CED POLICY BRIEF
The CHIPS and Science Act of 2022
August 9, 2022

The CHIPS and Science Act of 2022 is designed to incentivize the domestic production of semiconductors and support applied scientific research in the US. The bill, which garnered significant bi-partisan support, is largely in response to three main concerns: 1) the US need to remain economically competitive and a leader of technological innovation with the rapid growth and sophistication of the Chinese economy as an outgrowth of a substantial Chinese industrial policy; 2) concerns about disrupted supplies chains for such critical components for the modern economy due to the global pandemic and geo-political tensions, particularly with regards to Taiwan, the world's leader in semiconductor manufacturing; and 3) maintaining the integrity of the chips value chains for national defense given the reliance of all major US defense systems and platforms on semi-conductors.

The Act passed on a bipartisan basis—a 64-33 final vote in the Senate and a 243-187 vote in the House, with 17 Republicans in the Senate and 24 Republicans in the House joining Democrats to vote for the bill and the President signed it into law August 9, 2022. Enactment of the bill has been an 18-month process. In January 2021, Congress authorized, as part of the National Defense Authorization Act for 2021, several programs to promote semiconductor R&D and fabrication in the US. However, it did not appropriate funds for those programs. Since then, each chamber has separately voted for funding in some form, coupled with other measures to promote applied science.

The Senate passed the United States Innovation and Competition Act in June 2021. The House passed the America COMPETES Act in February 2022. A second push this summer resulted in this week's legislation, which largely adopts the Senate bill but moves in the direction of the COMPETES Act in several respects, notably on the purposes of the new funding for the National Science Foundation. The President strongly supports the legislation, having mentioned it in his State of the Union Address in March and again at a manufacturing-focused summit just before the bill came up for consideration and passage in Congress.

While drawing significant Republican votes in both the House and the Senate, particularly in a mid-term election year, the main arguments of the opponents of the bill centered on the deficit spending impact and the inclusion of subsidies combined with tax incentives for profitable companies that were responding to market forces and already diversifying their operations and supply chains. In essence, criticisms of the bill were not about the "why" but the "how" the semiconductor challenge was being addressed. The nonpartisan Congressional Budget Office (CBO) scoring of the bill estimated a $79 billion increase in the deficit over a 10 year period (additional spending of $55 billion and a reduction in tax revenue of $24 billion), which did not include the $200 billion in research funding since the funds were not appropriated. In short, the bill was not paid for at a time of historic debt and deficits which will cost more to service with the rise in interest rates.

Summary of Major Provisions

In brief, the Act, estimated to be a $280 billion bill, contains $52.7 billion in subsidies for domestic semiconductor production, managed by the Departments of Commerce and Defense, and an investment tax credit for domestic semiconductor manufacturing as well as $200 million to train and expand the domestic semiconductor workforce. The Act also authorizes funding, for both basic and applied research, for the National Science Foundation ($81 billion including $20 billion for a new Directorate for Technology, Innovation, and Partnerships focusing on applied research), the National Institute of Standards and Technology ($10 billion, including $3.1 billion for partnerships with manufacturers), the Department of Energy ($67.9 billion), and the National Aeronautics and Space Administration. The Act also directs the Commerce Department to establish twenty geographically distributed regional technology and innovation hubs ($10 billion). Overall, the Act is a rare example of bipartisan cooperation and contains numerous provisions designed to promote public-private collaboration.

More specifically, as enacted, the CHIPS and Science Act contains three divisions:

- Division A, operating largely through the Department of Commerce (DOC), contains $52.7 billion in subsidies for domestic semiconductor production, plus an investment tax credit for semiconductor manufacturing that the CBO estimates would reduce revenues by $24.3 billion over the next ten years. It also includes $1.5 billion for the Public Wireless Supply Chain Innovation Fund, to support development of US mobile broadband.
- Division B, with funding for DOC, the National Science Foundation (NSF), the National Institute of Standards and Technology (NIST), the Department of Energy (DOE), and the National Aeronautics and Space Administration (NASA), authorizes roughly $200 billion in applied research (and some funding for current operations). The largest portion of this, $81 billion, would go to the NSF, boosting core NSF funding and establishing a Directorate for Technology, Innovation, and Partnerships (TIP) which will focus on accelerating applied research.
- Division C, thematically unrelated to the rest of the legislation, boosts security funding for the Supreme Court in response to recent threats against the Court and its Justices.

Division A: CHIPS Act of 2022
The first part of the CHIPS Act, contains semiconductor subsidies, tax credits, and other related provisions:

- $39 billion in DOC manufacturing incentives to build, expand, or upgrade semiconductor facilities in the US, including $2 billion specifically for mature node semiconductors—the type most critical to the automotive industry. Up to $6 billion of this total may be used for loans and loan guarantees.
- $11 billion for DOC research and development subsidies, including the creation of a National Semiconductor Technology Center (NSTC). The research and development subsidies would fund a variety of public-private partnerships to invest in new research, improve assembly test and packaging capabilities (adding subsidies beyond semiconductor manufacturing), and improve measurement science standards.
- $2 billion for a CHIPS for America Defense Fund, which would support Department of Defense applications.
- $200 million to train and expand the domestic semiconductor workforce.
- $500 million for a Department of State CHIPS for America International Technology Security and Innovation Fund, which would support secure telecommunications technologies in coordination with foreign partners.

