# Improving U.S. Competitiveness in the Global High-Performance Computing and AI Markets

Stephen Ezell
VP, Global Innovation Policy, ITIF

Hyperion Research HPC & AI Conference

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@ITIFdc

@sjezell

# About ITIF

- The world's leading science and technology policy think tank.
- Supports policies driving global, innovation-based economic growth.
- Focuses on a host of issues at the intersection of technology innovation and public policy across several sectors:
  - Innovation and competitiveness
  - IT and data
  - Trade and globalization
  - Life sciences, agricultural biotech, and energy

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# ITIF and the "CHIPS and Science Act of 2022"

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## Five Bold Steps Toward a Reimagined American Innovation Agenda

STEPHEN EZELL AND JOHN KAO | FEBRUARY 2021

There is a growing sense something is amiss with the U.S. innovation system. It's time for a vigorous initiative to restore belief in innovation's potential as a force for social and economic progress, for the benefit of America and the world.

**KEY TAKEAWAYS**

- The first step is telling the story: reclaiming a positive narrative about innovation, contextualized as "creating an inclusive innovation economy that works for all Americans."
- The second step is stewardship: defining authorities and responsibilities by convening a representative set of stakeholders to craft the outlines of a high-level agenda, recognizing it will have many owners, executors, and benefactors.
- The third step is to produce a coherent national strategy with a "whole-of-society" perspective. A wide range of players and stakeholders must be able to contribute, and an equally diverse milieu of stakeholders must benefit.
- Fourth, if it is going to be meaningful, impactful, and benefit all Americans, a renewed U.S. innovation strategy must be scalable and broadly accessible.
- Finally, a reimagined U.S. innovation system must maximize the three most importance sources of capital: human talent, intellectual capital, and financial capital.




## Why America Needs Semiconductor Legislation to Bolster Its Economic and National Security

By Stephen Ezell | January 24, 2022

# ITIF's "A New Frontier Report"


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## A New Frontier: Sustaining U.S. High-Performance Computing Leadership in an Exascale Era

STEPHEN EZELL I SEPTEMBER 2022

Continued leadership in high-performance computing (HPC) as it enters the exascale era remains a key pillar of U.S. industrial competitiveness, economic power, and national security readiness. Policymakers need to sustain investments in HPC applications, infrastructure, and skills to keep America at the leading edge.

### KEY TAKEAWAYS

- HPC represents an essential strategic national capability, and global HPC leadership depends on staying at the cutting edge of both HPC systems development as well as their application and use.
- The advent of exascale supercomputing opens doorways for researchers from a variety of fields to explore physical phenomena at a scale and level of resolution, detail, fidelity, and confidence that heretofore was scarcely imaginable.
- Competence in HPC is increasingly important to industrial competitiveness, underpinning research and development (R&D) and innovation in a range of sectors from aerospace and biotechnology to consumer packaged goods and clean energy.
- Given the critical importance of supercomputing to countries' economic and national security, many nations and regions are competing fiercely for supercomputing leadership.
- In 2015, the United States had nearly twice as many of the world's top 500 supercomputers as China. But China has flipped the script, now reporting 173 (which is even likely an undercount) versus 128 for the United States.
- To keep America at the leading edge, policymakers must leverage HPC-related funding and programs in the CHIPS and Science Act, expand its STEM (science, technology, engineering, and math) pipeline, and democratize access to HPC computing resources.

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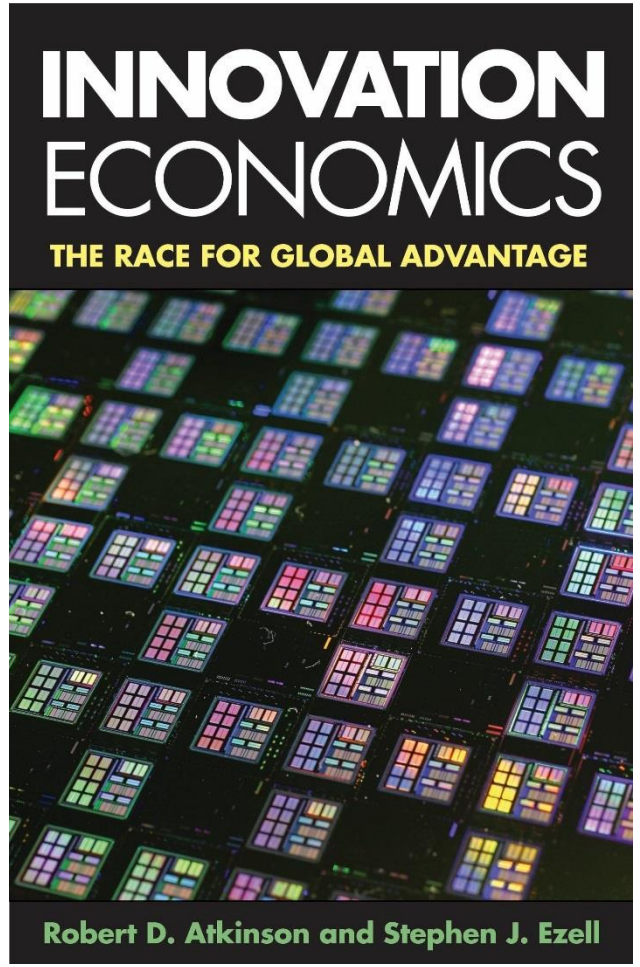
# ITIF's "A New Frontier Report"

