The Si² Fund: Building a Microelectronics Fund of Funds

A White Paper Proposal

Rick Switzer
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This paper was written by SCSP Senior Fellow Rick Switzer who is on a one-year sabbatical from the Department of State. Prior to joining SCSP, Rick was a State Department visiting professor at the National Intelligence University teaching graduate courses on China's economy and innovation system. Rick also served as a member of the Secretary of State's Policy Planning Council. From 2018 to 2019 he was a Senior State Department Advisor to the Department of Defense working with the Air Force and the Army. Preceding that he was the Environment, Science, Technology and Health Minister Counselor at Embassy Beijing, the largest science section in the world. Prior to joining government Rick co-founded a wireless technology start-up and also conducted innovation policy research at the University of California.

The views in this paper are the author's own and based on research he conducted prior to and during his sabbatical with SCSP. These views are not attributable to SCSP, the SCSP Board, or its staff.

Proposal Summary

Despite its boldness, existing CHIPS & Science Act funding is insufficient to rebuild U.S. semiconductor production without significant private investment. The challenge is designing the right incentives to attract that investment to complement federal dollars. A solution will require the same imaginative thinking that generated CHIPS originally. Congress should authorize and the Administration should establish a Semiconductor Industry Investment Fund (or Si² Fund – pronounced SI Squared) to support the establishment of public-private investments targeted for the semiconductor industry. This "fund-of-funds" model proposes channeling federal dollars through the Si² Fund as matching startup capital to incentivize private investment into domestic semiconductor manufacturing capacity. The Fund provides a unique structure that is capable of solving a key challenge identified in the Executive Order on the CHIPS Act, which seeks to rebuild the U.S. semiconductor manufacturing base by "catalyzing private-sector investment, including by reducing risk and maximizing large-scale private investment in production."[1] The fund would de-risk investment and increase returns to investors willing to put capital to work in support of national security goals. Startup funding should begin at $10 billion and come either from existing CHIPS funding or a new special purpose federal investment vehicle.

Why a Fund of Funds Model?

1. The Problem of Scale

In August, Congress passed the CHIPS & Science Act to rebuild U.S. leadership in microelectronics.[2] But without additional actions to channel America's vast private capital markets, these efforts will fall flat. For the United States to regain market share closer to the 37% of global semiconductor production enjoyed in the 1990s,[3] Washington will need to develop policies that catalyze private sector investments that are double or even triple the numbers anticipated in a CHIPS Act plus industry investment on an annual basis for the foreseeable future.

The CHIPS legislation provides $39 billion over five years to support U.S.-based investment in new fabs.[4] However, semiconductor industry capital expenditures are forecast to reach $185 billion in 2022, up 21% from the previous year,[5] with total chip sales expected to hit over $1 trillion before the end of the decade.[6] When implementation and other costs are factored, the total CHIPS-based investment subsidy into new productive capacity is likely to be $7.8 billion per year over five years[7] or just over 4% of global forecast annual investment.

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[1] See Executive Order on the Implementation of the CHIPS Act of 2022, The White House (2022).
[2] Pub. L. 117-167, The CHIPS and Science Act of 2022 (2022).
[3] See 2021 State of the U.S. Semiconductor Industry, Semiconductor Industry Association at 10 (2021).
[4] See Fact Sheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China, The White House (2022).
[5] Peter Clarke, Semiconductor Capex Cut in 2022, eeNews Europe (2022).
[6] Ed Sperling, Chip Industry Heads Toward $1T, Semiconductor Engineering (2022).
[7] Note: This is a based average of funds available under CHIPS of $39 billion divided by 5 years of funding equaling $7.8 billion. See Elizabeth Zane, et al., CHIPS Act: What Companies Need to Know, Orrick (2022).

