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CHIPS and Science Act: A Catalyst for US Semiconductor Industry

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***Abstract*—The CHIPS and Science Act of 2022, a crucial U.S. law, seeks to strengthen the domestic semiconductor sector and global tech dominance by dedicating $280 billion to research, innovation, and production; reduce foreign reliance; and boost national security. The Act spurred over $200 billion in private investments from major firms, aiming to create 44,000 jobs and achieve a 28% global market share in advanced logic chips by 2033. It also enabled partnership with India for its first semiconductor fabrication facility. Despite challenges such as funding diversions, high costs, skilled labor shortages, supply chain dependencies, and geopolitical tensions, the Act aims to maintain U.S. technological competitiveness and preparedness for future economic and security challenges.**

Keywords—Chips Act, Semiconductor, Manufacturing, Advanced Packaging

I. INTRODUCTION

The CHIPS and Science Act of 2022 is a historic law of the United States of America to strengthen the semiconductor industry and maintain the lead in the technology race. This law is bipartisan, and it allocates a huge amount of money which is about $280 billion [1] on science, innovation and domestic chip production. The main one? To decrease the reliance on the semiconductors produced in other countries particularly in the country which is China.

To accomplish this, the Act provides incentives in the form of subsidies and tax incentives to firms that are establishing semiconductor plants in the U.S. But it is not only about constructing factories, but it is also about constructing people. The legislation provides funding for STEM education and the workforce, which means that there would be an adequate workforce to sustain the industry.

Through the CHIPS and Science Act, the US strives to support domestic manufacturing and advance research to enhance the national security and protect the supply chains, as well as to preserve the leading position of the United States in the fields of artificial intelligence, quantum computing, and advanced telecommunications. It is not an investment in chips alone, it is an investment in the future.

II. BACKGROUND

The *CHIPS and Science Act of 2022* was urgently needed to address the critical issue of U.S. dependence on foreign chip manufacturers, which had become a significant vulnerability for both economic and national security reasons. Over the past few decades, the U.S. has seen a dramatic decline in its share of global semiconductor manufacturing, dropping from approximately 37% in the 1990s to approximately 12% in recent years [1]. This decline was largely due to the outsourcing of semiconductor production to countries such as Taiwan, South Korea, and China, where labor and production costs were lower. As a result, the U.S. became heavily reliant on these foreign manufacturers for chips

that power everything from consumer electronics and automobiles to advanced defense systems and AI technologies.

Overreliance on Asian countries, particularly Taiwan (home to TSMC, the world's largest semiconductor manufacturer) and South Korea (home to Samsung), poses significant risks. Taiwan's geopolitical tensions with China, which claimed the island to be part of its territory, raised concerns that any disruption, whether from conflict or natural disasters, could severely impact the global supply of semiconductors. Such disruption would have cascading effects on industries worldwide, given that semiconductors are essential components of modern electronics, vehicles, medical devices, and defense systems.

Meanwhile, China has been rapidly advancing its own semiconductor capabilities as part of a broader strategy to achieve technological self-sufficiency and reduce its dependence on the U.S. and Western technologies. This has been viewed as a direct challenge to U.S. technological leadership, especially in areas such as artificial intelligence (AI) and 5G telecommunications, both of which rely on cutting-edge semiconductor technologies. The U.S.'s dependence on foreign chipmakers, particularly in China, heightened concerns about national security, as relying on potential adversaries for critical technology components could expose the U.S. to supply chain vulnerabilities or even sabotage.

The global semiconductor shortage that emerged during the COVID-19 pandemic exposed these vulnerabilities in stark terms. Disruptions in chip production in Asia have led to supply shortages that have affected industries worldwide, particularly in the automotive, consumer electronics, and telecommunications sectors. Automakers, for example, were forced to halt production lines because of the unavailability of essential chips, leading to billions of losses and the delayed delivery of new vehicles. This shortage highlighted the urgent need for the U.S. to restore its domestic semiconductor manufacturing capabilities and reduce its reliance on fragile global supply chains.

In response to these growing risks, the *CHIPS and Science Act* was designed to bolster domestic semiconductor production and strengthen U.S. supply chain resilience. It provides $39 billion in subsidies, tax credits, and loan guarantees to encourage American companies to build new chip manufacturing plants, or fabs, on U.S. soil. These incentives are crucial for bringing manufacturing back to the U.S., as chip production is capital-intensive, and companies have previously found it more cost-effective to operate in countries with lower manufacturing costs.