- Why HPC Matters?
  - Confers a critical first-mover advantage to every downstream industry.
  - Generates significant economic impact for industries/regional economies.
  - Changes in technological leadership in computing architecture can shift the global landscape of technological competition.
- Some Interesting Data Points:
  - "Our university alone could use 5 times the HPC capacity we have."
  - U.S. weather/climate forecasting could utilize "100 times the current operational computing capacity."

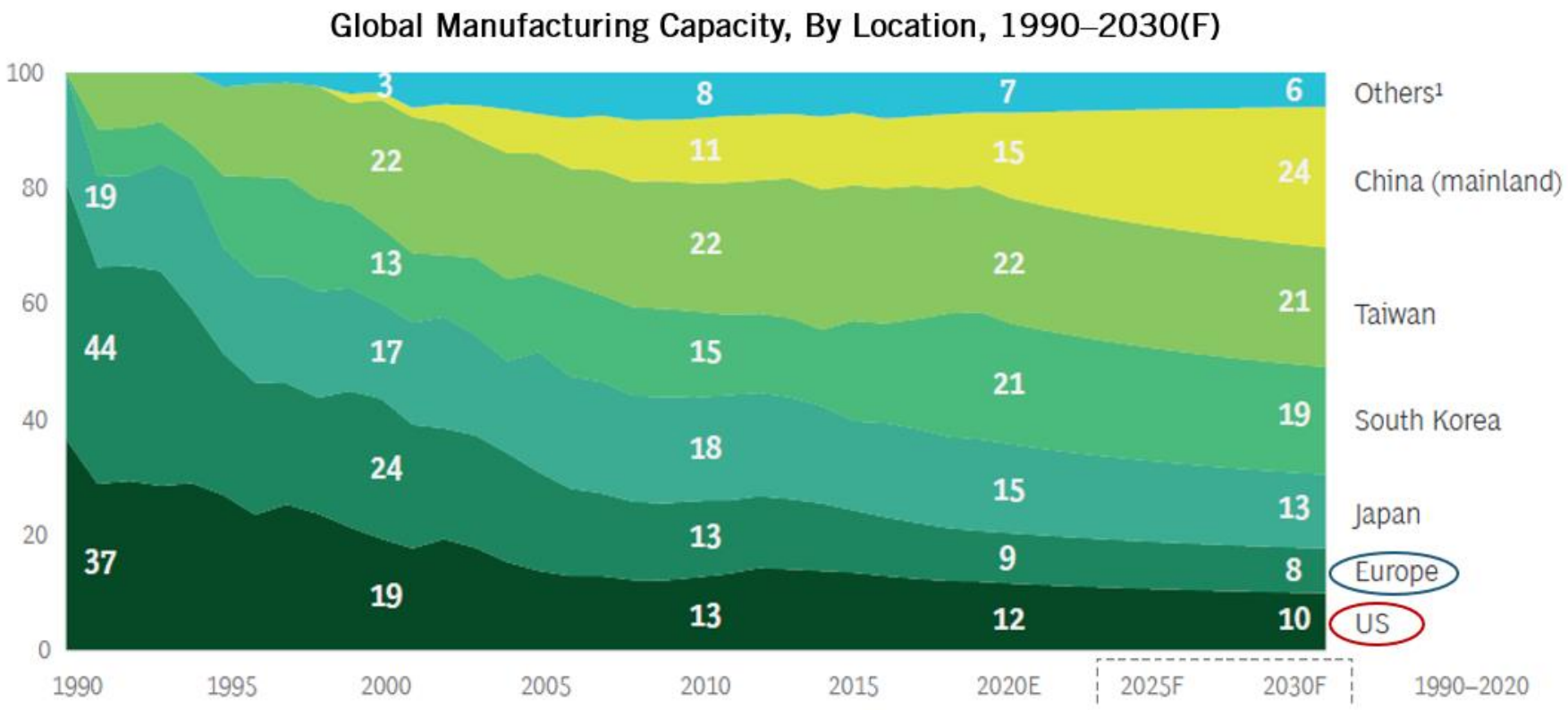
# Technology and Manufacturing Leadership Matters