CHIPS success is predicated on federal subsidies being matched by industry, potentially bringing the total to $22 billion in annual investments or 10% of global investment.[8] That number likely represents the lion's share of U.S. capital expenditure on new fabs on an annualized basis. Meanwhile, leading semiconductor-producing nations around the world, including China and U.S. allies like the EU, Japan, South Korea, and Taiwan, have already announced plans for more than $500 billion in investments over the same time period.[9] TSMC alone is on track to invest $40 billion in semiconductor capital equipment in 2022.[10]

If annual capex remains at roughly 10% of global total as we project, the United States will not increase its share of global production, with a best-case scenario where it stabilizes at the current 12%,[11] reversing a decades-long trend where, on average, America's share of global output shrunk at just under 1% per year starting in the late 1990's.[12] If the goal is to increase America's share of global semiconductor fabrication, then the United States must find additional, more efficient ways to channel the United States' vast pool of investment capital into national and economic security priorities.[13]

2. Insulating Industrial Strategy from Politics

Beyond scale, one of the primary criticisms of the CHIPS Act is that it will lead to top-down economic policies. Critics of the bill claim that it will devolve into a situation where government bureaucrats are picking winners.[14] As currently structured, some of these criticisms have salience and open the program up to greater scrutiny, raising the political stakes for supporters of CHIPS and for the idea that smart techno-industrial policy is the only way America can compete in a global technology manufacturing ecosystem that is dominated by the subsidies and market bending policies by our competitors. The United States needs a mechanism to place final investment decisions into the hands of private sector investment professionals who must answer to their shareholders and investment partners. A fund of funds model not only increases the likelihood that market-based decisions from seasoned professionals will be at the heart of all major investment decisions, it will also provide the actual mechanism to crowd in tens of billions of private investment capital not available under the direct subsidy to

[8] Specifics about how much private sector investment will be catalyzed by the $39 billion in Chips grants and loan guarantees have not been released by Congress of the Executive Branch. However, the Chips implementation RFI from NIST notes that loan guarantees could yield as much as $75 billion, which when added to the remaining $33 billion in manufacturing support funding comes to $114 billion or $22 billion per year over the program's five years. See CHIPS Incentives Program Implementation, American Economic Association (2022); 87 Fed. Reg. 62080, Manufacturing USA Semiconductor Institutes, National Institute of Standards and Technology (2022).

[9] Kim Jaewon, South Korea Plans to Invest $450bn to Become Chip 'Powerhouse', Nikkei Asia (2021); Wei Sheng, China's 'Big Fund' Raises RMB 200 billion to Fuel Chip Industry, TechNode (2019); Paul McNamara, $160 Billion European Chips Act Seeks to Boost Semiconductor Production 4X, Supplyframe (last accessed 2022); Been Dooley & Hisako Ueno, Japan Once Led the World in Microchips. Now, It's Racing to Catch Up, New York Times (2022).

[10] See Debby Wu, TSMC to Spend at Least $40 Billion to Address Chip Shortage, Bloomberg (2022).

[11] See 2021 State of the U.S. Semiconductor Industry, Semiconductor Industry Association at 10 (2021).

[12] This is an average of U.S. market share loss starting at 37% in 1990 dropping to 12% in 2020 for an average loss of 0.83% per year. See 2021 State of the U.S. Semiconductor Industry, Semiconductor Industry Association (2022).

[13] For further discussion on this, see Restoring the Sources of Techno-Economic Advantage, Special Competitive Studies Project (2022).

[14] See Bryan Riley & Andrew Lautz, Senate Should Reject $76B Chips Subsidies Bill, National Taxpayers Union (2022).