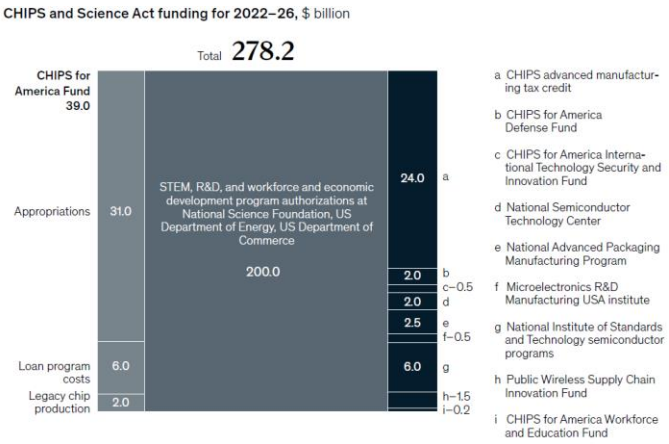


Fig. 1. Funding Breakdwon, Source: Mckensy Report[1]

The CHIPS Act dedicates a total of $280 billion [1] over the next decade, with a significant portion—$200 billion—focused on scientific research, development, and commercialization. About $52.7 billion will support semiconductor manufacturing, research, and workforce training, along with an additional $24 billion in tax incentives [Fig. 1] to boost chip production. Furthermore, $3 billion is allocated for initiatives in advanced technology and secure wireless supply chain development.

The CHIPS and Science Act aims to boost domestic chip production and lessen reliance on foreign manufacturers, securing the U.S.'s technological future and mitigating risks from geopolitical tensions, supply chain disruptions, and foreign control over essential components. This strategic investment in the U.S. semiconductor industry ensures competitiveness in the

global tech race and preparedness for future crises that could threaten economic and national security.

III. IMPACT OF THE ACT

CHIPS Act has already spurred significant growth in the U.S. semiconductor industry, catalysing investments and creating new jobs at an unprecedented rate. Since its enactment in August 2022, the Act has attracted more than $200 billion in private sector commitments, with companies such as TSMC, Intel, Samsung, and Micron announcing major expansion projects across the United States. For example, Intel's $20 billion [3] investment in Ohio, projected to grow to a $100 billion commitment, represents the largest single private investment in state history. TSMC has similarly pledged a $65 billion investment in Arizona to establish advanced chip manufacturing facilities, creating an estimated 6,000 jobs, and Samsung is contributing $17 billion [4]to a new fab in Texas, the largest foreign direct investment in the state.

In terms of job creation, the Semiconductor Industry Association estimates that the CHIPS Act will help create 44,000 direct jobs in the semiconductor industry. Additionally, research by the Boston Consulting Group [5] and the Semiconductor Industry Association projects that by 2033, the U.S. will capture 28% of the global market share in advanced logic chips, nearly tripling its current share. This projected increase reflects the expansion of semiconductor manufacturing within U.S. borders, reducing reliance on foreign manufacturers and creating a more resilient domestic supply chain.

The Act also strides to promote technological innovation. In the first two years, the National Science Foundation's Technology, Innovation, and Partnerships (TIP) Directorate was awarded over 2,400 grants and signed 25 R&D contracts, incentivizing $8.15 billion in private capital. Furthermore, the NSF established 10 new Regional Innovation Engines [6] and issued the first 40 awards through the ExLENT program, which promotes hands-on semiconductor engineering training at universities to close the skills gap in the workforce.

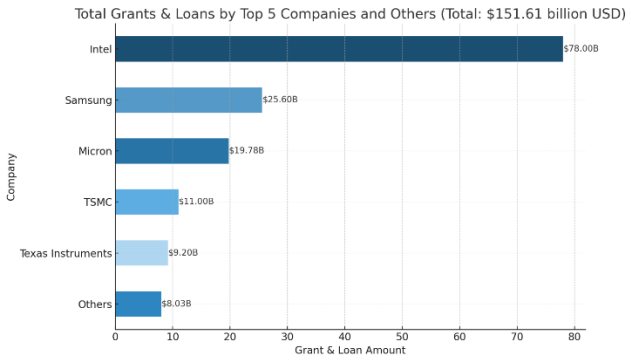
Beyond manufacturing and innovation, the CHIPS Act emphasizes environmental and social responsibility within the semiconductor sector. The Department of Energy has focused on funding sustainable practices, including projects in quantum computing, biotechnology, and energy-efficient chip design. Additionally, approximately $100 million has been allocated to metrology research, which is crucial for advanced measurement techniques to ensure quality and efficiency in chip production. To address potential workforce shortages, the Act's workforce development initiatives are projected to help fill an estimated 300,000 semiconductor-related roles in the coming years, from technician positions requiring two-year degrees to advanced engineering roles.

The macroeconomic impacts are equally significant, with federal grants and tax credits expected to reach $75 billion, supplementing the Act's $39 billion funding pool for manufacturing incentives. By mid-2024, $32.8 billion of this had already been allocated. Together with investments from the Inflation Reduction Act and Infrastructure Investment and Jobs Act, the CHIPS Act has driven over $988 billion in private investments and $630.3 billion in public infrastructure spending across sectors, including electronics, clean energy, and industrial manufacturing, demonstrating its broad impact on the U.S. economy. As the U.S. continues to implement these projects, the Act is projected to transform the nation into a global semiconductor powerhouse, ensuring long-term economic stability and technological leadership.