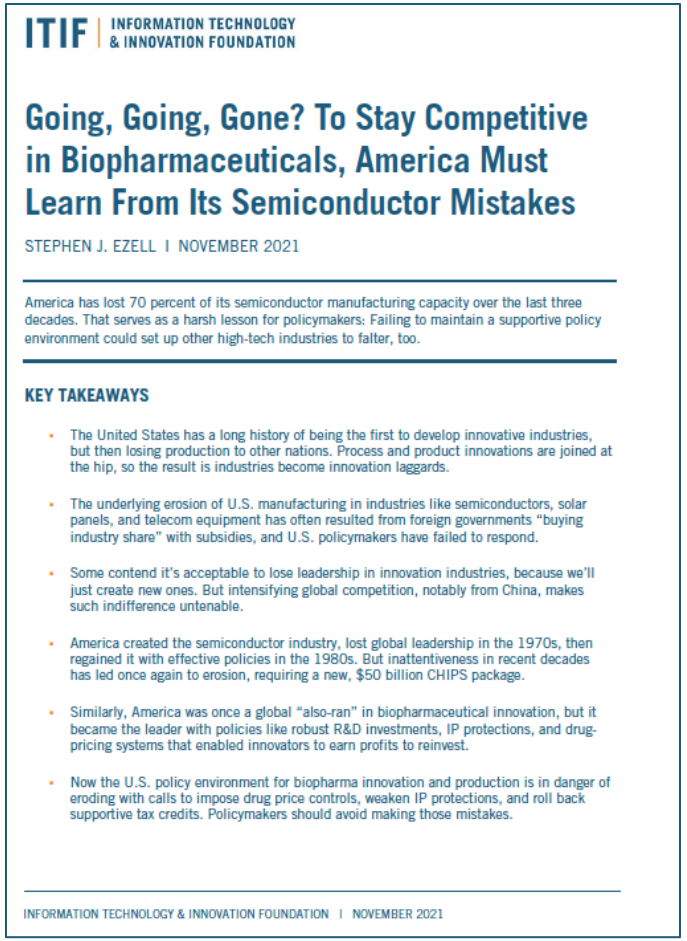
"Potato Chips…Computer Chips…What's the Difference?"
– Michael Boskin

"America's role in the world is to be a contributor of knowledge, ideas, and technology; it's not to make things."
– Lawrence Summers



# National Leadership in Advanced Technologies Never Assured



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## Going, Going, Gone? To Stay Competitive in Biopharmaceuticals, America Must Learn From Its Semiconductor Mistakes

STEPHEN J. EZELL I NOVEMBER 2021

America has lost 70 percent of its semiconductor manufacturing capacity over the last three decades. That serves as a harsh lesson for policymakers: Failing to maintain a supportive policy environment could set up other high-tech industries to falter, too.

**KEY TAKEAWAYS**

- The United States has a long history of being the first to develop innovative industries, but then losing production to other nations. Process and product innovations are joined at the hip, so the result is industries become innovation laggards.
- The underlying erosion of U.S. manufacturing in industries like semiconductors, solar panels, and telecom equipment has often resulted from foreign governments "buying industry share" with subsidies, and U.S. policymakers have failed to respond.
- Some contend it's acceptable to lose leadership in innovation industries, because we'll just create new ones. But intensifying global competition, notably from China, makes such indifference untenable.
- America created the semiconductor industry, lost global leadership in the 1970s, then regained it with effective policies in the 1980s. But inattentiveness in recent decades has led once again to erosion, requiring a new, $50 billion CHIPS package.
- Similarly, America was once a global "also-ran" in biopharmaceutical innovation, but it became the leader with policies like robust R&D investments, IP protections, and drug-pricing systems that enabled innovators to earn profits to reinvest.
- Now the U.S. policy environment for biopharma innovation and production is in danger of eroding with calls to impose drug price controls, weaken IP protections, and roll back supportive tax credits. Policymakers should avoid making those mistakes.