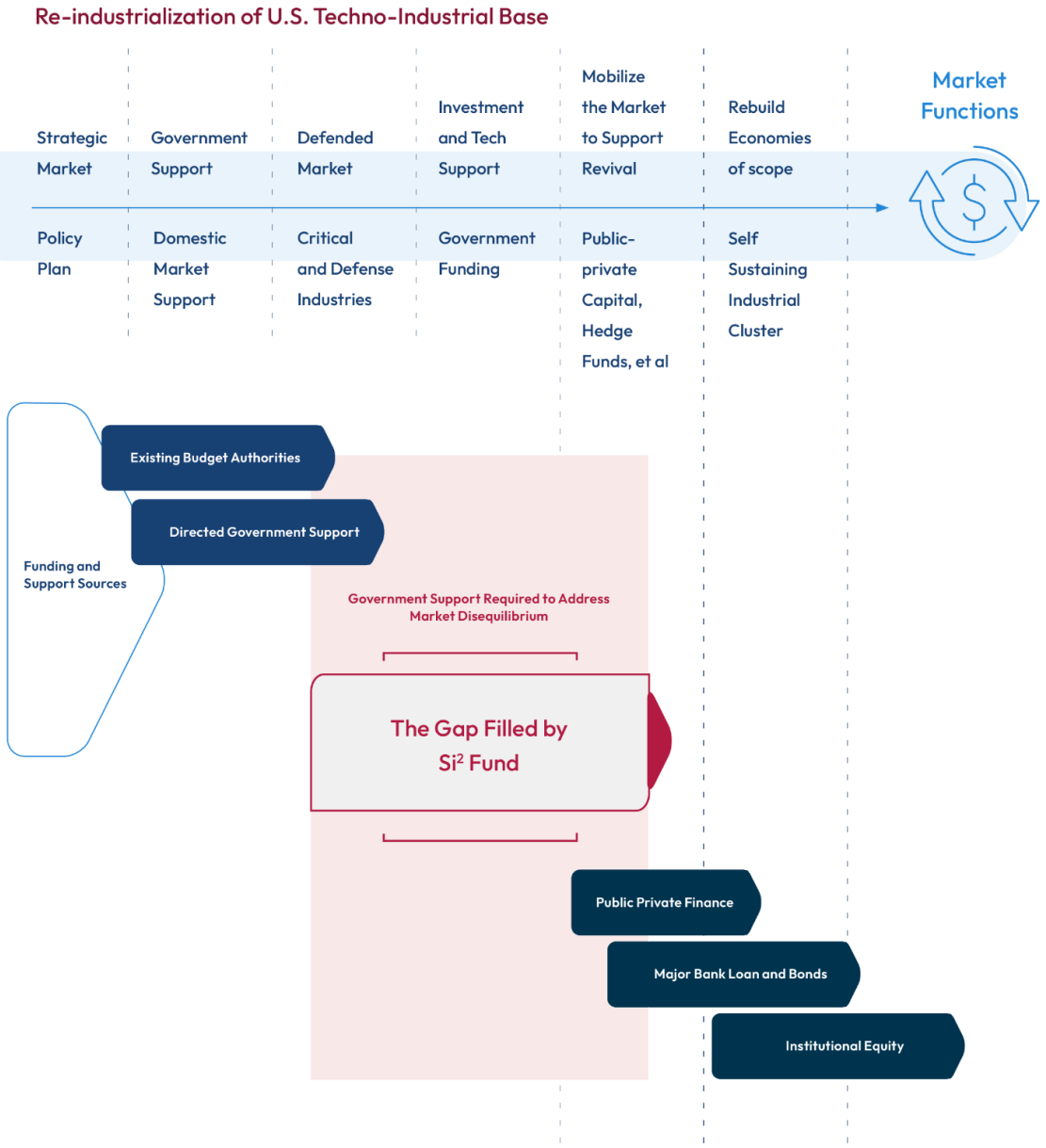
industry model.

3. The Problem of Incentives for Private Investment

The loss of U.S. leadership in chip manufacturing is the result of complex market factors, however, at its core it stems from domestic incentive structures and policies that incentivize short-term profits and short-term shareholder value maximization over long-term productivity and investment in domestic production capacity. The latter or long-term capital investment strategy, which promotes sustainable GDP growth and a vibrant growing middle class, requires rewarding patient capital for investing in domestic techno-industrial manufacturing in order to compete against market manipulation and subsidies designed to reduce the cost of capital in critical industries by competitors.[15] The confluence of these forces led to America's exit from chip manufacturing leadership and contributed to our current status as a third tier producer of chips.

America possesses the largest, deepest, and most liquid capital markets in the world, in addition to the lowest market-based costs of capital. However, fixed-asset investment requirements in semiconductors and related microelectronics are very large,[16] requiring long time horizons to turn a profit in an industry that thrives on disruption. This makes investment riskier while also increasing the opportunity costs due to the long lead investment horizon. As such, most new high volume, leading node foundries are now only built-in markets where the local government provides significant incentives to investors by de-risking investments thereby decreasing the true cost of capital. For example, before Chips Act legislation was announced, Intel's Fab 42 – first announced in 2011[17] and not fully operational until 2020[18] – was the only leading node foundry built in the United States by Intel, America's largest semiconductor manufacturer by sales, between 2011 and 2017. Between 2018 and 2020 Taiwan, primarily invested almost 20 times as much in industry leading 300mm foundries than the United States.[19] Only by addressing this fundamental market disequilibrium can the United States hope to return to market dominance in this critical industry. Thus, the need for a fund of funds that incentivizes private capital participation.