The companies grouped under the "Others" category [Fig. 2] received substantial grants and loans collectively. Among these companies, GlobalFoundries stands out with $3.1 billion in funding, followed by Wolfspeed with $1.5 billion and SK hynix with $950 million. Global Wafers have been allocated $800 million, while Amkor received $600 million. Hemlock Semiconductor was awarded $325 million, and Infinera received $186 million. Microchip Technology followed with $162 million, while Polar secured $123 million in grants and loans. Entegris and Absolics each received $75 million, and HP was granted $50 million. BAE Systems was allocated $35 million, SolAero (Rocket Lab) received $23.9 million, Edwards

Vacuum secured $18 million, and Rogue Valley Microdevices was granted $6.7 million. These companies, though receiving smaller individual amounts than the top five, play crucial roles in the semiconductor and technology landscape, contributing to various aspects of production and innovation.

Fig. 2. Loans and Grants, Source: SIA and Department of Commerce [2]



A recent report from the Semiconductor Industry Association (SIA) and Boston Consulting Group (BCG) highlights substantial progress in strengthening the resilience of the semiconductor supply chain in the U.S. and globally, largely due to industry investments and incentives provided by the CHIPS and Science Act. The report forecasts that the U.S. fab capacity will increase by 203% from 2022 to 2032 [Fig. 3], representing the largest growth percentage worldwide for that period. This tripling of capacity is a testament to the significant industry expansion facilitated by the CHIPS Act's incentives. Additionally, the U.S. is projected to capture 28% of global capital expenditures in semiconductor manufacturing from 2024 to 2032, amounting to an estimated $646 billion, second only to Taiwan. Without the CHIPS Act, the U.S. share of global capital expenditures would likely have been limited to 9% by 2032.

For the first time in decades, the U.S. is also expected to increase its share of global fab capacity, rising from the current 10% to 14% by 2032. Without the CHIPS Act, this share was projected to decrease by 8% over the same period. Furthermore, the report indicates that the U.S. will strengthen its position in critical technology segments, including leading-edge fabrication, DRAM memory and advanced packaging. By 2032, the U.S. capacity for advanced logic chips (less than 10 nm) is expected to reach 28%, a significant increase that includes new capabilities at the forefront of semiconductor technology. This report underscores the transformative impact of the CHIPS Act on U.S. semiconductor manufacturing, both in capacity and technological advancement, and reinforces the nation's role in the global semiconductor supply chain.

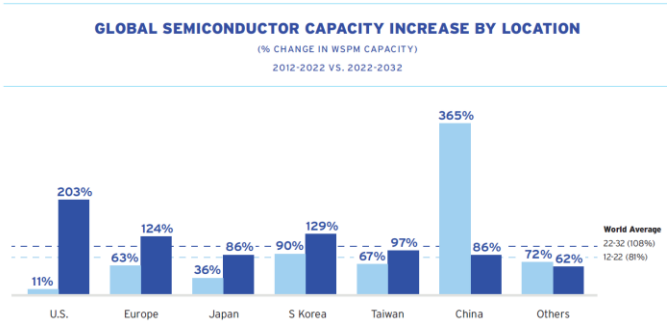


Fig. 3. Global Semiconductor Capacity Increase by location, WSPM(Wafer Starts Per Month), Source: 2024 state of the U.S. semiconductor industry [8]

IV. US-INDIA COLLABORATIONS

The *CHIPS and Science Act* has enabled a groundbreaking partnership between the United States and India, leading to the establishment of the Bharat Semi Fab, India's first semiconductor fabrication facility dedicated to national security. This collaboration, announced by the U.S. President Joe Biden and Indian Prime Minister Narendra Modi were involved in the U.S. Space Force (USSF), Bharat Semi [10], and 3rdiTech [11,12] marked the first international technology alliance of its kind for the U.S. military. Named "Shakti," this multi-material facility in India will focus on producing advanced semiconductors, including silicon carbide, infrared, and gallium nitride chips. These components are essential for high-voltage power systems, advanced communications, and modern warfare sensors and provide critical technology for defence applications [9].

The project is supported by the *India Semiconductor Mission*, which provides a 50% capital expenditure [12] subsidy and aligns with the United States–India Initiative on Critical and Emerging Technology (iCET). The facility will support military-grade semiconductor production for various applications, such as night vision, missile guidance, drones, and fighter aircraft, while enhancing supply chain resilience in both nations. Additionally, the collaboration includes plans to establish design hubs, testing centres, centres of excellence, and two fabrication units, with the first phase of production slated for 2027, and an annual output target of 50,000 units.