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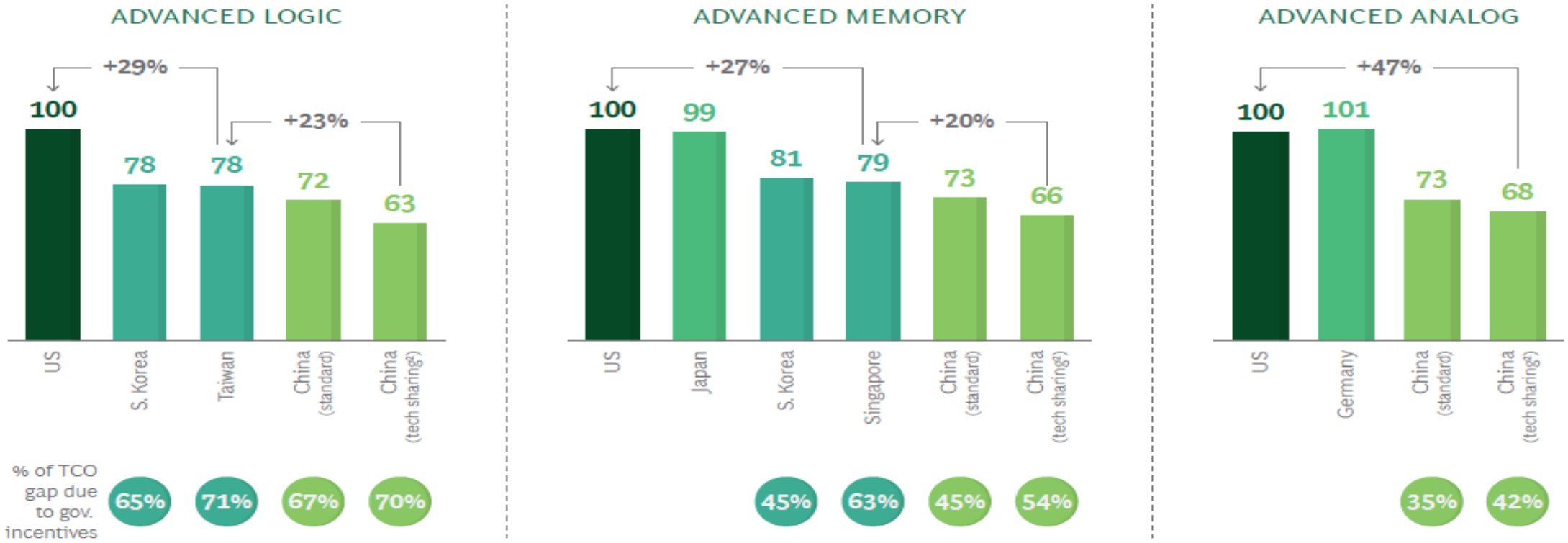
Source: BCG and SIA, "Government Incentives and U.S. Competitiveness in Semiconductor Manufacturing"
ITIF, "Going, Going, Gone? To Stay Competitive in Biopharmaceuticals, America Must Learn From Its Semiconductor Mistakes"

# Government Incentives to Attract Semiconductor Mfg.

Estimated 10-Year TCO of Reference Fabs By Location (U.S. Indexed to 100)




Source: BCG and SIA, "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era"

# CHIPS and Science Act of 2022: Top-Line Funding

- @$52 billion for CHIPS, fully appropriated:
  - $39 billion grants/incentives; $13 billion R&D; $24 billion ITC.
  - National Semiconductor Technology Consortium vitally important. Funds up to three Manufacturing USA Institutes. (10 overall in leg.)
- @$81 billion FY 23-27 for NSF: $61 billion for core science R&D activities and $20 billion for a new directorate focused on technology transfer and commercialization activities.
- Increases Department of Energy (DOE) Office of Science funding by 17% from FY 2022-2023 and provides for 6% annual increases thereafter.

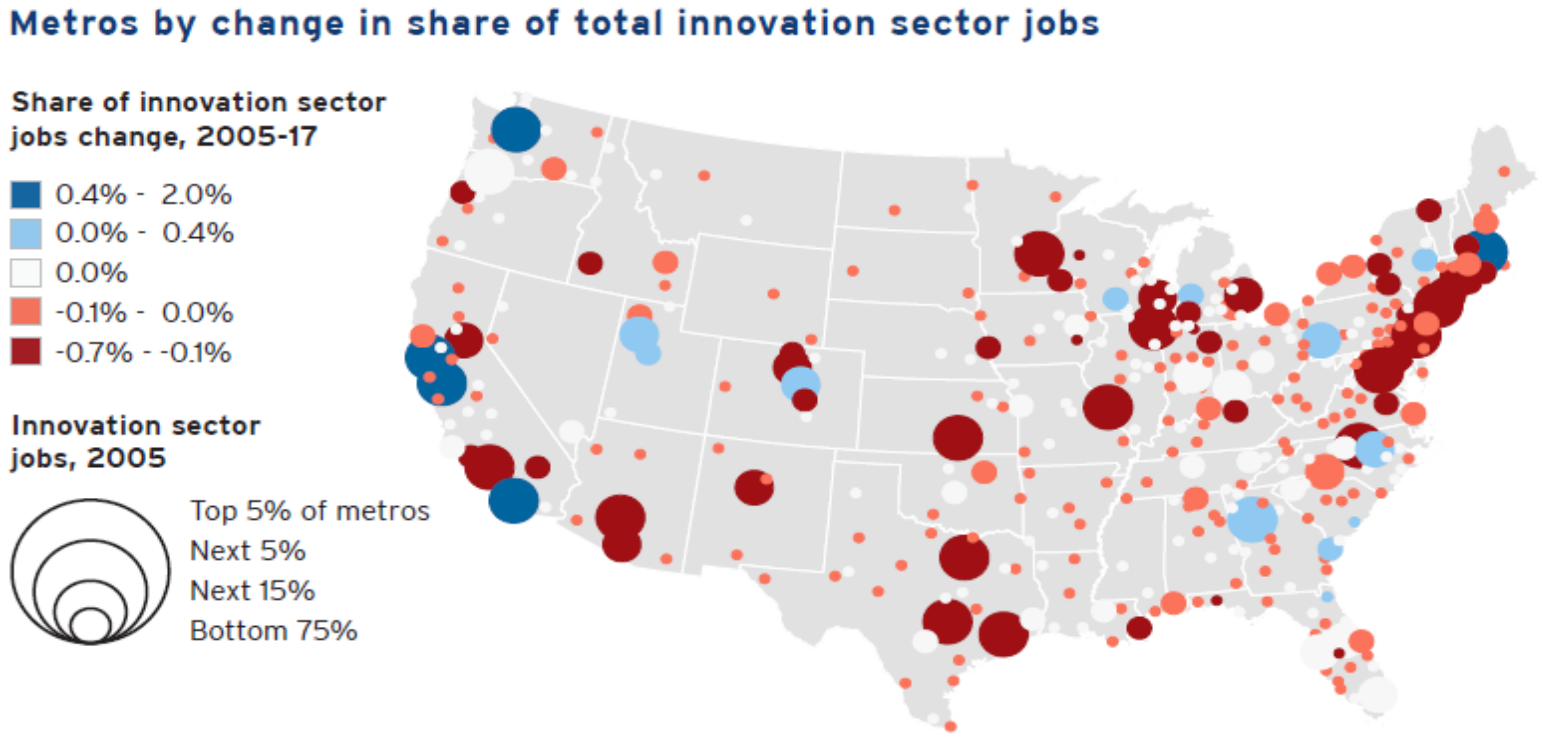
**Source:** Stephen Ezell and Stefan Koester, "Three Cheers for the CHIPS and Science Act of 2022! Now, Let's Get Back to Work"