- A 25 percent tax credit for investments in domestic semiconductor manufacturing, estimated to reduce revenues by $24.3 billion over the next ten years.
- $1.5 billion for a Public Wireless Supply Chain Innovation Fund, which will provide financing for the National Telecommunications and Information Administration to support the domestic development of advance wireless and mobile technologies.

Both the subsidies and the tax credit for semiconductor manufacturing include language that limit or prohibit the expansion of semiconductor manufacturing in the People's Republic of China and other countries of concern for up to ten years after receipt of funds. Companies would be required to notify the DOC of their plans in countries of concern, and if DOC determines those plans would violate the terms of the subsidies, firms would have an opportunity either to change their plans or return the financial assistance.

Division B: Research and Innovation
The second part of the legislation focuses on funding for scientific research. It contains seven titles:

- **Title I, Department of Energy Science for the Future**, increases funding for the DOE Office of Science, as well as other scientific initiatives in the DOE. In total, the legislation's five-year authorization for the Office of Science is $50.3 billion, $12.9 billion over baseline. Other funding for science and innovation adds $17.6 billion. This funding supports research in basic energy and materials science, chemistry, nuclear physics, climate science relevant to new energy technologies, and other applied sciences. It also provides workforce training, facilitates the technology transfer of clean energy to other countries, and accelerates the commercialization of energy technologies.
- **Title II, National Institute of Standards and Technology for the Future,** increases funding for NIST, with a five-year authorization of $6.9 billion, $2.8 billion above baseline, to support research and standards development in key industries including cybersecurity and artificial intelligence. It also contains $3.1 billion for partnerships with manufacturers to assist them with cybersecurity, workforce development, and minimizing supply chain disruptions.
- **Title III, National Science Foundation for the Future,** boosts funding for NSF substantially and establishes a Directorate for Technology, Innovation, and Partnerships (TIP), which focuses on applied research. In total, core NSF activities are authorized at $61 billion, or $16 billion above baseline, to grow basic research across a wide variety of scientific fields. TIP, authorized at $20 billion, would focus on applied research in areas critical to national security or the economy, such as artificial intelligence, 6G telecommunications, and energy and material science.
- **Title IV, Bioeconomy Research and Development,** requires the White House Office of Science and Technology Policy to implement a National Engineering Biology Research and Development Initiative, to advance biological sciences, particularly in molecular biology, including genomics, proteomics, and metabolomics.
- **Title V, Broadening Participation in Science,** contains provisions to diversify participation in federal science programs, for instance by making federal grant policies more flexible to individuals with caregiving responsibilities, collecting demographic information on recipients of federal awards and STEM faculties at universities, and combating sexual harassment. It supports STEM education efforts in rural areas and at minority-serving institutions such as Historically Black Colleges and Universities.

- **Title VI, Miscellaneous Science and Technology Provisions,** directs the DOC to establish twenty geographically distributed regional technology and innovation hubs to focus on supporting innovation efforts in their area. $10 billion is authorized for this program, plus $1 billion for the Recompete Pilot Program, which supports persistently distressed communities.
- **Title VII, National Aeronautics and Space Administration Authorization,** authorizes the Artemis Program to return to the Moon and continuing US support for the International Space Station until its planned retirement in 2030 and expresses the sense of Congress that NASA's scientific research priorities should include experimental aircraft, the search for life beyond Earth, planetary defense, and observatories.

Subsidies for Domestic Semiconductor Manufacturing

Semiconductors are an essential foundation of a modern economy and, consequently, for US defense capabilities. In recent decades, semiconductors have become part of the supply chain for a huge variety of consumer goods, from microwaves to automobiles to phones. They are also critical to virtually all defense functions, including military vehicles and communications equipment.

While semiconductors can be cheap when manufactured in bulk, supply of semiconductors is highly inelastic in the short run: that is, consumer demand cannot immediately spur higher production, even if consumers offer much higher prices. Semiconductor "fabs" (manufacturing plants) require a substantial up-front investment, often taking several years to construct. Therefore, in an adverse event that creates a semiconductor shortage—such as the COVID-19 pandemic—semiconductors become unavailable or extremely expensive, reflecting a high consumer willingness to pay and inelastic supply.