The project, with an estimated $500 million investment, is further strengthened by the involvement of General Atomics, serving as the technology validation partner [13] for 3rdiTech, and lending expertise in compound semiconductor technology. These compound semiconductors, which are known for their efficiency in high-temperature and high-power applications, are essential for both defence and green energy technologies. By fostering the domestic production of these critical semiconductors, Bharat Semi Fab [14] supports India's *Atmanirbhar Bharat* (self-reliant India) goal, aiming to reduce India's dependence on imported chips, which amounts to $1 billion annually for national security needs.

As one of the world's first multi-material semiconductor fabrication facilities [15], Bharat Semi Fab will bolster India's position as a "net security provider" in the Indo-Pacific region. For the United States, this partnership offers an essential alternative to East Asian supply chains by establishing a reliable and diversified source of advanced technology within a strategically significant region. By addressing both defence and commercial semiconductor needs, the fab not only strengthens India's semiconductor supply chain, but also reinforces long-term technology, defence, and economic ties between the United States and India [16].

V. CHALLENGES

The CHIPS and Science Act, enacted in 2022, is a strategic initiative by the United States to boost domestic semiconductor production, reduce dependency on foreign supply chains, and advance technological leadership in critical industries. However, few implementation challenges have hindered the Act's objectives, thus impacting its potential effectiveness. Key challenges include funding reallocation, high manufacturing costs, skilled labour shortages, ongoing global supply chain dependencies, and geopolitical tensions. These issues underscore the complexity of achieving semiconductor independence and competitiveness in the current global landscape.

1. **Funding Diversions**: A notable challenge was the reallocation of funds initially designated for the CHIPS Act. In March 2024, $3.5 billion [17] of the allocated budget was diverted to the Secure Enclave, a classified Pentagon project, which disrupted planned investments in semiconductor research and prompted concerns regarding transparency and prioritization of CHIPS Act resources.
2. **High Manufacturing Costs**: Semiconductor manufacturing is capital-intensive, with individual fabrication plants often costing over $20 billion [18] to establish. Despite subsidies, financial demand remains significant, and companies must navigate these costs to expand operations sustainably.
3. **Workforce Shortages**: The U.S. semiconductor industry faces a shortage of skilled labour [Fig. 4], particularly in engineering and technical roles crucial for both manufacturing and research. This talent gap constrains the industry's ability to meet production targets and inhibits innovation.
4. **Supply Chain Dependencies**: Although the CHIPS Act aims to bolster onshore production, the U.S. remains dependent on global supply chains for essential materials and components, exposing domestic semiconductor production to vulnerabilities from international supply disruptions.
5. **Geopolitical Tensions**: Geopolitical dynamics, particularly in China and Taiwan, add further complexity to establishing a stable, independent semiconductor supply chain. As US–China tensions

intensify, the U.S. dependency on Taiwan for advanced chips underscores the challenge of achieving the semiconductor self-sufficiency.

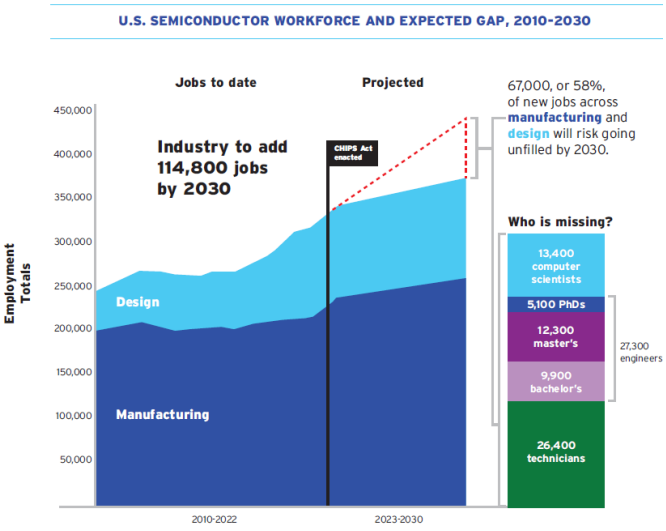


Fig. 4. US Semiconductor Workforce & Expected Gap, 2010-2030, Source: 2024 state of the U.S. semiconductor industry [8]

VI. CONCLUSION

The CHIPS and Science Act of 2022 is a strategic initiative aimed at strengthening the U.S. semiconductor industry by promoting domestic production, innovation, and supply chain security. The Act has driven significant private investment and fostered international partnerships, notably with India, to secure critical technology resources. While challenges such as workforce shortages and geopolitical tensions remain, the CHIPS Act is a foundational step toward a more resilient semiconductor ecosystem. Its impact on the U.S. economy and global tech leadership will set a precedent for future policies in technological and industrial strategy.

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