# CHIPS and Science Act of 2022: HPC Funding/Strategy

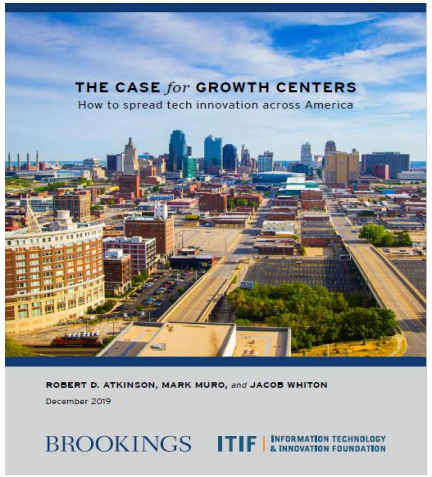
- 40% increase in funding for Advanced Scientific Computing Research (ASCR) program, growing from $1.03B FY 2021 to $1.41B FY 2027
- NDAA: Increase funding for DOE NNSA's Advanced Simulation and Computing program at a similar level to the ASCR increases (i.e., 40%).

# CHIPS and Science Act of 2022: Technology Hubs & HPC

- Act authorizes $10 billion over five years to create 20 geographically distributed "regional technology and innovation hubs."



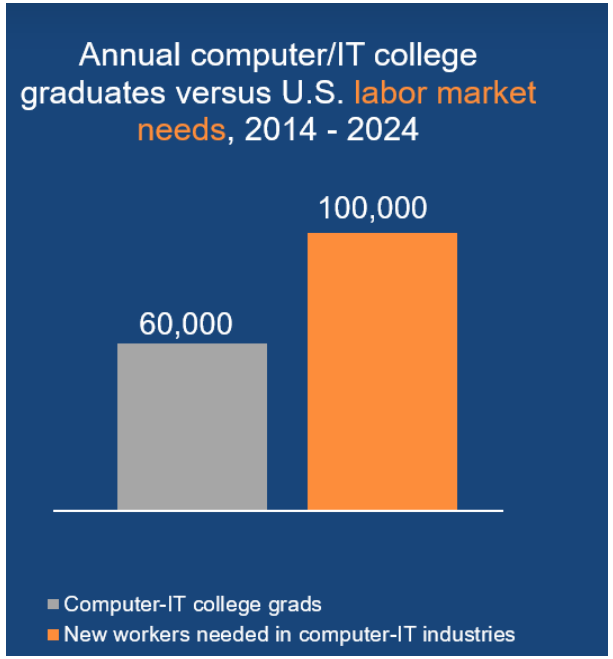

*One-third of jobs in innovation-based industries are concentrated in just 14 U.S. counties.*




Source: ITIF and Brookings, "The Case for Growth Centers: How to Spread Tech Innovation Throughout America," December 2019

# What More Needs to Be Done?

- Dramatically ramp up U.S. STEM education initiatives, especially in the electrical engineering and computer science fields.
  - @80% students pursuing EE/CS degrees at U.S. universities at Masters/PhD level are foreign born.
  - We'll graduate 400K fewer IT/college graduates than we need from 2014 to 2024.




Source: Mark Muro, "Digitalization and the American Workforce"

# What More Needs to Be Done?

Only one-third of working-age Americans possess even limited digital skills. One in six are unable to use email, web search, or other basic online tools.

- Double the number of U.S. STEM Charter Schools.
- Have all U.S. high schools teach computer science.
  - Share went from 35% in 2018 to 51% in 2021, but more CA high schoolers take pottery.
- Enhance R&D tax credit generosity; establish a knowledge tax credit.