[15] Rick Switzer & David Feith, China Hit Some Bumps on its Road to Semiconductor Dominance, Wall Street Journal (2022).
[16] Willy Shih, TSMC's Announcement Of A New U.S. Semiconductor Fab Is Big News, Forbes (2020).
[17] See Ann Kelleher, Fab42: Our Recent Announcement, Intel Newsroom (2017).
[18] Bob Swan, Why Manufacturing Matters: Intel's 40 Years in Arizona, AZCentral (2020). See also Andrew Cunningham, Intel Will Invest $7 Billion to Finish a Factory It Started in 2011, Ars Technica (2017) ("Fab 42 will be Intel's third manufacturing facility in Chandler, Arizona. Fab 12 opened in 1996, and as of 2011 or 2012 Intel said it would be producing 22nm chips there. Fab 32, opened in 2007, manufactures 22nm and 14nm chips.").
[19] Rick Switzer, U.S. National Security Implications of Microelectronics Supply Chain Concentrations in Taiwan, South Korea and The People's Republic of China, OCEA Occasional White Paper (2019).



Si²: A New Model

Rebuilding America's Techno-Industrial Base

The United States is not destined to lose in manufacturing, but it does need a creative new way to ensure CHIPS and other federal funding mechanisms actually address the core problems. With the right policies and stronger public-private partnerships, a portion of CHIPS funding or newly authorized funds can be channeled so that most of the new money comes from America's enormous pool of private investment capital. Achieving this requires a strategic response that leverages America's considerable competitive advantages and channels our national

endowments toward our shared national security and economic prosperity in key technology sectors across the electronics value chain such as printed circuit board, discrete integrated circuits, and analog chips in addition to leading node fabrication.

According to industry research, due almost completely to government subsidies and non-market interventions, fabs cost 30-50% less to build and operate in our competitors' markets than our own.[20] Industry sources note, the cost of semiconductor manufacturing equipment (SME) and the water and air purifications equipment required to run the clean room make up the overwhelming majority of the cost (as high as 80% in some cases[21]) of a modern $20 billion fabs, meaning the 20-40% relative cost discrepancy only makes sense when seen through the lens of competitors' market-bending industrial policies. While the United States is the leading producer of SMEs[22] – and as such, the shipping and installation of these large, complex machines should be the same or even lower for U.S.-based producers – additional support through a fund of funds could increase U.S. market share.

The Si² Fund Implementation

The creation of a fund of funds would likely require the expansion of existing authorities. As a basis for discussion, the plan below offers one possible vision for how this proposal could be constructed and implemented.

1. Charter

Establish an independent semiconductor manufacturing investment corporation that falls under a government board chaired by the Secretary of Commerce. This special purpose government vehicle named the Semiconductor Industry Investment Fund or Si² Fund will be established with $10 billion dollars in multi-year funding.

The Si² Fund's charter will be to reestablish broad-based domestic IC foundry and related microelectronics production capacity in the United States and ensure that our domestic economy and defense sector needs can be met primarily from domestic sources in case of a crisis.

2. Process

With appropriate statutory authority, the Si² Fund will disburse funds used to create public-private investment funds dedicated to investment in U.S.-based semiconductor production directed at the charter. The primary goal of the fund is to incentivize the formation of patient capital that will in turn channel America's vast well of private capital into investments that support domestic capacity and innovation in the critical semiconductor space. Federal investment capital grants will be provided to multi-source domestic

[20] Antonio Varas, et al., Government Incentives and US Competitiveness in Semiconductor Manufacturing, Boston Consulting Group and Semiconductor Industry Association at 1 (2020).
[21] See Bharath Ramsundar, A Deeper Dive into Semiconductor Foundries, Deep into the Forest (2021).
[22] Note, three of the top five SMEs by sales volume are U.S.-headquartered. See Biggest Semiconductor Equipment Stocks 2022, FinanceCharts (2022).