The world's manufacturing plants of the most commonly used 300mm semiconductor chips are largely concentrated in east or southeast Asia, where 98 were located in 2019, just before the pandemic. Of those, 60 were in China or Taiwan. Taiwan is the world's leader in semiconductor manufacturing, with over 60% of total global semiconductor foundry revenue in 2020 and 90% for advanced semiconductors. One company, TSMC, itself accounts for 54% of total global foundry revenue. Taiwan, South Korea, and China account for 87 percent of global market share; one US company (Global Foundries) has 7 percent. In 2019, the US accounted for 11% of the world's semiconductor fabrication capacity, down from 40% in 1990.

TSMC is also a leader in advanced and next-generation chip production, where Taiwan's lead is even greater, with one consulting firm estimating its market share at 92 percent (South Korea holds the other eight percent; China does not yet have this capacity). By any measure, Taiwan is a friend of the United States, but this level of market share leads to sharply increased geopolitical and supply chain risk.

It is hard to build a stand-alone semiconductor industry. China's industry is highly subsidized by the government. Taiwan's started with strong government assistance, including building links between domestic manufacturers and purchasers and offering intellectual property to TSMC and another company. While the US remains a leader in semiconductor research and design with a well-established and profitable semi-conductor sector, many of its most innovative firms have moved to a "fabless" model, outsourcing the physical production of the chips to other firms, typically located in Asia.

Given the size of its domestic market, China is rapidly developing its superconductor industry with heavy government subsidies, building many new manufacturing facilities as well as buying chips from Taiwan. The European Union is also embarking on a program to encourage new semiconductor fabrication in its proposed European Chips Act, involving more than €43 billion in public and private investments and monitoring the semiconductor value chain through a new coordination mechanism between Member States and the European Commission. The US is gaining more fab capacity; TSMC has announced plans to build a 5-mm plant in Arizona, and Samsung will build one in Texas; Intel is expanding its facilities in Arizona and will build two new plants in Ohio. Each complex is expected to cost at least $12 billion to $20 billion.

By any measure, $52 billion in subsidies is a significant investment compounded by the tax credits also in the Act and involves government more deeply in the economy. While the bill received important bi-partisan support, concerns remain about the subsidies and tax credits for an industry that is generally profitable. Normally, market solutions are far preferable to direct government subsidies, as subsidies run the risk of subsidizing inefficient projects that might not be started without the subsidy. Opponents of the CHIPS Act have also argued that the US semiconductor industry is already diversifying and changing its supply chains so that the provision of subsidies is unnecessary—and that the cost to the Treasury exceeds any marginal benefits the Act would provide.

Proponents of the bill argued that the government subsidies and tax credits were needed due to the importance of semiconductors to national security and the danger of depending on foreign sources of supply for an item essential to national defense. The bill is intended to encourage onshoring and nearshoring. Second, the US is in a truly global competition for semiconductors, which have become indispensable to the functioning of the modern economy. As competitive rivals offer subsidies for location of facilities, the US may otherwise lose the competition, putting supply chains throughout our economy at risk. Third, in general, market solutions can be suboptimal in the presence of an externality, in this case the exceptionally high cost of shifting semiconductor manufacturing, a cost ultimately borne by industries that use semiconductors as well as by manufacturers.

But, the CHIPS Act of itself will not offer the US a complete supply chain; there will still be supply chain risk. True supply chain resilience will also require addressing assembly, testing, and packaging facilities as well; currently, just 3 percent of global semiconductor packaging takes place in the US. A resilient supply chain would consider geopolitical concerns as well as issues of labor and other costs. New US capacity will also require trained workers, perhaps as many as 90,000, which would require a 50 percent increase in trained workers, according to one report. Public-private training initiatives will be essential to meet the challenge, along with the $200 million appropriation for workforce training.

Government's Role in Research Funding

The Act calls for the expansion of government funding of both basic and applied research and, over time, in order to help preserve and restore US leadership in many advanced sectors, helping US businesses bring new innovations to market. While CED has called for increasing government funding of basic research in critical technologies, which has lagged in recent years, disseminating research funding effectively is essential. The method used to determine the location of the new publicly funded research and innovation hubs will require careful consideration to ensure the money is well spent and the hubs become genuine catalysts for further R&D and production. Current hubs such as Research Triangle Park, Silicon Valley, the tech hub in Northern Virginia, biotech hub in Maryland, and the earlier Route 128 hub in Massachusetts grew more organically, albeit with strong public-private collaboration (in particular, for Research Triangle Park). Some hubs—such as defense and tech in northern Virginia, biotech in Maryland—arose in part because of the presence of government and government funding, but they were tied to specific industries and local expertise rather than simply being imposed as a government initiative. The Act's focus on research in applied sciences likely to enable commercially useful or strategically important products raised the possibility that public funds, will be used on research priorities the private sector might have funded adequately on its own.

While concerns remain about tax credits and subsidies, especially to a profitable industry, the Act is a rare example of bipartisan cooperation, focused on national security imperatives and important products and fields that are essential to continued economic growth. It contains numerous provisions designed to promote a welcome public-private collaboration and CED will monitor the implementation of this legislation.