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**Assessing the State of Digital Skills in the U.S. Economy**

STEPHEN EZELL I NOVEMBER 2021

An increasingly digitalized global economy requires ever-more digitally skilled workforces for nations to remain productive. Unfortunately, domestic and international assessments of digital skills show the United States is lagging its competitors.

**KEY TAKEAWAYS**

- According to the OECD, fully one-third of working-age Americans possess even limited digital skills. One in six are unable to use email, web search, or other basic online tools.
- The United States ranks just 29th out of 100 countries for the digital acumen of its workforce in business, technology, and data science, according to Coursera.
- This comes against a backdrop of increasing digital skills requirements for many U.S. occupations. Brookings found that whereas only 44 percent of U.S. jobs required medium-high digital skill levels in 2002, 70 percent did by 2016.
- Digital skills are critical to higher wages: Jobs that incorporate higher levels of digital content pay more—in fact, for every 10 percent increase in ICT-task intensity, the average U.S. worker's salary increases 4 percent.
- The United States needs to increase its number of computer science graduates and concentrate particularly on women, who represented 37 percent of U.S. computer scientists in 1995, but just 24 percent today.
- The United States needs to significantly increase its investment in workforce training, including for digital skills. As a share of GDP, the federal government now invests less than half as much in such programs as it did 30 years ago.
- With corporate investment in workforce training also falling by 30 percent as a share of GDP from 1999 to 2015, Congress should expand Section 127 tuition credits.

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Source: ITIF, "Assessing the State of Digital Skills in the U.S. Economy"

# An Allied Approach to Semiconductor Competitiveness

Collectively advance the competitiveness of like-minded nations' semiconductor industries through:

1. Coordinated technology development.
2. Coordinated ecosystem support.
3. Coordinated technology protection.
4. Supportive trade policy, regimes, and practices.

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**An Allied Approach to Semiconductor Leadership**

STEPHEN EZELL I SEPTEMBER 2020

Many countries rightly seek to maximize their value added in the global semiconductor industry. But like-minded allied nations can also advance their leadership collectively by collaborating on technology and ecosystem development, intellectual property, and trade liberalization.

**KEY TAKEAWAYS**

- The semiconductor sector constitutes one of today's most important industries, providing the core technology that powers the modern digital world and spurs innovation and productivity across virtually every sector of the economy.
- The increasing expense, complexity, and scale required to innovate and manufacture semiconductors means that no single nation or enterprise can go it alone. In the face of challenges from China, allied cooperation in semiconductors is critical.
- Successful semiconductor innovation depends on scientists, researchers, and engineers working together internationally across companies, universities, government agencies, research institutions, and public-private research consortia.
- Each segment of the global semiconductor value chain has, on average, enterprises from 25 countries involved directly, and enterprises from 23 countries in support functions.
- Some nations have focused on building their domestic semiconductor ecosystems, but the U.S. industry's track record of success shows how to effectively leverage global supply chains for mutual benefit.
- Countries that would seek self-sufficiency in the sector, especially through unfair mercantilist means, risk inflicting considerable damage on the industry, slowing global semiconductor innovation.
- The United States should increase funding for collaborative, pre-competitive R&D and incentives for greater domestic production.

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Source: ITIF, "An Allied Approach to Semiconductor Competitiveness"

# Coordinated Semiconductor Technology Development Activities

- At the 3-10 year timeframe there exist opportunities for pre-competitive research collaborations that nations wouldn't likely undertake alone.

✓ The SRC-led Decadal Plan for Semiconductors develops strategic ecosystem vision to solve common challenges, align key stakeholders.

✓ Identify long-term semiconductor sector moonshots and encourage allied participation therein (with benefits proportionate to investment).

  - Develop affordable desktop semiconductor fabrication facilities;
  - Build a commercial, gate-based computer to work on large-scale problems.

# China's Threat to Global Semiconductor Innovation

- China's $170 billion National IC Plan targets global semiconductor leadership.
- Seeks import substitution and autarkic outcome.
- Distorts global markets with massive subsidization, state-financed foreign firm acquisitions, IP theft, etc.

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**Moore's Law Under Attack: The Impact of China's Policies on Global Semiconductor Innovation**

STEPHEN EZELL | FEBRUARY 2021

China's mercantilist strategy to grab market share in the global semiconductor industry is fueling the rise of inferior innovators at the expense of superior firms in the United States and other market-led economies. That siphons away resources that would otherwise be invested in the virtuous cycle of cutting-edge R&D that has driven semiconductor innovation for decades.