investment funds, established with matching federal and private sector funding, designated to invest in IC manufacturing capacity that meets the Si² Fund's charter requirements. Federal grant funding dispersed via the Si² Fund will be used to leverage private and other capital investment sources incentivizing formation of these funds. Grant funding from the Si² Fund should not account for more than 30% of total investable capital of these public-private investment funds. The Si² Fund will retain a board seat on any public-private investment fund providing direct oversight.

All final decisions to invest in specific projects or fabs will be made by private sector fund managers responsible to their private investors, while also meeting the industry funding guidelines of the Si² Fund. Leveraging America's market-based principles, the Si² Fund would move final financial decisions to fund managers responsible to private equity partners with experience in investment decisions, deal structure, and risk premium discovery. By taking the final investment decisions out of the hands of government actors it would also avoid charges that the government is "picking winners."

Aside from Si² Fund grants, these unique public-private investment funds can draw matching funds from state and local governments, private firms, foundations, and private equity and hedge funds. The charter of the Si² Fund establishes a ceiling for federal government funds at 30% of the total of partner funds' investable capital, which creates a floor of $30 billion in investable capital provided by the private investment funds before industry investment and participation. Canada's Brookfield Infrastructure recently signed an agreement to provide 49% of the investment into a new Intel foundry project[23] – private investment funds taking under 50% of a given project provides a likely model for fund of funds participation. *With this as a model the Si² Fund yields a total investment of potentially six times the allocated $10 billion in federal support for fund of funds funding or $60 billion for new investment.* The greatest impact is in building an investment model that demonstrates the profit potential to private investors willing to fund domestic U.S. semiconductor manufacturing infrastructure, rebuilding America's traditional strength of investing in high-technology manufacturing capacity.

As the goal of the Fund is not to make a profit, but to lower risk and increase the potential for return to private sector investors, making them more willing to support national security goals, any potential returns are secondary to that mission. With that as a guide, returns to private equity investors will be prioritized over the Si² Fund who will only receive returns equal to the average of the 5-year Treasury Bond yield over the period of the public-private funds' tenure. Any return on investment to the Si² Fund only accrues AFTER private investors' return crosses the 10-year average of the S&P 500 index, with all excess profit retained by the private investors. Capital paid out to the Si² Fund will either be reinvested per the fund's charter or returned to the U.S. Treasury.

[23] Brookfield Infrastructure committed to investing up to $15 billion for a 49% stake in Intel's manufacturing expansion in Chandler, Arizona. Intel is retaining a 51% stake. See Brookfield Infrastructure Signs Definitive Agreement with Intel, Brookfield (2022).

3. Governance

The Si² Fund shall be overseen by a board of six advisors that are headed by the board chairperson. The Secretary of Commerce, or her/his designate, shall serve as the chairperson. The other board members shall be the Secretary of Defense, or his/her designate, and four additional board members appointed by the Secretary of Commerce. The Managing Director of the Si² Fund shall be appointed by the Secretary of Commerce and approved by the board of advisors. Fund investments over $500 million must be approved by the board with not more than one dissenting vote. The Si² Fund is authorized to hire staff needed to support the managing director, the board, congressional notification requirements, and the day-to-day management of the fund – estimated to cost not more than $10 million per year of operation.

Other Inducements Incentivizing Cluster Formation

Additionally, investments should support other government efforts to create an interacting cluster of domestically located firms with the objective to capture the spillover from the presence of leading foreign and domestic high-tech firms through training, technology transfer, and direct cooperation with suppliers and subcontractors. Leading research universities, national labs. and private research labs should also be encouraged to participate. In addition to other standard economic incentives – the government should seek to provide tax credits, support for licensing technologies, and granting subsidies to encourage domestic suppliers to expand production to meet the input requirements, where competitive, to create critical economic and technology agglomeration effects. This is critical support as providing technical support to locally based manufacturers serves as the training ground for young engineers, which facilitates the diffusion of spin-offs and start-ups.