI to be a crucial technology in its strategic competition with the US. Beijing is particularly emphasising self-sufficiency in homegrown AI chips. A major turning point came in 2015 with the launch of the 'Made in China 2025' initiative, which set a target of producing 70% of semiconductors domestically by 2025. This effort was underpinned by the creation of the China Integrated Circuit Industry Investment Fund – commonly known as the Big Fund – designed to inject significant state-backed capital across the entire semiconductor value chain. The third phase of the investment fund plans for a more targeted approach and a focus on China's bottlenecks to technological advances – lithography equipment and chip design software.

China has made notable advances across several semiconductor domains. Huawei has emerged as China's flagship chipmaker, working closely with Semiconductor Manufacturing International Corporation – the country's most advanced logic foundry. However, its overall push for self-reliance has revealed significant limitations. Domestic alternatives often fall short in both performance and innovation. Chinese firms continue to rely on high-end foreign chips, frequently procured through indirect channels. For example, Chinese AI start-up DeepSeek reportedly procured Nvidia's H20 chips by re-exporting them from Singapore. Meanwhile, critical gaps persist in upstream technologies such as chip design software and EUV machines – areas still dominated by Western suppliers. Despite billions in state investment, China's domestic alternatives remain several generations behind the global cutting edge.

Both the US and China strive for dominance in AI technology, and their ecosystems are already fragmenting into separate technology stacks. The United States' AI leadership will continue to depend on the ability to build and maintain global chip coalitions and its response to any spillover effects from other policy domains. While Beijing's self-sufficiency campaign threatens to erode existing dependencies over time, its long-term success will depend on whether it can build a fully independent ecosystem of component and subsystem suppliers – free from any Western technology nexus. Achieving this without a broad base of allies or trusted partners remains a formidable challenge.

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