**KEY TAKEAWAYS**

- No industry has an innovation dynamic quite like the semiconductor industry, where "Moore's Law" has held for decades: The number of transistors on a microchip doubles about every two years, producing twice the processing power at half the cost.
- The pattern persists because the semiconductor industry vies with biopharmaceuticals to be the world's most R&D-intensive industry—a virtuous cycle that depends on one generation of innovation to finance investment in the next.
- To continue heavy investment in R&D and CapEx, semiconductor firms need access to large global markets where they can compete on fair terms to amortize and recoup their costs. When they face excess, non-market-based competition, innovation suffers.
- China's state-directed strategy to vault into a leadership position in the semiconductor industry distorts the global market with massive subsidization, IP theft, state-financed foreign firm acquisitions, and other mercantilist practices.
- Inferior innovators thus have a leg up—and the global semiconductor innovation curve is bending downward. In fact, ITIF estimates there would be 5,100 more U.S. patents in the industry annually if not for China's innovation mercantilist policies.
- To address the challenge Chinese innovation mercantilism poses to the semiconductor industry, the United States needs to work with like-minded nations while enhancing its own innovation capacity in the sector.

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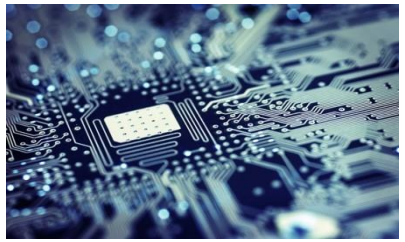
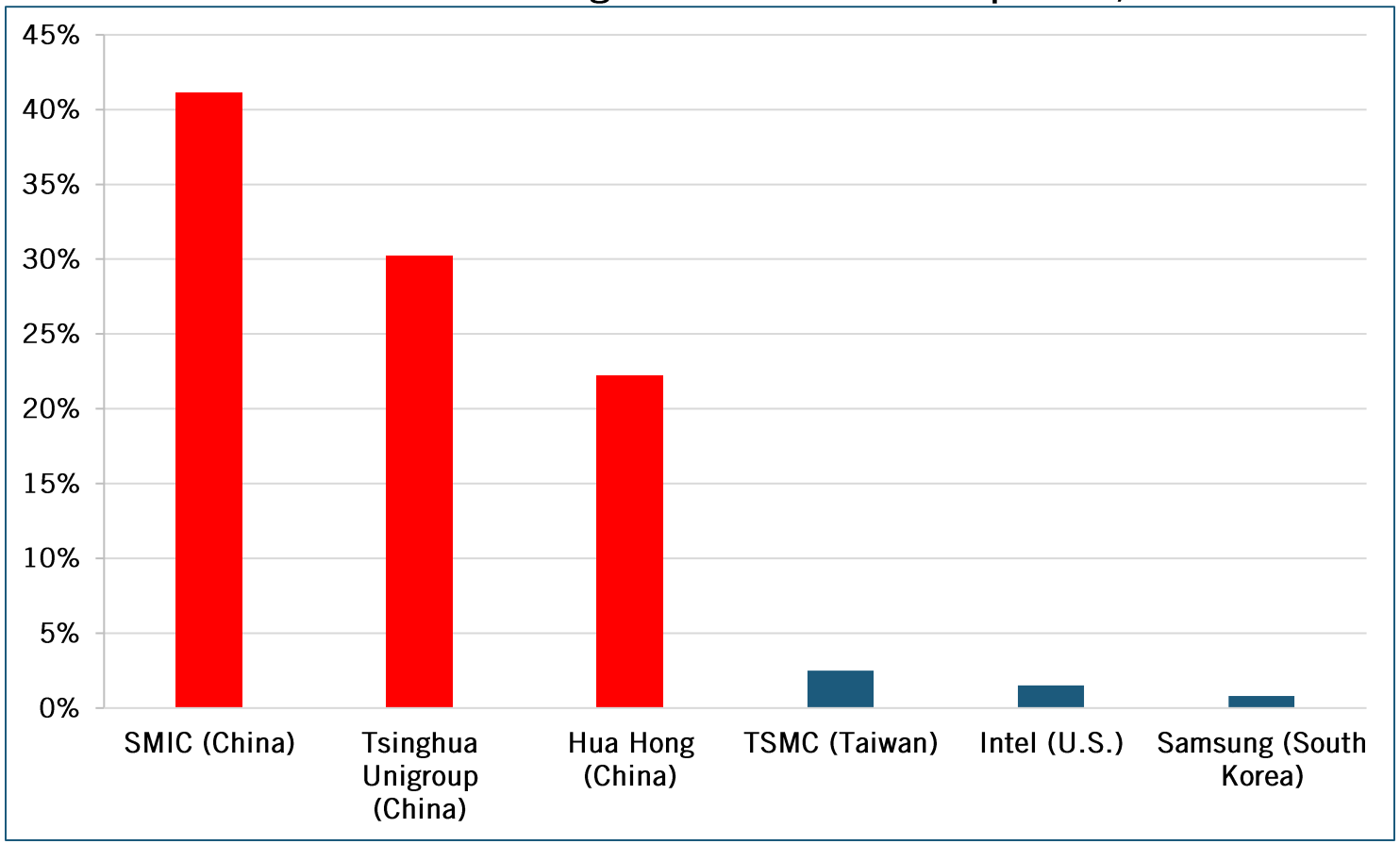
Source: ITIF, "Moore's Law Under Attack: The Impact of China's Policies on Global Semiconductor Innovation"

# Chinese Subsidies to the Semiconductor Industry

- OECD: "86% of identified global semiconductor subsidies from 2014-2018 to Chinese firms."
- "A direct connection between equity injections by Chinese gov. and new Chinese semi fabs."
- YMTC stood up by whole cloth.



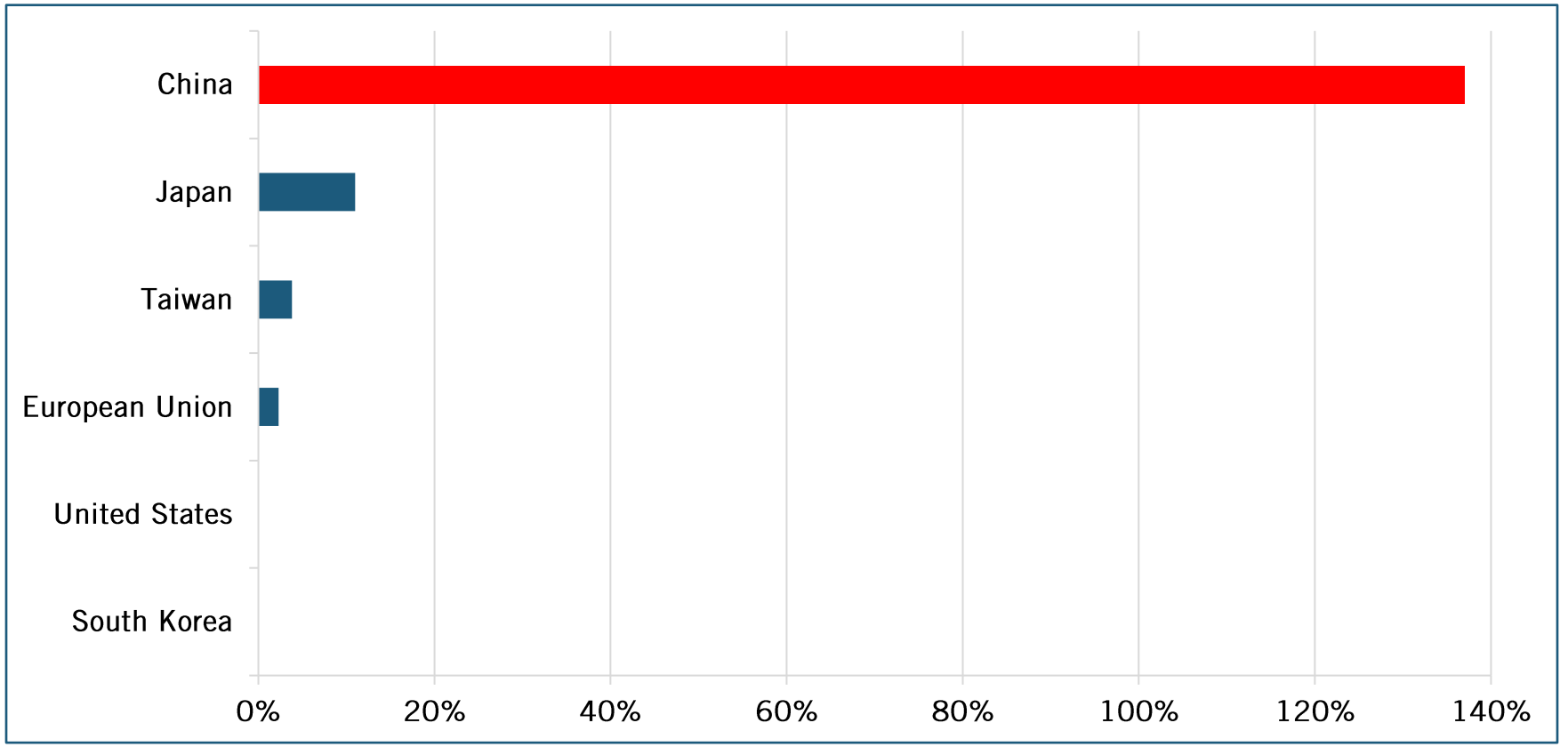
State Subsidies as a Percentage of Revenue for Chip Fabs, 2014-2018




Source: OECD, "Measuring Distortions in International Markets: The Semiconductor Value Chain"

# Chinese Subsidies to the Semiconductor Industry

Estimated Value of Total Semiconductor Sector Funding Assistance as a Percentage of Global Sales, 2019




Source: Peter Cowhey, "Expanding the Analysis of Subsidies and Semiconductors," World Semiconductor Congress, 2019

# Trade Policy Recommendations

- ✓ Rearchitect the global ICT economy to allied advantage.
- ✓ Work with allies to align semiconductor incentives and export control policies.

  Do we need an “Aircraft Sector Understanding” (ASU) for semiconductors?

- ✓ Expand the Information Technology Agreement (ITA).

# Thank You!

Stephen Ezell | sezell@itif.org | 202.465.2984

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